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January 25th, 1895 … … … …	STEEL PLATE PORTRAIT OF MR. R. E. CROMPTON, *President of the Institution of Electrical Engineers.*

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NOTES.

It is well known that the defective supply of the City of London Electric Lighting Company has been attributed to the temporary nature of the plant, and surprise has been expressed that the permanent equipment should have been so long delayed. The Thomson-Houston plant has given so little trouble that its existence has been almost forgotten. We learn from Messrs. Willans and Robinson, of Thames Ditton, that they have just received from the British Thomson-Houston (Limited), for the Bankside station of the City of London Lighting Company, one of the most important orders ever given for electric light engines. There are eight engines, each of 700 I.H.P., coupled direct to Thomson-Houston alternators, to be supplied. We learn that the British Thomson-Houston (Limited) have the complete order—of which this forms a part—for the entire plant: engines, dynamos, boilers, pipes, exciter plant, &c. They have already at this station put down four Willans engines of 300 I.H.P., each coupled direct to their alternators, and it is, no doubt, owing to the excellent working of these sets that the order for more of the same type has been given. The alternators will be of 400-kilowatt output, with separate exciters: a combined efficiency of 80 per cent. is stipulated in the specification, and the British Thomson-Houston (Limited) inform us that they have every reason to expect that this will be exceeded. We are glad to learn that although one or two of these alternators will be imported, the bulk of the order will be manufactured in this country. So little has been heard about the Thomson-Houston alternator of late, that it is commonly supposed to be a somewhat inefficient machine electrically, but that, owing to the great self-induction of the armature, it may be short-circuited without damage. This feature, which has more than once saved the City lighting from collapse, has been regarded as bought at the cost of a large coal bill. The British Thomson-Houston (Limited), however, do not for a moment admit this, and, in reply to our inquiries, they inform us that the proposed improvements in the new machines relate to the regulation only, that the efficiency will compare well with other machines, and that they will be short-circuitable, as usual.

We conclude in the present issue Mr. E. J. Wade's series of articles on "The Chemical Theory of Accumulators." Electrical engineers who have to do with accumulators, and who may be desirous of obtaining a bird's-eye view of how their chemical *confrères* explain the complex reactions which are at the same time such a scientifically interesting and such a practically irritating feature of the storage cell, will be grateful to the author for giving them such a lucid *aperçu* of the whole business. Mr. Wade has not brought forward any brand-new theories of his own, but simply discusses the leading theories in existence, and, by taking this man's explanation of one phenomenon and that man's explanation of another, succeeds in presenting to his readers a tolerably coherent and comprehensive theory, which does not, however, it must be confessed, hold out much hope of revolutionary improvement along present lines.

Our correspondent who signs himself "Consulting" replies this week to our comments on his letter of last week. A fair definition of "unfairness," it seems to us, is that of "taking a mean advantage." Our correspondent gives, as an instance of what *he* considers to be unfair competition in house-wiring, that which arises when a firm of cable manufacturers tenders for the job. Last week he instanced as a case of fair competition that of an electrical sundries manufacturer. His reason for this "nice derangement of epitaphs" is that in the former case one-third, in the latter one-eighth, of the total value of the goods fitted are made by the contractor. If our correspondent were to argue that house-wirers must in no case be manufacturers, we should not, indeed, be able to agree with him; but at any rate it would be possible to understand his logic.

"Consulting" further considers that we have overlooked the possible disadvantage to cable makers of their going in for house-wiring. If he will again read our comments of last week he will see that we said that, whilst there could be no doubt as to the "fairness" of the proceeding, its wisdom was a matter of opinion. Again, our correspondent seems to think that the wiring of houses by electric supply companies at cost price must of necessity result in nastiness as well as cheapness. Judging by our experience of gas stove fitting by the gas companies, cheapness and niceness would seem the more probable; and an electric supply company would have even more reason than a gas company to see that the house fittings were properly put in.

The decision of Mr. Justice Romer in the "Worthington" pumping-engine case is one which possesses an interest for engineers and manufacturers. The Worthington Pumping Engine Company, which still manufactures under expired patents the well-known "Worthington" steam-pump, brought an action against the Naval Construction and Armaments Company for selling engines of similar construction bearing the same trade name, but not manufactured by the plaintiff Company. A fine point of law was involved as to the legality of naming goods after the name of the inventor when not made by the original patentee, or by a purchaser of the patent. It is as if the right of an electrical manufacturer to advertise dynamos provided with "Gramme" armatures had been called in question, or as if he might be prohibited from selling "Bell" telephones which have not been manufactured by the former holders of the "Bell" telephone patents. Mr. Justice Romer's decision was to the effect that the defendant Company might continue to name and advertise their pumps as formerly, on the understanding that the defendant Company would not pass off their pumps as Worthington pumps in such a way as to lead purchasers to suppose they were pumps supplied by the Worthington Pumping Engine Company.

◆

It is impossible to call in question the wisdom of this decision, which steers very judiciously between two very objectionable alternatives. On the one hand, it would be not a little inconvenient to manufacturers in general if an article, the patent for which had expired, might not be given the name by which it had become popularly known during the period of the patent. The Gramme armature, the Bell telephone and Watt's parallel motion are cases in point. On the other hand, it would be very unfair if any rival who chose to do so might offer for sale inferior imitations of such an article, without giving the slightest intimation that it was not the manufacture of the original patentee company. What injustice it would be, for example, if unscrupulous foreign firms might place on the English market a number of so-called "Swan" lamps without the least indication that they were "made in Germany."

◆

Having been informed that a Paper on the "Theory of Two- and Three-Phase Motors" had been read before the American Institute of Electrical Engineers, and being desirous of placing before our patient readers all that might possibly be of use in the contemporary writings on this apparently recondite subject, we hunted up the aforesaid Paper. Of course, we were prepared to find a few minor "assumptions" in any mathematical discussions which the author might venture upon. No self respecting up-to date electrical mathematician would think of taking *all* the practical considerations into account; he would feel himself bound to assume the absence, or distortion, or constancy where there is no constancy, of some of them. But when we encountered in this Paper no less than 13 pages of analytical mathematics, prefaced by the following interesting qualification, we decided to postpone the publication of an abstract of it *ad Kalendas Graecas*:—

> "The complete mathematical solution of the two- and three-phase motors with the coefficients of self-induction as variables, and the effect of magnetic leakage taken account of, is extremely difficult, if not impossible. But an approximate solution in which the change of magnetic properties of the iron and magnetic leakage are neglected, the coefficients of self induction considered constant, while the mutual induction between the armature and field circuit follows a sine law, and the field supposed to be without projecting pole pieces, is quite easy. We will then proceed to the solution with these assumptions."

Cable Interruption: Date of Interruption.
Zanzibar-Mombasa.......... .... September 4. 1894.

Swan Patent.—The Swan "parchmentised cotton filament" lamp patent, No. 4,933, of November 27th, 1880, expired on Saturday last.

Bolton.—The new municipal electric supply station was formally opened and the supply commenced last Wednesday afternoon. The high-pressure alternating-current transformer system has been adopted.

Storage Battery Litigation in America.—The Accumulator Company of Philadelphia (the owners in America of the Swan and other patents known as the E.P.S.) have obtained a preliminary injunction issued by Judge Lacombe in the United States courts against the manufacturers of the Chloride Storage Battery.

Electric Quackery.—Speaking of the electric current in relation to health, a Chicago newspaper says that it knows of a woman who has "gained twenty pounds by the use of her battery." That is nothing: we know of a man who has gained thousands of pounds by other people using his battery.

Electricity in Mining Work.—According to a report which reaches us from a German source, the Siemens and Halske process of treating "tailings," and which is now being tried, is giving most satisfactory results. It is claimed that it is cheaper to work, recovers more gold, and of better quality than the MacArthur-Forrest process hitherto in use. The firm have some hope of ousting the latter process altogether.

The Electric Light at Bristol.—We hear in connection with the extension of the electric light to Clifton that the Clifton College authorities will take for the College and the masters' houses near it as many as 1,000 incandescent lamps. This should prove a very satisfactory matter for the municipality, not merely because of the large number of lamps, but also because their use will probably be long and regular.

Largesse.—The total number of exhibitors at the Antwerp Exhibition amounted to 12,000, to whom 401 grand prizes, 812 diplomas of honours, 1,813 gold and 2,238 silver medals have been awarded; that is to say, to nearly half the exhibitors. Great Britain, Australia, Canada, and India have furnished 271 exhibitors, who have received 21 grand prizes, 42 diplomas of honour, 105 gold, 79 silver, and 46 bronze medals, and 38 honourable mentions, or actually more honours than there were exhibitors!

Geodesy and the Telegraph.—It is proposed, says the *Engineer*, to engage three survey parties during the coming season in determining by telegraph the difference between Karachi and Greenwich. The work will consist in the telegraphic measurement of certain arcs of longitude taken viâ Teheran, Odessa, and Lowestoft. The operations will probably extend over at least a year, and the subsequent calculations are not expected to be completed until the end of March, 1896.

Electric Traction in Germany.—The steam tramway running between Frankfort and Eschersheim is to be converted into an electric line. The necessary permission having just been given, work is about to be commenced on the construction of an electric tramway at Leipzig. Electricity is to be adopted as the motive power on the tramways at Dantzig. The work will be carried out by the Allgemeine Electricitäts Gesellschaft, of Berlin. There is an agitation on foot for the construction of a system of electric tramways at Heilbronn.

Lectures on Polyphase Currents.—A short course of lectures on polyphase current working will be given at Finsbury Technical College by Prof. Silvanus P. Thompson, on Mondays, at eight p.m., through the month of November. The first lecture deals with polyphase generators, the second with the history and development of the rotatory field motor. The third is devoted to the theory of non-synchronous motors; and the series concludes with some account of the tests on modern types of alternate current motors, their construction, and methods of starting and regulations.

Telegraphy in Queensland.—During the last twelve months telegraph construction in Queensland has been practically at a standstill. A very considerable amount of heavy work has, however, been done since the disastrous floods of February, 1893, in raising the main wires between Brisbane and Ipswich, and from South Brisbane to Corinda. Everything possible has been done on these sections, the wires of which are stated to be now above the limit of any flood yet recorded. There are now 10,004$\frac{1}{4}$ miles of line, and 17,810$\frac{1}{2}$ miles of wire open for public business in Queensland.

Telegraph Pole Setting.—A French engineer's recipe for preventing the decay of telegraph poles immediately below the surface of the ground is to protect them by excavating the soil around the pole, to clean it thoroughly from soil and all decaying wood, and then to give it a coat of hot tar. The pole is then surrounded by a sleeve of glazed earthenware, which is made in semicylindrical halves, to facilitate the putting in place. The annular space between this sleeve and the pole is then filled with some dry material, which is finally capped with a waterproof layer of asphalte or some similar material. The cost is said to be 2s. per pole.

French Cable Companies.—The *Journal des Debats* makes the following announcement: The Minister of Commerce, Posts and Telegraphs, with the sanction of the Council of Ministers, has signed a decree, dated October 27th, which authorises the French Paris-New York Telegraph Company to transfer to the French Submarine Telegraph Company the rights and charges of the concession granted to it on January 7, 1879, for the establishment of a submarine trans-Atlantic cable. This decision officially confirms and renders definitive the amalgamation of the two companies agreed upon by the meetings of their respective shareholders.

Electric Motors on Men-of-War.—The four new French armoured cruisers, "Latouche-Tréville," "Charner," "Chanzy," and "Bruix," are each to carry electrical machinery for the loading and elevating of their guns and the training of their turrets. The machinery of the first-named is now completely fitted. It is somewhat similar to that which was fitted two years ago by the Société des Forges et Chantiers de la Méditerranée in the Chilian armoured cruiser "Capitan Prat," but it embodies improvements. Electrical machinery of a like kind is being fitted in the battleship "Jauréguiberry," and is to be fitted in the first-class cruiser "D'Entrecasteaux."

How a Dynamo Works.—Most of us have, at one time or another, experienced a difficulty in making it clear to a non-technical friend how a dynamo works. The following explanation, given by an American *daily*, shows how the matter may be compressed into a few words by the sacrifice of accuracy and detail :—

> "Each machine was propelled by means of a wide leather belt passing through a pulley at the end of the dynamo. The pulley revolved at a very rapid rate—some 600 or 700 revolutions per minute—and the electricity was generated by the pulley causing another wheel in the middle of the machine to revolve among some coils of wire. The electricity was then collected, and taken away at the far end of the machine, away from the pulley that supplied the power from the steam engine."

Speed and Fuel.—As showing the effects of high train speed on coal consumption, the following report made by a committee of the American Master Mechanics' Association at their late convention is of interest : "The time of a train scheduled to make 100 miles in 4$\frac{1}{2}$ hours with six cars and 27 stops was reduced to four hours, and immediately the fuel bill of the train increased $100 per month with the same engine and men. When the running time was changed back to 4$\frac{1}{2}$ hours, the fuel record at once dropped to its old figures." This serves to illustrate the costliness of wind friction, which increases with the speed, and which is the same, of course, whether the coal is burned on the locomotive or in an electric railway generating station.

To Give Polarity to a Needle.—In a quaint-looking electrical periodical published in 1845, namely, Vol. 1. of Walker's *Electrical Magazine*, the following incomprehensible recipe for "giving polarity to a needle" is extracted from "Jesuits' Letters from China":—"Equal quantities reduced to fine powder of cinnabar, realgar—male or female and steel filings. Mix up with blood (from a cock's crest). Cover the needles with the mixture, wrap them in paper, and put them in an oven, under which you will keep a charcoal fire for seven days and nights. This done, wrap them and carry them next your skin for three days; they will then serve for the mariner's compass." What had the heathen Chinee been telling the missionaries? It reads like a blend of the witches' incantation in "Macbeth" with the cementation process for making steel.

Heating by Combustion and by Electricity.—Herr A. Wilkie, says the *Journal of Gas Lighting*, discusses certain experiments made by Mr. J. L. Roberts with the object of ascertaining the comparative efficiency of heating by electricity and by combustion. Mr. Roberts heated masses of metal (rods of platinum and iron) to a red heat, first by combustion methods, and then by the electric current. When the substance was heated by a flame, the energy expended was calculated from the loss of weight of the combustible, and the corresponding calorific power; when electrical energy was used, the energy expended was calculated from the current and voltage. In the first series of experiments, a platinum rod was heated in the flame of a spirit-lamp, and also by passing a current through it. When red hot, it was dropped into water. The results showed that less than 0·5 per cent. of the thermal energy produced in the flame was transferred to the bar, whereas 90 per cent. of the electrical energy appeared as heat. In the second series of experiments, an iron bar weighing about a kilogramme was heated, first by means of well-dried charcoal, and then electrically. In the former case, about 0·75 per cent. of the thermal energy was transferred to the bar, in the latter case 88 per cent. was thus accounted for. These experiments are admittedly crude; but they show sufficiently well, says our gas contemporary, "that for some purposes electrical heating has claims to consideration."

Changes of Length Due to Magnetisation.—A careful investigation of these complex phenomena has been carried out at Berlin by Mr. H. Nagaoka, who publishes his results in the current number of *Wiedemann's Annalen*. The metals investigated by the Japanese physicist were iron, nickel, and cobalt, and the method of observing the changes of length was by the optical lever in preference to the interference fringe method. The metals were given the form of ellipsoids, so as to ensure the magnetisation being uniformly distributed. The behaviour of the three metals in gradually increasing positive and negative magnetic fields was fundamentally different. In iron the length increased gradually at first with increasing field intensity, then the elongation became more rapid and reached a maximum at an intensity of 240 C.G.S. units, after which it fell asymptotically below its original value, having reached the latter at 305. On reversing the magnetisation, the changes of length showed a very perceptible hysteresis. The maximum elongation was between four and five millionths of the length. Nickel showed no elongation, but a shortening approaching a limiting value at higher intensities. Cobalt showed an exactly opposite behaviour to iron, since it shortened at first gradually, then more rapidly passed through a maximum, and then lengthened asymptotically; but the maximum required a higher field intensity. A study of the relation between elongation and magnetisation shows that for all three metals the change of length stands in an approximately linear relation to the square of the magnetisation. Joule's law for iron also applies to nickel and cobalt in the case of feeble magnetisations.

Earth Current Phenomenon.—A writer in the *Electrical World* of New York mentions the following peculiar phenomenon on a single-wire telephone circuit: A short telephone line running south-east and north-west had an ordinary extension bell at its southern end, and a battery of three cells; at the northern end was a magneto relay and local battery and bell. The battery at the southern end was set up some two months ago, and so connected that its electromotive force was in the same direction as that of an earth current which was found to exist. Sheet-iron plates having an area of 4 square feet each were used at each end. The first heavy thunderstorm since putting up the line occurred on September 16th, when the line refused to work. On testing with the transmitter battery and a galvanometer in circuit the electromotive force of the earth current was found to have changed sign, and was consequently in opposition to the electromotive force of the cells. The transmitter cell was then placed in the circuit with the same polarity as that of the earth current, with the result that a call was established at the other end of the line.

The battery of three cells was again tried, but refused to work until connections were reversed. A few days later, on the approach of a similar storm, the relay, which has a resistance of 20 ohms, and is not very delicately adjusted, had to be disconnected to prevent the local bell from running continuously. Such a strong earth current over a line of less than one mile in length appears to be somewhat remarkable.

A New Car Wheel.—A new style of car wheel has been brought out by a Philadelphia firm under a patent granted to Mr. L. R. Faught, their mechanical engineer. The peculiarity of the wheel, says the *Street Railway Gazette* of New York, consists in the rim being divided circumferentially into a series of cavities or cells located between the inner and outer diameter of the rim of the wheel. The cells diminish the heavy body of metal usually massed in the rim, reducing particularly the thickness of the part which forms the tread, but in such a manner as not to decrease its strength. Several advantages are claimed for this form of wheel. It overcomes, it is asserted, the difficulties ordinarily attending the production of a deep, durable, and uniform chill on the tread of heavy wheels intended for use under severe conditions of service. In casting a heavy wheel of ordinary form the heat of the mass of metal in the rim, and also that communicated through the arms or spokes, has a tendency to reduce the depth of the chill so that the necessary strength is obtained at the expense of durability of the tread, and this in spite of the fact that the heavy loads carried call for increased rather than diminished hardness on the tread, as well as greater strength. The rim of wheel is more elastic under the strains and concussions of severe service, it is stated, and the comparatively light section of the rim insures the metal being more dense and, consequently, harder in the chilled portion, from the well-known fact that smaller bodies of cast-iron are denser than greater ones. The light section also reduces any tendency to blowholes and shrinkage cavities. The cellular section equalises the shrinkage strain on the wheel at the time of casting, lessening, it is claimed, any tendency to fracture from heating caused by excessive or prolonged use of brakes. The cellular form of rim does not necessarily alter the weight of wheel; but wheels of this form, the manufacturers claim, are stronger for the same weight than the ordinary form. It is held that the principle of a cellular tread is applicable to all forms of cast-iron or cast steel wheels.

Nottingham.—After long and careful consideration the Nottingham Town Council decided, by the aid and advice they had obtained from Dr. John Hopkinson and Mr. Preece, to take in hand the supply of electricity themselves, they being already the suppliers of both gas and water. Accordingly an Electric Lighting Order was obtained in 1890. The compulsory area includes eighteen of the principal streets in and around the market place, the business centre of the borough. For the appointment of electrical engineer 117 candidates presented themselves. Mr. Herbert Talbot, of Chelsea, was chosen in 1892. The three-wire system has been adopted. The station is situated about 300 yards from the Great Market Place. The boiler-house contains three boilers of the Lancashire type, and work at a steam pressure of 115lb. In the main flue is fixed a Green's fuel economiser of 128 tubes, and there is a Berryman's feed-water heater. The steam pipes are by Messrs. Lloyd and Lloyd, of Birmingham, and are of mild steel: in the engine room the steam mains are of the ring form fed at different points from the boiler-room main. The main steam pipes are 8in. bore [illegible] steel. Willans engines are used—there are three of 80 H.P. and three 131 H.P., and space for an additional one of each size. The dynamos are Siemens' shunt wound, and have bar armatures. The three smaller ones have an output of 330 amperes at 145 volts when running at 440 revolutions. The three large ones have an output of 370 amperes at 220 volts when running at 390 revolutions per minute. The smaller machines are used for charging the accumulators, and for balancing between the centre cable and either of the outside distributors, while the three large dynamos are used on the outside feeders only. There are 112 K type cells in the accumulator room capable of giving 150 amperes at 212 volts for seven hours, or 500 amperes at 210 volts for one hour. The end 13 cells of each set are led to the adjusting bar on the centre panel of the switchboard, each side having 56 cells capable of varying from 43 cells to 56 cells as required. The mains, &c., were laid by the Callender Bitumen Company, drawn into bitumen conduits. The Great Market Place is extremely well lighted by a large number of arc lights. Considering the short time the current has been available it has been well received, there are about 70 consumers and nearly 1,000 amperes output on heavy load nights.

Electric Smelting in Germany.—The United States Consul-General at Frankfort has much to say concerning the Taussig process of electric smelting under the influence of rarefied air. The Taussig plant includes a long, air-tight smelting chamber, the hearth of which inclines to a central orifice, through which the fused metal passes into the moulds. The necessary heat is generated by passing a current through the mass without the employment of carbon electrodes. For smelting raw ores, the most obvious advantage claimed for this process is that it can be worked wholly by water power, and without fuel, in mountainous and remote districts which produce ores, and have abundant water, but no coal. For fusing iron, steel, or other metals for casting, the advantages claimed are rapidity of operation, improved quality in the castings, susceptibility of continuous working, and—even where steam-power is used to generate the current—an economy in fuel which is estimated at from 30 to 50 per cent. With a furnace capable of containing at one charge about 1½ tons of metal, and working it with a current of 30,000 amperes, at 50 volts (2,000 H.P.), the entire charge of 3,000lb. can be fused and run into castings within a quarter of an hour. Comparisons have been made with the well-known results of making iron and steel castings by smelting in a Siemens-Martin regenerative furnace, where from 1,000lb. to 1,400lb. of coal are burned to smelt 2,000lb. of iron. Assuming that water-power for the Taussig process is not available, and that the dynamo and air-pumps must be worked by steam, it is claimed that the same result, the smelting of 2,000lb. of iron or steel, can be effected by the consumption of from 720lb. to 800lb. of steam coal, an economy of 50 per cent. in the use of fuel. This economy is still greater if, instead of the foregoing comparison with smelting in a Siemens regenerator, we consider the treatment of steel in crucibles, where 1,200lb. of the best coal is consumed for each 1,000lb. of steel. While the preliminary experiments—which have been conducted with a plant of 18 to 20 H.P.—have been successful, with resulting products of high and uniform quality, the practical application of this new process on an industrial scale has yet to be made. Works have been built at Copenhagen, where it will soon be put into practical operation, and a syndicate has been organised for a similar purpose in southern France. The first use of the system will be in the production of small castings of iron and steel. In the earlier experiments, four-bladed propellers of a size suitable for launches were cast with excellent results. In the production of pig iron and other metals direct from the ores, greater difficulties will no doubt be encountered, for the reasons, among others, that the charge to be smelted will be necessarily small, and the furnace must be so constructed as to provide for the elimination of the slag. The experiments in this direction have been made thus far on only a small scale, but the produced iron, owing to the absence of coal or coke and the prompt withdrawal of the air and gases generated by smelting, is very pure; and since it contains a much lower percentage of carbon (2·99 per cent.) than ordinary iron, it would seem to be well adapted to the manufacture of steel. (1) It has been shown that by the Taussig process sufficient heat to smelt a ton or more of iron within 15 minutes may be generated, sustained, and applied at will without the use of carbon electrodes, and without excessive heating or injury to other portions of the circuit. (2) Castings of iron and steel, up to a weight of 200lb. or more, have been made, which have shown all desirable qualities. (3) Pig iron of excellent quality has been produced in small quantities by direct smelting from Swedish ores. The tests of this iron, as made by the Royal School of Mines at Berlin, give net results, which may be summarised in the statement that the tensile strength of a round rod 0·4in. in diameter was 3,110lb., and the resistance to compression of a rod 12in. in length and 1·2in. in diameter was 127,270lb.; that is, about 22,000lb. and 116,000lb. per square inch respectively.

MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 743, Vol. XXXIII.)

The Expansion Curve.—The curve on the indicator diagram corresponding to the period of expansion calls for some closer consideration, even though we must digress from the main study embodied in this section. Quite apart from the misrepresentation of the actual state of affairs in which the indicator often indulges, it is evident that there can be no *fixed* law of the expansion curve, no general equation which can adequately represent it. The expansion curve represents the relation between the pressure and volume of a certain mass of steam, which is supposed to be isolated in an expanding space, and which, if there is no leakage, *is* so isolated. But the behaviour of steam under these conditions depends upon the state of wetness or superheat of the steam, upon whether it receives heat from a hot jacket, as well as upon the influence which the metal walls are permitted to exert upon it. It will therefore be found that the character of the expansion curve depends upon the type of engine, upon the speed at which the engine is run, upon the load imposed on it, and upon the quality of steam supplied to it. Sometimes the curve will be nearly a true adiabatic; sometimes it will approximate to the saturation line; sometimes it will rise above the curve of saturation in a manner indicating that the expanding steam is becoming superheated; sometimes, indeed, a composite curve results, a curve not considerably departing from a rectangular hyperbola, and one whose characteristics are produced by the re-evaporation of condensed steam in later parts of the expansion. Though never strictly a hyperbola, this last-named curve has a subtended area so nearly equal to that of a true hyperbola that it is often called "hyperbolic expansion." Some theorists would like every steam engine to have "hyperbolic expansion"; they are as keen about it as some electric alternator theorists are about sine curves. It is surprising what a number of problems can be "solved" and what a collection of data can be deduced, if only the steam engine is assumed to have hyperbolic expansion. It is not so surprising that the mass of these deductions are utterly opposed to the practical conclusions arrived at by actual work with steam engines. The assumption of hyperbolic expansion for the mere purpose of calculating a very rough approximation to the horse-power of a steam engine has nothing to condemn it; but the mischief lies in the frequent attempt made by theorists to settle questions as to the design and setting of valves, the proportions of the engine, and the relative values of clearance, compression, &c., &c., on the purely gratuitous assumption that the engine is working with dry steam expanding hyperbolically. Little else than geometrical convenience sanctions the use of the hyperbola, but the behaviour of actual steam in an actual engine is not controlled by any consideration of geometrical convenience.

Radiation and Conduction.—Radiation from the exposed surfaces of the cylinder or of the enveloping jacket, and conduction of heat away from the steam through the metal parts of the engine in communication with it, have both a direct and an indirect effect on the economy of the engine. The direct effect is, of course, represented by the number of thermal units thus abstracted from the steam; and the indirect effect, which may be of even more serious consequence, is represented by the increased wetness of the cylinder steam which will result from this loss of heat.

Steam Leakage.—Leakage of steam in the engine chiefly arises either at the valves, or at the piston, or at the glands or stuffing boxes. Valve leakage may be caused by either bad design, bad setting, or excessive wear. In those forms of valve, such as the ordinary slide valve, where the steam and exhaust distribution are both controlled by one and the same sliding piece, this form of leakage is usually more abundant than in those, such as the Corliss valves, in which the steam and exhaust are controlled by isolated mechanisms.

Relation of Distribution to Economy.—The fifth cause of the failure of steam to perform indicated work was stated to be: Uneconomical distribution on account of badly-designed or carelessly-set valves. The general features in the distribution of steam have already been considered, and we have also noticed the effect of bad valve setting on the loss of steam by leakage. But there are other influences which the design and setting of the valve will exert upon the consumption of steam by the engine in the performance of a given amount of indicated work, which it will be necessary to notice. To give a comprehensive account of the relation of steam engine valves to steam economy would require the whole of a volume of no mean size; it is the author's intention, therefore, to discuss briefly only some of the most important features of the subject.

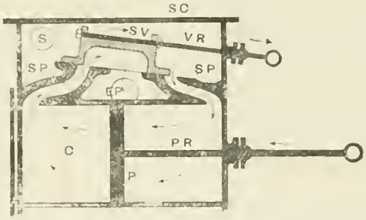

Fig. 29.—C = Cylinder, E P = Exhaust Pipe, P = Piston, P R = Piston Rod, S = Steam Pipe, S C = Steam Chest, S P = Steam Ports, S V = Slide Valve, V R = Valve Rod.

Action of a Simple Slide Valve.—We will commence by considering the action of a simple slide valve, which, though not commonly met with in engines of the types used for electric power purposes, forms an admirable basis for the study of more complex valves. Fig. 29 gives a diagrammatic representation of a slide valve and its connections with the cylinder, and is sufficiently explained by the footnotes and the arrows. The slide valve receives an almost perfect simple harmonic motion, being operated by an eccentric and long eccentric rod from the crank shaft. The motion of the valve is, in general, opposite to that of the piston; the eccentric being set forward ahead of the crank by a right angle *plus* a certain angle, called the "angle of advance." Remembering this relation between the harmonic motion of the valve and that of the piston, we may apply the method of polar co-ordinates to the study of the steam distribution which will be produced by the valve. If we combine under one diagram the polar curves representing the positions of the inside and outside edges of the valve, the edges of the steam and exhaust ports, and the position of the crank (which also gives the position of the piston), we shall follow a very convenient graphic method of treatment which was devised by Zeuner.* In Fig. 30 a slide valve and seat have been drawn to scale, and the problem is to obtain a graphic solution, by Zeuner's method, of the distribution of steam which this valve will give. The valve is shown in the middle of its travel, symmetrically with the ports, and shows its *outside lap* as the distance *o*, and its *inside lap* as the distance *i*. If there were no angle of advance the piston would now be at the commencement of its stroke. But as it would result in wasteful steam distribution to have the steam port

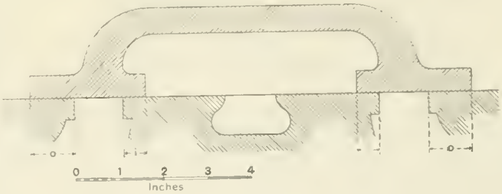

Fig. 30.

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* Zeuner: "Treatise on Valve Gears." (Translated by Müller.)

closed at this point, it is obvious that the crank cannot be permitted to be at right angles with the eccentric. If we imagine the piston to be firmly held at the commencement of the stroke while the valve is shifted so as to be on the point of giving steam, we see that it will be necessary to shift the eccentric a certain angle forward beyond its position at right angles to the crank. And if we wish to admit steam actually before the commencement of the stroke we must shift the eccentric still further forward; and the effect of this will be, that at the exact commencement of the stroke the steam port will have a certain amount of opening. The amount of steam port opening at the commencement of the stroke is called the *lead* of the valve. The reader will easily perceive that there is a simple algebraic relationship between the lead, the outside lap, and the angle of advance.

Zeuner's Valve Diagram.—The slide valve in Fig. 30 has an outside lap of 1in. and an inside lap of ½in. We will assume that the angle of advance of the eccentric is 45deg., and that the travel of the valve is to be 3½in. Zeuner's diagram for this arrangement, drawn to full size, is shown in Fig. 31. From the centre O the circle A E B D, having a diameter equal to the travel of the valve (on the given scale), is drawn. This circle may be conceived to represent the path of a point on the engine crank at a distance from the centre equal to the eccentric radius; it therefore determines the position of the piston. The piston may be conceived to start its stroke when a point on the circle is at A, and to complete the stroke when the point has travelled in a clockwise direction to B. Now, the valve eccentric is to be placed ahead of the crank by an angle which is the sum of 90deg. and θ, the angle of advance. Consider the instant when the crank is at A, the piston being at the commencement of its stroke. If there were to be no angle of advance, the valve would be in its middle position at this same instant. But, as there must be the angle of advance, θ, the valve will evidently come into its middle position somewhat earlier—namely, when the crank has the angle θ yet to pass through before it will have reached the point A. We may, therefore, determine the middle position of the valve by setting back the angle θ from A in the reverse direction to the motion of the crank. This will give the diameter marked "middle position of valve" in Fig. 31. In the same way we may consider that when the piston is about to commence its stroke the crank will have to turn through only (180deg. − θ) before the valve will next arrive at its middle position; so that this position may be determined by setting forward the angle (180deg. − θ) from A in the same direction as the motion of the crank. The valve makes a simple harmonic motion about this middle position, and the polar curve of such a motion consists of two equal circles drawn on an axis, H J, at right angles to this mid-position diameter. The polar circles each have a diameter equal to half the travel of the valve, and are in contact at the centre of the larger circle A E B D. One of these circles, of course, represents the positive and the other the negative motion; but since, when only one side of the cylinder is considered, the positive motion relates to steam and the negative motion to exhaust, it is convenient to call these the steam and exhaust circles respectively. If any point on the outer circle, such as the point *a*, be taken as representing the position of the crank at any moment, then the radius vector O*p*, on the radius O*a*, such that *p* is the point of intersection of O*a* with the polar curve, will give the displacement of the valve from its middle position. In dealing with the positive or steam polar circle, it is convenient to consider the displacement of the edge of the outside lap, since this edge regulates the steam; and in dealing with the negative or exhaust polar circle, it is convenient to consider the displacement of the edge of the inside lap, since this edge regulates the exhaust and compression. Let, now, the circle *o*, at a radius equal to the outside lap, be drawn from the centre O. Until the radius vector exceeds the radius of this circle steam will not be admitted into the cylinder; for a glance at Fig. 54 will show that the displacement must exceed the outside lap before any of the steam port can be uncovered.

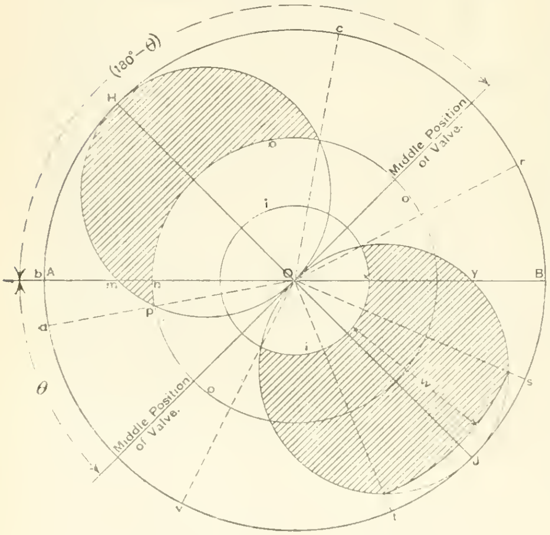


Fig. 31. Zeuner's Diagram for a Simple Slide Valve.

Imagine that the point on the crank which we have said may be conceived to travel round the circle A E B D is in the position, between A and D, where it lies on the line of mid-position of the valve; and, further, let this point be supposed to travel clockwise round the circle. As it advances, the radius vector of the polar co-ordinate increases from zero, until, when the point is at *a*, the radius vector has attained the value O*p* equal to the outside lap. The point *a*, therefore, gives the position of the crank at the moment of admission. A moment later the revolving point has reached the point A, and the piston is about to commence a new stroke. The radius vector, meanwhile, has grown to the value O*m*, of which O*n* represents outside lap; so that *m n* represents the amount of opening of the steam port at this instant, *i.e.*, the steam lead. From A to H the value of the radius vector increases, and the portion of it intercepted by the shaded portion of the diagram will represent the amount of opening of the steam port. From H to *c* the valve is moving in the other direction, having reversed its motion at H; and when the revolving point has reached *c*, the steam port has just been closed. The point *c* is, therefore, the point of cut-off. Onward from *c* to the mid-position of the valve the outside lap is covering up the steam port, and expansion takes place; and the same condition of things is prolonged until the edge of the inside lap moves away from the port, so as to give release. Release, therefore, occurs when the radius vector of the exhaust polar circle is equal to the amount of the inside lap; so that the point of release is found by drawing the circle *i*, having a radius equal to the inside lap. The upper intersection of this circle with the exhaust polar circle gives the required point. Release, therefore, takes place when the crank is at *r*, and exhaust continues until the corresponding point *v* has been reached. The amount of exhaust lead is shown at *x y*. When the crank is at *s* the exhaust port has become fully opened, as is shown by measuring off its full width *w*. From *s* to *t*, therefore, the exhaust remains fully open, and the edge of the inside lap slides over the solid valve seat. From *v* to *a* is the period of compression.

(To be continued.)

A State Electrical Standardising Station for Switzerland.—The question of the establishment of a State electrical standardising and testing station in Switzerland is at present under consideration.

NOTE ON THE MEASUREMENT OF INSULATION AND OTHER RESISTANCES.

BY ALBERT CAMPBELL, B.A.

In measuring the insulation resistance of the wiring of a house supplied by two leads, three measurements may be made, the first measurement being taken from lead to lead, and the other two from each lead separately to earth. In some instances the insulation resistance from lead to lead comes out just equal to the sum of the resistances from each lead to earth; but this is by no means necessarily the case, as will be seen from the following instance with which the writer had to do a short time ago. In a certain large house the insulation resistance from lead to lead was found to measure 1·02 megohms, while from each lead separately to earth it was 0.94 and 1·07 megohms respectively. In such a case it is interesting, and sometimes useful, to decompose the three observed numbers into the three actual component resistances, x, y, and z, as shown diagrammatically in Fig. 1. Fig. 1 will be found to be equivalent to Fig. 2, and the latter is simpler, the leads, P and N, being shown end on, as their resistances may, of course, be neglected.

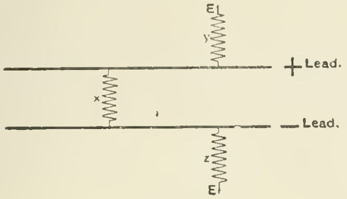


FIG. 1.

To effect the decomposition into x, y, and z, let the observed resistance between the leads N and $P = a$, that between P and $E = b$, and that between N and $E = c$.

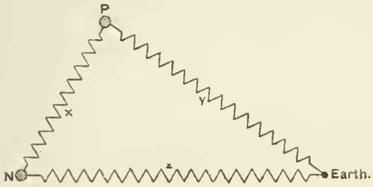


FIG. 2.

Now it is clear that the observed value a is equivalent to x in parallel with $y+z$. Similarly we have b equivalent to y in parallel with $x+z$, and c equivalent to z in parallel with $x+y$. This gives us the three equations:—

$$\frac{x(y+z)}{x+y+z}=a, \quad \ldots \ldots \quad (1)$$

$$\frac{y(z+x)}{x+y+z}=b, \quad \ldots \ldots \quad (2)$$

$$\frac{z(x+y)}{x+y+z}=c. \quad \ldots \ldots \quad (3)$$

These equations, which are not unfamiliar to the mathematician, may be solved in the following manner:—

Let $x+y+z=m$, and the equations become

$$xy+xz=am, \quad \ldots \ldots \quad (4)$$

$$yz+xy=bm, \quad \ldots \ldots \quad (5)$$

$$zx+yz=cm. \quad \ldots \ldots \quad (6)$$

Adding (4) and (5) and subtracting (6), we obtain

$$2xy=(a+b-c)m, \quad \ldots \ldots \quad (7)$$

Similarly $$2yz=(b+c-a)m, \quad \ldots \ldots \quad (8)$$

and $$2xz=(c+a-b)m. \quad \ldots \ldots \quad (9).$$

Hence, dividing (8) by (7), we have

$$\frac{z}{x}=\frac{b+c-a}{a+b-c}.$$

$$\therefore z=\frac{b+c-a}{a+b-c}x; \text{ and, similarly, } y=\frac{b+c-a}{c+a-b}x.$$

Substitute these values in (1), and we have

$$x^2\left(\frac{b+c-a}{c+a-b}+\frac{b+c-a}{a+b-c}\right)=ax\left(1+\frac{b+c-a}{c+a-b}+\frac{b+c-a}{a+b-c}\right).(10)$$

Now, suppose a is not equal to 0 (*i.e.*, that we have not found a "dead short" across the leads). Then x cannot $=0$, and therefore we may divide across by x,

$\therefore$ equation (10) becomes, after simplifying,

$$x\cdot\frac{2a(b+c-a)}{(c+a-b)(a+b-c)}=a\left[1+\frac{2a(b+c-a)}{(c+a-b)(a+b-c)}\right]$$

i.e., $$x=\frac{(c+a-b)(a+b-c)}{2(b+c-a)}+a;$$

and similarly y and z may be found.

Now let a, b, c be the sides of a triangle A B C, and, according to the usual trigonometrical notation, let $s=\frac{1}{2}(a+b+c)$. So we have—

$$x=a+\frac{(s-b)(s-c)}{s-a}. \quad \ldots \ldots \quad (11)$$

$$y=b+\frac{(s-c)(s-a)}{s-b}. \quad \ldots \ldots \quad (12)$$

$$z=c+\frac{(s-a)(s-b)}{s-c}. \quad \ldots \ldots \quad (13);$$

x, y and z can now be found with ease from the observed values of a, b, and c; but we can simplify the results still further. For—

$$\frac{(s-b)(s-c)}{s-a}=\frac{s(s-a)(s-b)(s-c)}{s(s-a)^2}$$

$$=\frac{1}{s}\left[\frac{\text{area of } ABC}{s-a}\right]^2=\frac{r_a^2}{s},$$

where $r_a=$ the radius of the escribed circle for side a of the triangle A B C.

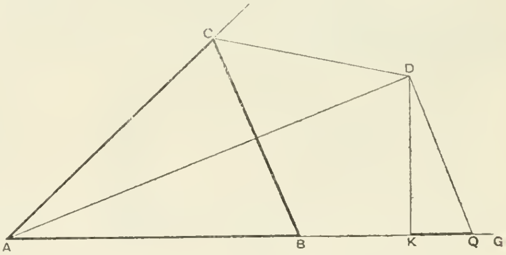


FIG. 3.

So the results take the simple form:—

$$x=a+\frac{r_a^2}{s},$$

$$y=b+\frac{r_b^2}{s},$$

$$z=c+\frac{r_c^2}{s}.$$

From these we see that the real component resistances x, y, and z are greater than the observed a, b, and c by $\frac{r_a^2}{s}$, $\frac{r_b^2}{s}$, and $\frac{r_c^2}{s}$ respectively.

We can now use a simple geometrical construction to find these values.

Construct the triangle A B C (Fig. 3) with sides the observed a, b, and c.

Produce A C and A B, and bisect the interior angle A and the exterior at C by lines meeting at D. Draw D K perpendicular to A G, and D Q perpendicular to A D.

Then $$\text{K Q is equal to } \frac{r_a^2}{s},$$

so $$x = a + \text{K Q}.$$

Proof. A D Q is a right angle:

$$\therefore \text{D K}^2 = \text{A K} \,.\, \text{K Q},$$

$$\therefore \text{K Q} = \frac{\text{D K}^2}{\text{A K}}, \text{ which} = \frac{r_a^2}{s};$$

for D is the centre of an escribed circle touching A G at K, and, as is shown in all books on trigonometry, A K $= s$.

By obtaining the centres of the other two escribed circles we can, by exactly similar constructions, find y and z.

To complete the above solution we must consider the case temporarily excluded after equation (10), viz., when $a = 0$. If $a = 0$ then b must $= c$.

$$\therefore x = 0 \text{ and } \frac{yz}{y+z} = b = c,$$

but y and z *cannot be determined*, for we cannot find separately two resistances connected permanently in closed circuit.

If $a = \infty$, then b or c must also $= \infty$;

$$\therefore x = \infty \text{ and } y = b,\ z = c.$$

As an example let us take the actual case mentioned at the beginning of this Paper.

Here
$$a = 1{\cdot}02\ \Omega,$$
$$b = 0{\cdot}94\ \Omega,$$
$$c = 1{\cdot}07\ \Omega.$$

By formulæ (11), (12), (13), or by the graphical method we find:

$$x = a + 0{\cdot}52 = 1{\cdot}54\ \Omega,$$
$$y = b + 0{\cdot}38 = 1{\cdot}32\ \Omega,$$
$$z = c + 0{\cdot}64 = 1{\cdot}71\ \Omega.$$

Of course, the actual leakage from lead to lead is determined by a: but the separated elements of this resistance, viz., x, y, z, may be of considerable assistance in determining whether a fault is due to bad insulation to earth, or merely between the leads.

Resistances in Closed Circuits.

The above algebraical and graphical solutions are also applicable to the measurement of any three *or more* resistances joined permanently in series in closed circuit, where only the junctions are accessible.

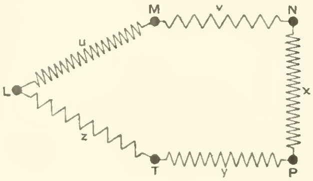


FIG. 4.

For example, consider the case given in Fig. 4. To find the resistances u, v, x, y, z, we may first measure across L M, M N, and L N respectively, and by the solutions given above we can obtain u and v. By measuring across three other consecutive points (*e.g.*, N, P, T) we can obtain two more of the resistances (x and y), and so on until all are found.

Thus we can find the separate resistance of each coil of a closed circuit armature, using, of course, an ammeter and a voltmeter, if the resistances are low. The writer has used the method with the armature of a small Siemens exciter and obtained the following results, which must, however, only be taken as a rough illustration, as the ammeter and voltmeter connections were quickly extemporised. A current of 13·6 amperes was used; it was led into the armature by narrow brushes of sheet metal applied to the commutator at the desired points. The volts were measured by a Siemens potential galvanometer connected to the armature by an independent pair of brushes. The resistance across the commutator bars of coil (1) was found to be $= 0{\cdot}0201$ ohm; across coil (2) it was $= 0{\cdot}0198$; while across the two in series it was $= 0{\cdot}0380$. In the notation used above,

$$a = 0{\cdot}0201,\ b = 0{\cdot}0198,\ c = 0{\cdot}0380.$$

Hence resistance of coil (1) $= a + 0{\cdot}00097 = 0{\cdot}02107$ ohm,
and of coil (2) $= b + 0{\cdot}00094 = 0{\cdot}02074$ ohm.

These numbers are in good agreement with previous measurements of the total armature resistance.

THE CAUSES OF FLYWHEEL ACCIDENTS IN ELECTRIC-POWER ENGINES.

The *Electrical World* of New York has recently opened its columns to an instructive and important discussion of the causes of flywheel accidents in electric-power stations; perhaps it would be more correct to say the *peculiar* causes of such accidents. The ordinary liabilities of a flywheel, defective in design or construction or over-loaded by a racing engine, to fly to pieces, is admitted; but there are conceivably other influences, due to sudden variations of the electric current in the dynamo driven by the engine, which may be powerful enough to make a wheel "explode." In opening the discussion Mr. Coykendall takes this view of the subject, as is seen by the following abstract of his letter:—

"There are two conditions found in stations: First, where a single dynamo supplies one or more circuits; second, where a number of dynamos running in parallel supply one or more circuits. In the first case, suppose a short circuit on the line to occur, in which case the machine circuit breaker immediately breaks circuit and all the load is removed from the engine. If the short circuit has been caused by the contact of a broken trolley wire with a rail, or any similar cause, it still exists, so far as the line is concerned, after the machine circuit has been broken. Nothing is known, however, in the power-house of the conditions of the line, and the circuit breaker is immediately closed by the attendant. The effect of this is to throw on the engine an instantaneous load much greater than the maximum for which the engine was designed, the load being due to the number of amperes at the machine voltage which would pass over the short circuit. The circuit would, of course, be immediately broken, but not before the engine had received the full impact due to the instantaneous load. In the second case, suppose one of the dynamos to be overloaded, due to maintaining too large a voltage or for any other reason; the circuit is thereby broken and the engine unloaded, its speed being thereby accelerated somewhat even with the best of governors, and the voltage therefore raised still more. If now the circuit breaker is closed, the machine will be subjected to a still greater load than that which caused the circuit to be broken before. Thus, again, the engine would be subjected to an instantaneous load greater than that for which it was designed. The preceding are said to be the conditions which existed at a recent power-house accident not far from New York, and the result was the wrecking of the engine and destruction of part of the power-house. Thus, in either case, by the closing of the circuit breaker the engine may have thrown on it with the suddenness of the blow of a hammer, a load of much greater than the maximum for which it was designed."

Replying to this hypothesis, Professor Thurston writes a letter, of which the following is an abstract:—

"The conditions described are unquestionably likely, even certain, to occur occasionally, perhaps frequently. Their existence would as certainly introduce overload and risk, and I think it extremely possible that they may have been the occasion of some of the accidents which have come to be common since the introduction of the electric current for transmission of power. The breaking of a flywheel and the consequent wrecking of an engine is not a recent innovation or an accident confined solely to electric power stations. Liability to the accident from the causes to which our attention is here called—sudden excess of current at the driven dynamo is equal with all classes of engine. In such cases, the instantaneous application of abnormal resistance, if the wheel be weak, is liable to throw upon its arms a proportionally excessive load, and the wheel may go to pieces. But, I think, in most cases the belt would slip before the over strain could reach the danger limit, and where this might not occur, if the wheel were properly proportioned and given a good "factor-of-safety," it would usually carry the load until it reached such a limit that the provision at the dynamo, the circuit breaker or fuse, or some other limit to raising voltage or current, would be affected, and the crisis would be safely passed. The fact that so few such accidents occur with high-speed engines would seem to indicate this to be the case. But a weak wheel, on either class of machine, would be apt to yield to such treatment as your correspondent describes.

"In such accidents as I have known, of the class referred to, the engine is found after the break-down to have had its governor deranged and, presumably, this has been the cause of the accident. A belt slips or breaks, or the key comes out of the governor pulley, or the engine is relieved so suddenly and completely of its load that the charge of steam just taken into the cylinder is sufficient to accelerate its speed to the danger-point with a weak and faulty wheel. The conditions of operation of the engine in electric light and power stations are peculiarly favourable to the production of such accidents. The enormous variations of power, often from no load to an excessive load, in an instant, and the constant changes of load are sure to result in a constant jerking and shaking of the whole machine, and especially in the governor system. And this rattling of the governor pulley, if the key be not driven hard, and the shaking of its belt, make it certain that, sooner or later, something will get loose. If it shakes out the key, the result is pretty certain to be disastrous; if the governor belt simply slips, danger follows, if not disaster; if the belt breaks, the engine is gone.

"Another seldom-noted danger is that resulting from the fact that many governors are not so designed and built as to be capable of acting effectively, in these cases of exceptionally rapid rise in speed of rotation. The sudden jerk of the governor, in such instances, might cause the arms to bind on their pins, or in their sockets, in such manner as to render them nearly or quite inoperative, and thus to introduce the superlatively dangerous condition of a governor working satisfactorily on all ordinary occasions, and awakening no suspicion, and finally, when its services are most needed to prevent a possibly destructive and fatal accident, refusing to work at all.

"The danger, in case of short-circuiting of the dynamo, is ordinarily reduced by the fact that, in most cases, the power is transmitted from engine to dynamo through a pulley-flywheel, and the tendency is thus always to put a break upon the wheel in the most effective and safest manner, while the slip of the belt adds security. The only shock, in such a case, comes mainly of the inertia of the reciprocating parts of the engine, and then only when near the half centre."

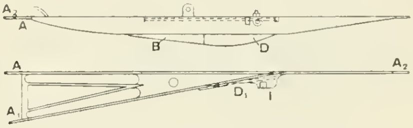
THE SOUTH STAFFORDSHIRE ELECTRIC TRAMWAY.*

BY ALFRED DICKINSON, ASSOC. M.INST.C.E.

The question of electric traction has on several occasions recently engaged the attention of the Institution, but, so far as street tramways are concerned, experience has been lacking of actual results obtained in the busy streets of English towns. A great deal of information has been given as to its operation in foreign countries, especially in America, but people have regarded with scepticism results obtained so far away from home; frequently reasoning that if the system were applied to the altered conditions of every-day working upon street tramways in this country very different results would follow. The author therefore hopes that this record of the construction and working of an electrical system nearer home may prove of interest. It is unnecessary to recite the history of the development of electric traction in America beyond mentioning the fact that in the United States many thousands of street cars are now worked direct by electricity, and that on the Continent of Europe this method is making rapid strides. On the other hand, at the present time there are only two street tramways in England worked by means of an electric current conveyed by bare conductors, viz., about three miles of line in Leeds and eight miles in South Staffordshire; the latter forming part of the South Staffordshire Tramway Company's system, of which the total extent is 23 miles. This apparently lethargical condition is, in the author's opinion, due to the obstacles which heretofore have had to be overcome before any direct system of electric traction could be introduced.

The streets and roads along which the South Staffordshire lines are laid are exceptionally difficult to equip with an overhead wire, because they are very tortuous and of ever-varying widths. There are no fewer than four 90° curves, one of which is of less than 40ft. radius, seven railway bridges, most of them with steep approaches, and one canal bridge with a hog back, to cross which the cars have to ascend a grade of 1 in 16. In fact, if the Authorities had consented to the American span-wire system, the author doubts whether it would have been possible to have equipped these lines by this method; for, running along one side of the road at Bloxwich for about a mile are telegraph wires so low down that they would have had to be removed to admit the introduction of supports for the span-wires, and for a short distance at Wednesbury there are ornamental telephone poles supporting a large number of telephone wires. The author dwells upon these matters to show that the South Staffordshire tramway system is not a simple line, but one presenting many difficulties; and he would like to lay special stress upon the fact that on this section of the line electric traction has superseded steam locomotives, weighing 13 tons, carrying a boiler pressure of 150lb. per square inch, and not horse traction. He does so because he finds many persons are loth to believe that electrically-driven cars can climb gradients and work in competition with steam tramway engines.

The whole of the current from the dynamos is supplied through an underground feeder, which is tapped at its extremities, and in 13 places along its length, branch feeders being taken from the main to terminals placed in special boxes fixed in the footpath at the bases of poles situated at distances of about half a mile apart. The trolley-wire (O. B. W. G.) is of hard-drawn copper. It is suspended at a height of 21ft. above the road from the arms of the poles by clips attached to "Ætna" insulators, at varying distances from the line not exceeding 13ft. On the trolley-wire at each of these poles is arranged a special device which insulates one section of it from the adjacent section, a separate feeder going to each. This arrangement allows of any half-mile of the line being worked or disconnected independently of the remainder. As the tramway is partly double line and partly single line with turnouts, of which there are thirty-seven in all, used mostly as passing-places for the cars, it was necessary to provide, as in double line, two trolley-wires, and, at the end of each turnout, a switch to permit of the trolley wheel diverging from the single to the double wire and *vice versa*. It will therefore be seen that as the trolley-wheel has double flanges, such a switch must be applicable to both a point and a crossing; the device will be understood by reference to Figure. When the trolley-wheel is travelling along the trolley-wire A_1 and is required to reach the trolley-wire A_2, the movable tongue D when closed forms a crossing, as it projects below the tongue B and permits the trolley-wheel to pass under it; but should it be necessary for the trolley-wheel to pass from the trolley-wire A to the trolley-wire A_2, the movable tongue D is pulled over to the position D_1, opening the point and allowing the trolley-wheel a clear passage in the desired direction. When the trolley-wheel is travelling from the wire A_2 to the wire A_1, the movable point D being closed, and projecting below the tongue B, permits the trolley-wheel to cross it and to pass to the wire A_1; and in the case of the trolley-wheel travelling from the wire A to the wire A_1, it passes along the tongue B and opens the point by pushing the movable tongue D to the position D_1—the point being automatically closed after the passage of the trolley-wheel by means of the helical spring I. The same device is used at the branch roads in the various car depots.



The poles are made of mild rolled steel and are 30ft. long. They are built in two sections, the lower one being a parrallel tube and the upper, 18ft. in length, being tapered to the top. They have buckled steel base-plates 2ft. square bolted to the bottom, and are fixed upon concrete foundations, the excavation for their reception being also filled in with concrete. They are made in three sizes. It was necessary to provide poles of extra strength as strain-posts at the ends of the several lines; these are 12in. in diameter at the base, tapering to 5in. at the top, and are of ½in. steel. They have attached to them two cast-iron grid frames 3ft. by 4ft., one at the base and the other 5ft. higher up, and the intervening space is filled with concrete, which forms with the pole a solid block. This type of pole is also fixed in positions originally occupied by lamp-columns at the junction of main roads, and has been fitted with lamp-fittings in substitution of those removed.

Sixteen cars have been built, each constructed to carry forty passengers, eighteen inside and twenty-two outside, and weighing, when unloaded, 6 tons 13cwt. Their principal dimensions are:—

	Feet.	In.
Length, including platforms	22	0
" of body, outside	14	3
Breadth of body, including mouldings	5	9
" inside	5	3½
" over roof	5	10½
Height inside, from the top of the floor to the under side of roof	6	6
Gauge of line	3	6
Wheel base	6	0
Distance between spring-centres	10	0
Diameter of wheels	2	9

The body is strongly made and has a bottom frame of channel bar iron. It is distinct from the motor truck, and is carried upon it by eight springs. The wheels are fitted with two sets of brakes, one to apply on the inside of the wheels, and the other on the outside. They are worked separately by hand-wheels from the platforms at the ends of the cars. The cars are fitted with Nicholson automatic couplings at each end, and four dry sand-boxes, two at each end. These also are worked from either platform.

Each car is fitted with and driven by two series-wound single-reduction motors. The gearing is of the double helical type, in the ratio of four to one. Each axle has an independent motor, one end being carried on the axle by two bearings and the other by a spring. There is also at the latter end a spring on the top of the motor, so that at this point it is between springs, the bottom one supporting it and the top one permitting vertical movement. By this method not only is the pitch-line of the gearing maintained, but the shock to the gearing at starting and stopping is considerably reduced, and the vibration of the motor when running is minimised. The armatures are drum wound. Ordinary arc-lamp carbons $\frac{3}{4}$in. in diameter are used for brushes, laid lengthwise along the commutator. The magnets are bi-polar with four limbs.

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* "Institution of Civil Engineers, Selected Paper Abstracts." An account of this undertaking appeared in *The Electrician*, Vol. XXX., p. 66.

The cars are fitted with switches in duplicate, one set on each platform. They consist of reversing, driving and motor switches. Those last-mentioned enable the driver to use either motor at will, or both in parallel. The varying resistance of the rheostat in the motor circuit is controlled by the driving switch at the will of the driver. As a precaution, and to prevent injury to the motors by careless driving or from other causes, safety fuses are placed in the motor circuit. A lightning arrester is placed in the circuit between the trolley wire and the driving switch.

The author then deals at length with the side trolley devised by him, and described on p. 68 of our issue of November 18, 1892.

After the formal inspection on behalf of the Board of Trade the electric system was of lines opened for traffic on January 1, 1893. From January 1, 1893, to December 31st inclusive the cars ran 262,692 miles and carried 1,668,057 passengers, the local authorities, the public and the Directors of the South Staffordshire Tramways Company being completely satisfied with the results. The line is worked by the Electric Construction Corporation under a contract with the Tramways Company, and, in dealing with the working cost for purposes of comparison, the author proposes only to deal with the charges where a direct comparison can be made; viz., all those for running and maintenance minus traffic charges and maintenance of permanent way. The following statement shows the cost of working several systems of tramway lines in 1893:—

Comparative Statement of Cost per Car-Mile for Running and Repairs, 1893.

Charges.	South Staffordshire Tramways Co. Wilkinson locomotive steam engines vertical boilers.	Birmingham Midland Company. Kitson locomotive steam engines.	Dudley and Stourbridge Company Kitson locomotive steam engines.	Birmingham Central Co.			South Staffordshire. Electric system.
				Kitson, Falcon and Beyer. Peacock locomotive steam engines.	Electric accumulator.	Cable.	
Running—	d.	d.	d.	d.	d.	d.	d.
Wages	1·83	1·99	1·45	2·14	3·37	1·54	1·93
Fuel.....	2·34	1·81	1·94	1·92	1·76	0·60	0·48
Stores	0·33	0·30	...	0·27	0·68	0·19	0·43
Water & gas...	0·28	0·11	0·35	0·18	0·12	0 03	0·08
Sundries	...	...	...	0·09	0·17	0·05	0·06
Repairs—* Wages and materials...	2·26	3·62†	4·83	2 19	5·49	1·81	1·08
Total cost per car-mile ..	7·04	7·83	8·57	6·79	11·59	4·22	4·06
No. of miles run	337,423	256,077	112,299	1,225,996	140,993	641,161	262,694

The average cost for fuel on the four lines worked by steam is 2·00d., electric accumulator 1·76d., cable 0·60d., and overhead electric traction 0·48d. per car-mile run.

Hitherto it has been most difficult to obtain a direct comparison between electric traction and any other system; but such now is not the case, at any rate so far as the South Staffordshire line is concerned, because the electric cars are running upon lines previously worked by steam.

When designing the system the author was in doubt as to the amount of steam-engine power to provide in the generating-station per car on the lines, and how to arrange its subdivision, as the number of cars upon the line at different times would vary considerably. However, he ultimately decided to split the power into three elements, so as to be able to reduce it to suit the number of cars running upon the line at any given time. He was prepared, from his experience in the working of the cable-line in Birmingham, for a considerable variation in the load; but he certainly never anticipated that its range would be so great in so short a time as he finds to be the case. With 16 cars on the line, the output has been found to vary as much as 233 E.H.P. in the space of five seconds, and with 11 cars upon the road as much as 202 E.H.P., in the same period. Taking into account even the extraordinary fluctuations caused during holiday times, it is satisfactory to observe that the cost per car-mile for fuel is below that of cable traction; and in this comparison it is well to bear in mind that the power on the cable route is distributed over only three miles of route, with double the number of cars running, as against eight miles of route on the electrical section. By many engineers the problem of arranging an economical mechanical plant for working a tramway may be considered simple; but the physical conditions of any district, the ever-varying condition of a tramway rail, demanding within a few hours as much as 50 per cent. increased tractive power, are more important factors in this problem than they are generally considered to be. It is a curious fact that as soon as mechanical traction of any kind is introduced, the public demands that gradients shall be ascended and descended at a constant speed; and the South Staffordshire electric system is able to comply with that demand. During the winter, when snow was on the line, the electric cars kept correct time, whilst the steam cars lost half-an-hour in a run of six miles. It may seem astonishing that an electric car carrying 40 passengers is occasionally called upon to exert 48 E.H.P., but of this fact evidence is afforded by the author's trial.

He has recently had a motor that had been running for 14 months taken from a car and tested with a "Prony brake," when its mechanical efficiency was found to be 78 per cent.—a most satisfactory result. At the same time he tested the torque of the armature with a current of 48 amperes taken from the trolley wire under normal conditions, and found this would raise a weight of 141lb. at the end of a lever 7ft. long. This is equal to a torsional force of 1,692lb. weight on the armature. Testing with a dynamometer the amount of pull to be obtained on the drawbar, with all the resistance cut out and both motors in circuit, he found it was 1 ton 7 cwt. He then tested a Wilkinson engine at a boiler-pressure of 150lb., with cylinders 7$\frac{3}{8}$in. diameter geared 1$\frac{3}{5}$ to 1, and this gave exactly the same pull.

The author had at first considerable misgiving as to the probable amount of wear and tear upon the trolley-wire, and after running for 14 months it is satisfactory to find that it is scarcely possible to measure it.

TECHNICAL EDUCATION.

Sir Frederick Bramwell, speaking at the annual prize distribution in connection with the Westminster Technical Institute, which was held in the Westminster Town Hall, on Monday, October 22nd, Mr. Burdett-Coutts, M.P., presiding, said: Baroness and Mr. Burdett-Coutts, I felt great difficulty in coming to speak here to-night, for I did not see what I had to talk about. However, here I am, and I suppose I have got to address you. Well, now, what is it to be about? The benefit of institutions such as these? Ten years ago, addressing a similar meeting, I said that subject for an address was practically unnecessary, because people had pretty well been converted to the utility of such institutions. Five years ago, when addressing another meeting, I said an address of that kind was entirely unnecessary. If that were true ten years ago, still more true five years ago, how very, very true it must be to-day. What, therefore, can I say? As regards yourselves, you have proved your own knowledge of the value of these institutions by the fact that has been communicated to us, that within four or five years your membership has increased from 20 to 1,000. When the membership of an institution increases in this way it is very patent that those who join the institution believe it will be for their benefit and advantage; and so it will, for you can obtain a teaching here and in such institutions that you cannot get elsewhere.

When I was a lad I was apprenticed to a master who taught me all he could teach me. He taught me that which has been very useful, viz., a great deal of good practical work. He did not teach me much theory. He had not got it to teach. This fairly represents that state of things in my boyhood. Since then, the apprenticeship system has nearly died out; therefore we want something as a substitute for it. Well, we have it in these institutions; and we have, moreover, not only a substitute for that which prevailed when I was a lad, but that which can give us the information and instruction which could not then be got at all. We now know why we do certain things and why certain results happen. When I was a lad we did not know why we did them;

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* The items referring to steam traction include repairs of every description; those to electric accumulator traction include stationary engines and boilers, dynamos, motors, batteries, switches and all repairs pertaining to an electric installation; to cable traction stationary engines and boilers, cable, pulleys in road, cars and all repairs incidental thereto; to overhead electric traction stationary engines and boilers, dynamos, motors, poles, feeders, overhead wire, cars and all other repairs in connection with an electric system.

† This item includes an amount taken from depreciation fund.

but we knew certain results happened, and we did them because our forefathers did them. It is well we should know why results happen. But don't despise practice. Let me give an instance of that which I mean. I believe if, from father to son and from generation to generation, good iron has been made from the iron ore of a particular district by a certain process, I had better follow that process than depart from it at the bidding of a scientific man. Let me tell you the story of the philosopher, the old lady and the tea-pot. The philosopher went into the cottage of an old lady just as she was taking tea. He saw that the tea had been made in a bright metal pot. He also saw an earthenware pot out of use on the shelf. He said, "My dear woman, why do you make the tea in the metal pot? Why don't you make it in the earthenware pot? The earthenware pot will make better tea. It will keep it much warmer, the reason being that metal is a good conductor, and lets the heat go away; while the earthenware is a bad conductor, and so keeps the heat in." The old lady said, "Drat you and your good and bad conductors. What have they got to do with tea-making? Besides which, I don't hold with the cry about bad conductors. I am sure they are always very civil and kind to me. They drew the 'bus up to the kerb, and they helped me on to the pavement." "Well," said the philosopher, "I see it's no use talking to you." "No," says the old lady, "it isn't conductors or no-conductors. The metal pot is the best. I have tried the two for many a year, and the tea in the metal pot was always the best." The philosopher went away very angry at being contradicted by an old woman; but when he had cooled down he thought he had better try for himself, and he found the old lady was right. The tea remained hotter in the metal pot than in the earthenware. He had to reconsider his philosophy, and he found that while there was greater conducting power in the metal than in the earthenware, the bright metal was a much worse radiator. Let us hope the philospher had the honesty to go back to the old lady, and, over a cup of tea, admit that she had been right. So if, in my illustration of iron making, a philosopher were to tell me that that which had answered well for generations was entirely wrong, and should be changed, I should be inclined to point out to him the practical and successful result, and should believe he had not yet mastered the whole theory. I admire theory; it teaches why certain things are done and why certain results happen, but don't despise practice. If I know that certain good results follow certain operations it is of little use for a man of science to tell me to give up these operations because they are opposed to his views. The practical results speak for themselves, and I should recommend him to go away and overhaul his science. Having given this warning against the despising of practice, let me, on the other hand, be allowed to say to the practical man, "Don't despise the beginnings of any scientific discovery, although these beginnings may be very small, and may even appear to be frivolous. I should like to say a word in this connection about the production of low temperatures. The low temperature researches cannot be carried out without very elaborate and, alas! that it should be so, very expensive machinery. Thanks to the munificence of the Goldsmiths' Company, who gave £1,000, and thanks also to the munificence of persons like Prof. Dewar himself, we found the means to put into the basement of the Royal Institution 50 H.P. in the shape of gas engines, and we are now just getting in a second 50 H.P. I wish these engines were at work. If they had been I would have asked Prof. Dewar to allow me to bring before you some liquid air. You may say "But what is the good of liquid air?" I cannot tell you at the present moment what good it is for commercial purposes. I could not have told you 20 years ago what would be the use of liquid carbonic acid; but at the present day a large trade is done in it. There is hardly anything discovered—except, perhaps, the satellites of Mars—that will not at some time have its value and purpose in ordinary life. Now, assuming that there is such a thing as an absolute zero of temperature, and the proofs of it are almost incapable of being disputed, Prof. Dewar is on the way to its demonstration, and he has got down to 203 of the centigrade scale, or within 70 degrees of the absolute zero. I don't know a more interesting sight than to see in an ordinary room like this an open glass vessel with another within it, and from that inner vessel liquid air streaming down and being accumulated in the outer vessel. Further, Prof. Dewar has devised not only the means of making this liquid air, but he has further devised the means by which it can be preserved for hours to admit of experiment and use; and he has done this in a most ingenious way. As you know, the incandescent lamps in this room have the air within them so far attenuated that the pressure within them is extremely small. Prof. Dewar takes two vessels of glass, one within the other, and joined together at the neck; then he deprives the space between the two vessels of air to a much greater extent than is the deprivation in these electric lamps; in fact, an almost absolute vacuum is created. Thus the conduction of heat is cut off while the effect of radiation is diminished by silvering the vessel. The liquid air which is produced is made to flow into the inner vessel with an open top, where it can be dealt with. People will say, "What is the good of it?" At present we do not know. But I do know that to a scientific man it opens up an absolutely new field of investigation; as new a field as if he had been translated to another planet. In my opinion this is one of the greatest scientific attainments of the present day.

Turning his attention to the work and advantages of technical institutes, Sir Frederick said: I know there are some who say "attend these classes and your success is secured." I think that is an exaggeration. The more correct way of putting it would be "don't attend and your failure is secured." A hundred years ago the important question was not technical education, but instruction in reading and writing, and then it was said "if a man can read and write his success is secured." We see how untrue this assertion has proved to be. Similarly, technical education cannot secure the success of all. In this hundred years things have become widely different. The conditions of life are changed. We live in a sphere with larger needs, and where more is required of us. And, to my mind, it is a salutary feeling—and one that may, I think, not disgust young men and young women—that though all cannot succeed, for there is not room for all to be first, these young men and women can, with the advantages that these institutes afford, say "I want to be at the top and will try to get there." Another thing. Don't despise those who 50 or 60 years ago had not the advantages you have. They had to get on, and did, with the help of their mother wit, and by their intense love for their profession, against enormous difficulties. They got on because they loved their work and stuck to it. To my mind there is nothing more sad than to hear a man say "I am waiting to give up work, and then I will enjoy myself." The man who can enjoy himself throughout his life is the man who can find pleasure in the work he does.

There remains but one thing for me to do, and that is, to ask you to unite with me in giving your heartiest thanks to the Baroness Burdett-Coutts for founding this Institute, for supporting it, for all her material kindnesses, and for coming here to-night to present the prizes which have been won by so many members of this her Institute.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, November 2nd.

London Chamber of Commerce.

2.30 p.m. Meeting of the Engineering, Electrical, and Allied Trades Sections at Botolph House, Eastcheap.

MONDAY, November 5th.

Royal Institution.

5 p.m. General Monthly Meeting.

THURSDAY, November 8th.

Institution of Electrical Engineers.

8 p.m. Ordinary Meeting. The following Papers will be read:—(1) "Notes on Electric Tramways in the United States and Canada," (Supplementary Paper), by H. D. Wilkinson. (2) "Electric Traction, with Special Reference to the Installation of Elevated Conductors," by R. W. Blackwell and Phillip Dawson.

FRIDAY, November 9th.

Physical Society.

5 p.m. Meeting at rooms of the Chemical Society, Burlington House. The following Papers will be read:—(1) "The Photographic Action of Stationary Light Waves," by J. Larmor, F.R.S. (2 "Vapour Pressure," by Prof. S. Young, F.R.S. (3) "The Luminescence of Glass," by John Burke.

Unscientific Phrases in Public Documents.—The *Engineer* observes that recently M. Hospitalier has drawn attention to the errors of language in French public documents relating to scientific matters. Thus, in Acts relating to the sale of land, the superficies is given in metres instead of square metres; the Bureau des Longitudes expresses the value of acceleration due to gravity in a falling body in metres instead of "metres per second" (should it not be "metres per second per second"?). The word "force" is used for "work," and "work" for "power." All nations exhibit the same confusion in the use of scientific terms, which are often imperfectly understood, even by so-called experts, and all nations adopt foreign expressions instead of inventing their own. It is nevertheless true that in scientific language there should be no synonyms; one word should be dedicated to one thing, and have a perfectly definite meaning. Where compound words are required, they should be formed according to a strict rule, and always used in their entirety.

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SPECIAL NOTICE.

Last week's number of "THE ELECTRICIAN" completed Vol. XXXIII. With this week's issue is published (Gratis) the Index to that Volume.

THE BOARD OF TRADE AND LIGHT RAILWAYS.

Early in the present year *The Times* gave voice to the complaint that England lacked light railways, laying the blame for this shortcoming at the door of the Board of Trade. In a leading article on this electrically interesting subject, appearing in our issue of April 6th, we echoed the complaint, and were obliged to admit that it certainly seemed as if the excessive rigidity of the regulations of the most many-sided of all our Government Departments was calculated to kill any attempt to popularise light railways in this country. Since that date the agitation has grown apace, our contemporaries have discussed and re-discussed the subject, and no gathering of business men, and especially no gathering of agriculturists, has been complete without some reference to the need for light railways and the consequent need for a revision of the Board of Trade railway regulations. The upshot of all this has been a remarkable circular addressed by Sir COURTENAY BOYLE to the Associated Chambers of Commerce, the London Chamber of Commerce, the Association of Municipal Corporations, and other similar bodies. The Board of Trade, we are told, are "sensible of the importance of the question," and have taken great interest in it, but have not as yet had before them "practical proposals," and with the object of "focussing views and information," the various bodies circularised are invited to send delegates to a conference at the Board of Trade on an early day to discuss :—(1) How far the usual requirements of the Board of Trade as to constructing and working new railways may fairly be relaxed, especially in the case of lines built through sparsely-populated and agricultural districts. (2) Whether additional legal facilities for obtaining powers to construct tramroads and light railways are necessary or desirable.

From this document it would seem as if the Board of Trade were dimly conscious of some defect in their regulations. But whether this be so or no, the circular rightly merits the epithet remarkable by the frank and open admission that a public Department exists for the public, and not the public for the Department, and that the best way to remedy a public grievance, imaginary or real, is not to stifle it with some panacea evolved by the very inner consciousness of a Government Department, but to discuss it over a rectangular table. When a Government Office wraps itself up in the ample folds of its departmental dignity the temptation to employ against it the handy weapon of invective is not easily overcome. A free and friendly discussion between the aggressors and the aggrieved, however, has the inestimable advantage of disarming the mere agitator and leaving the Department in a position to deal with a solid residuum of grievance from which all the froth has been blown off. This was the happy result of the conference on the electric traction regulations, and it will. we doubt not, be the outcome of the meeting now summoned, and which we are glad to see the Electrical Trade Section is making arrangements betimes to be represented at.

Government officials, it must be confessed, have many reasons for regarding the public as an unmitigated nuisance, and it is much to their credit that, in this country at least, the majority refuse to take up this disastrous but very natural attitude. An instance of what often occurs is afforded us by the Irish Light Railways, which have, we may remark in passing, so far proved but a qualified success. With the idea, probably, of testing the value of local government across the Irish Channel, it was deliberately decided that the plans and financial arrangements of these lines should be approved by the Lord Lieutenant in Council. Hence all questions as to gradients, curves, tunnels, bridges, permanent way, &c., &c., came before the Privy Council of Ireland, and not before the Board of Trade; an officer of which Department, however, inspects the equipment. Well, on the Tralee and Dingle railway an accident happens, with the result that coroner's juries, cesspayers, Members of Parliament, fall with one accord upon the Board of Trade and accuse them of licensing an unsafe line. Meanwhile, nearer home, the same Department was being told that if it would only permit in England the laying down of just such railways as that running from Tralee to Dingle, agricultural depression would be a thing of the past.

But reasonable regulations do not necessarily mean railways; nor, will railways, however, light and airy, by themselves, afford a genuine cure for agricultural depression. But the electrical engineer is not in that capacity concerned with the economic aspect of the problem. All that he knows is that if light railways are to be built, he means to have the building of most of them; indeed, apart from the possibilities of electrical engineering in this direction, the future of agricultural railways in England, even with the best of regulations and the most influential support, would not to our mind be particularly bright. It appears to be generally admitted that where light railways exist, as, for example, in France, they are seldom self-supporting, and must be assisted either by Government subsidy or by local support. The opposition of the great Railway companies to any light railways other than mere feeders to their systems, is not improbable. Acting, of course, always in the interests of the shareholders, and in the struggle for a dividend, nobody is more greedy or obstinate than the general manager of a large railway, whether in deliberately sacrificing a useful canal or in injurious arrangement of rates. Railway companies have a powerful representation in Parliament, and no modern party Government could afford to promote a new system of lines if the interests of the companies were in the least degree affected. Fortunately the Board of Trade can, if it thinks fit, relax its present rules without an Act of Parliament, and can thus permit light railways to be built and worked if anybody can be found to bear the expense. Electrical engineers will, of course, turn at once to their well-beloved local authorities, their open-handed town councils, and their progressive vestries. The average town-councillor probably knows more about railway traffic than about public and private lighting, and train-miles will be more easily understood than volts and amperes. "A man who is a town councillor," we have recently heard, "can effect in his term of office some small, practicable, and tangible good, such as even the erection of a pump. . . . He sees his pump, he sees the water flow, and he sees the monument of what he has done, and knows he has contributed to the health, welfare, and, possibly, the sanitation of his neighbours." Some old-fashioned people wish that he would stop here. But, no; he votes in favour of a municipal electric supply, makes a tour with the lighting committee, and at once yearns to spend the money. He badgers the consulting engineers and worries the contractors about matters of which he is utterly ignorant, and is lucky if he does not himself get into trouble with the ratepayers. As it is with electric lighting it may be with light railways, but as the subject is apparently more free from technicalities, the town councillor will be more than ever inclined to think that he knows all about it. The contractor may, perhaps, humour him and the consulting engineer keep him within bounds; but, thank Heaven, we have a Board of Trade!

REVIEWS.

L'Eclairage à Paris. Par HENRI MARÉCHAL. (Paris: Baudry et Cie. 1894.)

A collection of opinions from various experts on the causes which especially contribute to the *éclat* and *gaité* of Paris, would be both instructive and amusing. M. Maréchal, *ingénieur des ponts et chaussées et du service municipal de la ville de Paris*, unhesitatingly attributes it to "the intensity and harmonious variety which is the predominating feature of the lighting of its great public streets." He has produced a remarkable book, not upon the result—that has been attempted before—but upon the cause which he has selected. Beginning with Saint Louis in 1254 he passes on quickly in a short historical chapter to the discovery and use of gas and of electric lighting. One third of the book is devoted to an excellent description of the production and distribution of gas, and of the various burners and lanterns used in Paris. The various kinds of regenerative burners are fully described with good illustrations, and elaborate statistics of their first cost and annual expense are given.

Seven chapters are devoted to electric lighting, and in these the supply stations of Paris, the plant, methods of distribution, systems of mains, and other details are discussed. The descriptions are very clear, and are abundantly illustrated. Meters and various kinds of lamps and miscellaneous systems of lighting, including festive illuminations and illuminated fountains are reviewed. The last chapter on the lighting of public streets is the most original. This chapter begins with the mathematical calculations of the distribution of illumination and discusses the effect of the height of the lamps on the resulting illumination. Unfortunately the author allows his mathematics to run away with him. In a former chapter he has given the photometric curves of different sources of light, the candle-power being plotted with polar co-ordinates. In this chapter he proceeds to show how the cartesian illumination curve, in which ordinates represent illumination and abscissæ represent horizontal distances, may be deduced from a given polar candle-power curve. So far so good, but he then investigates the theoretical polar candle-power curve which corresponds to uniform illumination. "This is the ideal photometric curve," says the author, "which all our sources of light ought to realise." But he admits at once that "it is evident that such a result cannot be obtained in practice, unless one can construct sources of light emitting infinitely powerful radiations towards the horizon." The polar candle-power curves of various gas burners and of a continuous current arc are illustrated and discussed, and this theoretical curve is introduced into each diagram, and is drawn to different scales for the purpose of comparison of the actual with the ideal. But we cannot see that any such comparison is possible, nor do we think that this ideal is a useful one. Not only does it suppose horizontal rays of infinite brightness, but all the rays making angles with the horizon less than 20° or 30° must have extraordinary intensity. Uniform illumination is not, we believe, wanted for street lighting, nor would it be appreciated if it were provided. But granting that uniformity is required, this ideal curve is useless, for it is foolish to attempt to produce uniform illumination over an indefinitely large area by means of a single lamp, and equally foolish to do so by each lamp when a number are used. The obvious course is to select an ideal district for each lamp, and to endeavour to illuminate that district uniformly. The diameter of such a district, assuming a circular outline for simplicity, might conveniently be six to eight times the height of the lamp above the ground. No rays should, therefore, be sent out at a smaller angle with the horizon than about 18° to 15° respectively.

Following on these theoretical investigations we find a considerable number of diagrams, giving by means of contour lines the distribution of illumination in several streets in Paris. On closer examination it is very disappointing to find that all these diagrams are merely calculated, and have not been plotted from actual measurements. They are, however, of some interest, since the values of the maximum, minimum, and mean illuminations are given in bougies—by which, of course, bougie-metres is meant—and these values, no doubt, represent actual facts.

The Slide Rule. By Charles N. Pickworth. (Manchester and London: Emmott and Co.)

A large majority of those who use the slide rule have learned the use of it from a friend; they have envied the ease with which he carries out calculations, and they have been induced to buy one. Sometimes a sheet of instructions or a pamphlet is sold with the rule, but these are soon lost. Very few manuals have been written on this subject, and no doubt the author of the present little volume of 56 pages is right in observing that no work has appeared relating to the Gravêt or Mahnheim type of slide rule.

A large number of habitual users of the slide rule confine themselves to multiplication, division, proportion, and simple problems involving squares or square roots, such, for example, as the areas of circles. It is safe to say that one person out of three cannot tell where to put the decimal place in the result unless by a separate effort of mental or pencil-and-paper arithmetic. Many people do not understand the use of an inverted rule, and those who can work out compound interest and trigonometrical calculations are the exception. The popularity of the Gravêt rules are due, not so much to the excellent arrangement of the scales, as to their admirable clearness, and the extraordinary accuracy of the dividing; but so powerful a weapon is a Gravêt rule that its use is well worth studying. There are, of course, other rules of more or less English make, one mode of manufacture being to take a genuine Tavernier-Gravêt rule and to cut out the maker's name.

The book before us is a disappointment, the introductory explanation is academical and obscure, and the numerous examples have evidently been worked out by logarithms and not by slide rule, since they run to far more significant figures than can be read even on a Fuller's rule. All the older books on slide rules have been full of "gauge points" or conversion factors, and it is customary to provide a few of these on a slip pasted on the back of a rule. In the present work, two pages of such factors are given, but the author attempts to secure greater accuracy by selecting two factors, to be set against each other, one on each slide. To remember one factor is bad enough, but to have a pair is too much for any ordinary memory, and a table of these double factors becomes necessary. The author goes out of his way most strangely to complicate his factors. His first example of conversion is a very common one, viz., millimetres into inches. "Here the ratio is 1mm. = 0·03937in. —a very inconvenient setting if one of the factors is unity. But recognising the fact that 127mm. = 5in., we at once obtain a suitable and simple setting for the conversion required." It is true that 0·03937 is an inconvenient setting, but why not adopt 25·4mm. = 1in., as, indeed, everybody does; it is an easy setting, and is correct to about 1 in 50,000. For conversion of feet per minute into miles per hour, the author gives the factors 264 and 3, but the single factor 88 is exactly the same value, it is familiar to most people who have to do with miles per hour, because it is so easily remembered. The double factors given by the author do not seem to present any advantages whatever, for when one factor is inconvenient to set, the reciprocal is always available at the other end of the rule, and if neither is convenient, it is clear that an attempt is being made to force the slide rule beyond its limits of accuracy. If a few factors only are wanted they can be written on the back of a slide rule; if a complete and accurate collection is needed, nothing can be better than Mr. Latimer Clark's "Dictionary of Metric Measures," in which all the reciprocal values are to be found, thus giving a choice for convenient setting. In his examples on mensuration we find the following two successive problems: To find the circumference in feet of a pulley 17in. in diameter, "Set 191 on C to 50 on D, and under 17 on C read 4·45ft. on D." But why not set 12in. against π, and against 17 read the result? Again, "Given the diameter of a circle, to find its area. Set 164 on C to 185 on D, and over any diameter on D read area on B." But why burden the memory or the back of the rule with the numbers 164 and 185, when everybody who uses a slide rule knows that the area of a circle of diameter 2 is π? The ordinary way of finding areas of circles on a slide rule is to set 2 on C (that is, 4 on B), against π on A. On the next page the author speaks of setting 3·1416 on B. Most rules have a special mark at π, why not say π? To set the final 6 on the B slide would need a rule about 6ft. to 8ft. long. In a steam engine problem the author directs 42,016 to be set on B. In an example of compound interest to find the amount of £500 at 5 per cent. for six years the author gives the following directions:—"Set L H index of C to £1·05 on D, and read the index on the scale of equal parts on the underside of rule, 0·0212." We have attempted this on a fine 50-cm. Gravêt rule which we habitually use. To begin with we find we must set the index of D to 1·05 on C, instead of the reverse, in order to open the beginning of the number scale on the back, and, having done so, by a displacement of $10\frac{1}{2}$ millimetres, we find the number scale reads a little more than 0·021. This scale on our rule is 50 cm. long, and is divided into one thousand half-millimetre divisions. We admit that the "little more" may be a 2, since the author has probably worked it out, but as it is represented by a length of one-tenth of a millimetre, it is difficult to read with accuracy.

This work is not likely to induce anybody to use a slide rule unless, indeed, by giving a false idea of the accuracy which is possible, and is not of much use to those who are fairly familar with the instrument.

Electric Transmission of Energy. By Gisbert Kapp. (Whittaker and Co. London. 1894.) Fourth edition.

In outward appearance resembling the former editions, the present issue of this work has in its contents undergone a complete revolution. Originally, principally a collection of descriptions of actual plant for electric power transmission and of actual instances of the use of such plant, the work has now transformed into an exposition of the fundamental and general principles of electric power transmission. Commencing with the elementary theorems of electromagnetic energy and force, the author then rapidly reviews the fundamental phenomena in an ideal dynamo, motor and circuit; from this he passes to graphical discussions and the use of curves. The classification of systems follows, and in the same chapter the author disposes of the whole question of continuous-current transmission. Three chapters following are devoted to alternate currents, a subject which occupies a far larger portion of the book than any other single subject. Various systems of alternate current transmission, with single, double and multiple phase machinery are thoroughly and completely studied, insofar as theoretical principles are concerned. The next chapter comprises a subject which was much more extensively treated in the former editions, but which has not suffered very considerably by compression, namely, the line and its relation to capital outlay, working expenses and the choice of systems. The concluding chapter is devoted to a number of examples of dynamos and motors for use in the various systems of working, and it is very tastefully illustrated with pictures of the various machines. There is, on the whole, a lamentable scarcity of scale drawings, and an absence of scales from the few diagrams which *are* drawn to scale. It will be seen, then, by those who are acquainted with Mr. Kapp's former editions of his work, that a complete revision has been undertaken and that an entirely new scheme has been followed in the revising. Whether the general usefulness of the work has been enhanced thereby probably remains to be seen, for the treatise can no longer be taken as adequately covering the ground indicated by its title. Yet, even though as a general treatise it may have suffered, there is no doubt that Mr. Kapp's book is a very complete treatise on one particular branch of electric power transmission—some will say it is the most important branch—the alternate current systems.

The Telephone Handbook. By H. L. WEBB. (Chicago: Electrician Publishing Company. 1894.)

Although this compact and handy little book makes no pretension to be considered a complete treatise of the telephone, even as it exists in America, yet it contains a great deal of useful, practical information on the subject, which is lamentably absent from many more pretentious works. The author is a good writer, and he knows how to compress into clear, terse language a quantity of really valuable material. In reading the little manual one gets the impression that the writer has an intimate and close acquaintance with the actual construction and working of telephone circuits and appliances. Of theory there is little or none in the book; it has been wisely omitted. There is a number of descriptions of the various transmitting and receiving apparatus which have been invented; some of these being perhaps a little ancient, but for the most part apparatus now in actual use on public and private lines. The writer possibly stretches the point a little where he thinks it necessary to instruct his readers in the morphology of the human vocal and auditory apparatus. Or, if not, why stop short at the throat and ear; why not discuss the morphology and physiology of the lungs and heart—and especially of the liver—of the mortal subscriber? However, only a trifling space is devoted to these unnecessary matters.

On the subject of telephone circuits the author gives abundant information, considering the small space at his disposal; the chapters on line construction, metallic circuits, underground wires, inspection and maintenance, and exchange working having a very practical ring about them. The author gives detailed instructions in these; instead of the silly, obvious platitudes which pass for practical hints in some books, and which remind one of the guide to etiquette which opened by advising the reader "not to spill coffee on his shirt front." Private house circuits are not very fully treated; but in so small a book, where so many good things are provided, it would be hypercritical to clamour about "sins of omission."

The Electric Central Stations at Cologne and Amsterdam. By CARL COERPER. Translated from the German by CLARENCE P. FELDMANN. (London: The International Electric Company. Leipzig: C. G. Roder.)

In this elegantly designed volume we have a bound portfolio of a large number of double page plates of two of the electric central stations equipped by the Helios Company, of Cologne-Ehrenfeld, together with two well-illustrated descriptive accounts of the character and working of the alternate-current plant at these stations. The work has been written and produced by the able Managing Director of that Company, and has been translated into English by a well-known contributor to our columns. As the physical magnitude and artistic nature of the volume is, perhaps, the first thing to strike the eye—though by no means the only praiseworthy feature in the work—it may put matters on a better footing if we first of all enumerate these physical characteristics. The book is $22\frac{1}{4}$in. deep and $15\frac{1}{2}$in. in width; and it is bound in thick, stiff imitation leather covers, with strong leather edges to the binding. There are in all 33 double-page plates on stout cardboard, 13 of which are devoted to Cologne and 20 to Amsterdam. Besides these there are no less than 60 large textual illustrations, many of them nearly half a page in size, and some of them artistically coloured. There are 32 pages devoted to descriptive letter-press. Each of the two sets of plates commences with a plan of the town showing the network of electrical conductors, and, in the case of Amsterdam, a separate scale drawing for the primary and secondary mains is also given. The other plates include plans, elevations, sections, and detailed drawings of the plant, and external and internal views of the station buildings and their several rooms and departments. The greater number of the plates are drawn to a given scale. Turning now to the letterpress, we find the translator calling attention to the fact that so much has been said in favour of and against alternate-current stations, that the publication of reliable figures, based upon the results attained in actual stations, may be of some interest. He is quite right; it is just that very publication of reliable figures which alternate current station engineers in this country are so shy about, and which is so much wanted, in order that a really fair and practical comparison between the several systems of electric supply may be undertaken. We are rejoiced to see that the authorities of these two continental central stations, which are equipped with Helios plant, are not afraid of doing this; and it is a further satisfaction that they have a series of very creditable performances to recount. We could only wish that as much had been published about any single one of our British stations equipped with alternating-current plant. After the introductory part, the first section of the letterpress is devoted to a description of the Cologne station, which supplies power on the high-pressure transformer system, the generators being run in parallel on a primary network. Every part of the plant is minutely detailed. The next section deals in a similar manner with the Amsterdam station, the electrical system in which is the same as at Cologne; and this section concludes with a number of day and night load curves, receipt curves, and highest-load curves for this town. In the third section the transformers, meters, motors, and other devices are described, some efficiency curves of the transformers, and some candle-power or light distribution polar curves for the arc lamps, being included. These latter have already been published in our columns (see *The Electrician*, Vol. XXXIII., page 543.). The last section, on "Results," will be most closely examined by electrical engineers; for herein we have not only the statement of the performance of the plant at each of the stations, but the author has also been at considerable pains to give a careful comparison of these two sets of results. The numerous tables in this section are decidedly instructive and valuable. We can only comment on one or two of the several features in the analysis. The 600-H.P. engines at Amsterdam—the newer station—are stated to have been cheaper than those at Cologne; while it is found that the working costs of the engines are lower at Cologne than at Amsterdam. With a load of about 300 kilowatts, the engines at the former place gave 840 watts per kilogramme of coal per hour (cheap slack), while at the latter the yield was only 715 watts. The cost of lubrication also appears to be higher with the cheaper engine. With regard to the boilers it has been found that two slightly worked boilers will produce a given amount of steam per hour as one full steaming boiler, only with the additional supply of from 15 to 25 per cent. more coal; a fact which seems to put limitations to the hypothesis that an underworked boiler, if not very much underworked, is not less efficient than a fully worked one. It is instructive to find the experienced manager of the Helios Company stating that "the advantages of the Amsterdam (boiler) plant are the large water spaces, the easy firing and large evaporating surfaces," an opinion which some eminent authorities in this country have been at great pains to combat and pooh-pooh, in so far as the large water space and ample evaporating areas are concerned Will these matters ever get settled, we wonder? If they do, it will be by nothing more than the continual publication of facts and experiences such as only station managers are in the position to supply. We will not quote nor comment further on this excellent literary, artistic, and highly technical production; but will express the hope that many of our readers will turn to the actual book itself for the abundant instruction which it affords. As a fixture for a library or office the volume would be excellent; but we cannot recommend our readers to use it as a pocket-book—it is so heavy!

The Magnet Hand Telephone. By N. Hughes. (New York: Spon and Chamberlain. London: E. and F. N. Spon. 1894.)

This book professes to be an account of the construction, fitting up, and use of the Bell telephone, and it comprises some 80 small pages in large type. There is very little in the book, and what there is is either so obscure that it is impossible to say what is exactly meant, or else it is irrelevant or wrong. The following sentence seems to combine a little of all three qualities:—"Iron to conduct as well as copper would have to be 12 times the sectional area of copper. But when we consider high voltages, that is, many thousands of volts, rubber and glass will be found to act in a somewhat contrary manner." In matters of practical detail, too, such little as there is cannot be relied on; the writer, for example, gives a sectional diagram of the mouthpiece in which the diaphragm is shown with a very decided camber, as if it were a spherical shell. The rigidity of such a diaphragm would be fatal to good working.

THE CHEMICAL THEORY OF ACCUMULATORS.—VI.

BY E. J. WADE.

(Concluded from page 725, Vol. XXXIII.)

The reactions that occur when charging secondary cells must necessarily depend on those of discharge, the one being the reverse of the other as far as the ultimate products are concerned; that is to say, if lead and lead peroxide are both converted into lead sulphate on discharge, on charge lead sulphate is converted back to lead and lead peroxide; if only lead monoxide is produced on discharge, then the charging reactions will be similarly modified. The same thing holds good of the electrolyte. If on discharge hydrogen sulphate is absorbed and water eliminated, water must be absorbed and hydrogen sulphate eliminated when charging. In any case the cycle of changes must be such that the cell is restored to exactly the same state on its completion as at its commencement; for the cumulative effect of any reactions not complying with this condition will ultimately destroy the reversibility of the cell altogether, and, as a matter of fact, these do in practice determine its efficiency and life.

In the third article of this series it was stated that if the chemical reactions when charging were exactly the reverse of those occurring when discharging, then the back or counter E.M.F. in the former case would be exactly the same as the E.M.F. generated in the latter case. Now, in practice, this never happens. Even after full allowance has been made for the internal resistance of the cell, the charging E.M.F. is always higher than the discharging E.M.F. by some considerable amount. As a typical case to illustrate this point the curves given in Fig. 2 have been constructed from data furnished by Prof. Ayrton in his Paper on the "Working Efficiency of Secondary Cells." Curve *b* shows the variation of E.M.F. of a cell while discharging, expressed in relation to the ampere-hours *contained in the cell*, the point at which the discharge is stopped being arbitrarily assumed to correspond to emptiness. It is really, therefore, the ordinary discharge curve of E.M.F. (which is expressed in terms of the ampere-hours *given out from the cell*) but *plotted backwards*: *a* is a similar charging curve, and is of the usual well-known form, for in this case, on the assumption made above, the ampere-hours *put into the cell* and the ampere-hours *contained in the cell* are one and the same thing. By plotting the two curves in this way, so that points in the same vertical line correspond to similar conditions of the cell, as regards the ampere-hours it contains, in both operations, a very interesting comparison may be made between them, and one which brings out relations to each other that might not otherwise be noticed.

It will be observed that for approximately the first two-thirds of the charge, the E.M.F. is higher than that of the corresponding periods of discharge by practically a constant amount—in this instance, nearly 0·14 volt; but that from this point onwards the difference between them continually increases until the cell is quite full, and even after that the E.M.F. still continues to rise. The only attempt to explain the high E.M.F. of the cell when charging appears to have been that of Messrs. Gladstone and Hibbert, who ascribe it entirely to the local strengthening of the acid in and around both electrodes consequent upon the reduction of the lead sulphate they contain. This theory, though extremely plausible, is hardly consistent with the whole facts of the case. If it were correct, then the local weakening of the acid on discharge ought to be equally marked provided the current in both cases is the same, and the accompanying E.M.F. as much too low as the other is too high. Instead of this it will always be found that throughout the greater portion of the discharge the E.M.F. is but very slightly below what is required to correspond to the strength of acid indicated by a hydrometer inserted in the main body of the liquid. This may be readily seen by reference to the discharge curve *b* (Fig. 2). At the commencement, when only six ampere-hours have been taken from the cell, its E.M.F. is 2·04 volts, which corresponds to acid of specific gravity 1·205 (*see* Fig. 1, article No. 4); while towards the end, when only 10 ampere-hours remain in the cell, its E.M.F. is two volts, corresponding to acid of specific gravity 1·165, and these figures are approximately the same as those actually observed. If the same points are taken on the charging curve, it will be found that the E.M.F. at one of them is 2·13 volts, corresponding to acid of specific gravity 1·300, and at the other 2·22 volts, corresponding to acid of specific gravity 1·400—values far above that ever attained by the bulk of the acid.

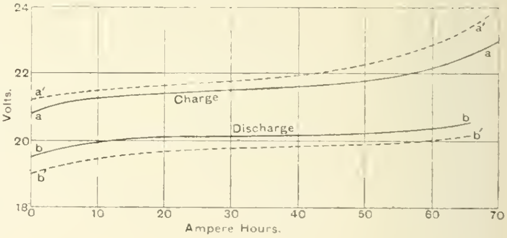

Fig. 2.

Besides this, the experiments of Messrs. Duncan and Wiegand have proved conclusively that diffusion from the interior of the electrodes takes place most easily and rapidly when a cell is fully charged, and becomes more and more impeded as the charge is withdrawn, owing to the clogging up of the pores of the active material with lead sulphate. It follows, therefore, that if the difference between the E.M.F.'s of charge and discharge were caused by imperfect diffusion, it would be greatest when a cell was empty, and least when full; whereas a reference to Fig. 2 will show that exactly the opposite is the case.

The most conclusive proof, however, that the high charging E.M.F. cannot be ascribed to the rapid accumulation in the electrodes of the sulphuric acid liberated by their reduction, lies in the fact that the same phenomenon occurs to an equally marked extent in a form of secondary cell in which the electrodes are perfectly solid and not in any way acted upon by the electrolyte—namely, Groves' gas cell. The theoretical E.M.F., according to Thomson's law, due to the combination of oxygen and hydrogen is 1·18 volts, and the E.M.F. of these cells when discharging is always below this value; but, nevertheless, the E.M.F. of the cell when charging may be forced up as high as 3·5 volts by sufficiently increasing the current density.

To say that this is merely the ordinary well-known polarisation effect, always observed when dilute sulphuric acid is decomposed with platinum electrodes, explains nothing, although it is the usual way of meeting the difficulty. The laws of thermo-chemistry still demand that appropriate chemical reactions must be taking place, otherwise this high E.M.F. would not exist, and to discover what these are requires a consideration of the electrolysis of dilute sulphuric acid in some little detail. It is generally assumed that the acid breaks up under the action of the current into hydrogen (H^2) at the negative, and sulphion (SO^4) at the positive electrode. According to modern views of electrolysis, some portion of the hydrogen sulphate in solution already exists in a dissociated form as free molecules of H^2 and SO^4, which are attracted to either electrode as soon as a difference of potential is set up between them, their place being at once taken by others; so that, if this assumption is correct, the water plays no direct part in the process, but merely serves as a solvent and a medium in which dissociation can take place.

The hydrogen passes off at the negative electrode; but the sulphion cannot exist in a free state, nor can it in the case under consideration enter into combination with the substance of the positive electrode. According to earlier notions, it reacted with the water present, reforming hydrogen sulphate with the liberation of oxygen.

$$SO^4 + H^2O = SO^4H^2 + O.$$

In 1878, however, Berthelot discovered persulphuric acid [$H^2(SO^4)^2$], and showed that it was the primary product at the positive electrode when dilute normal sulphuric acid was subjected to electrolysis. According to this theory, the free sulphion combines with sulphuric acid instead of with water, thus—

$$H^2SO^4 + SO^4 = H^2(SO^4)^2,$$

and it is this reaction that is the cause of the high E.M.F. required to produce the decomposition, for persulphuric acid is one of those comparatively rare compounds, termed "exothermic," whose formation is accompanied by an *absorption* of energy, and which *liberate* energy on decomposition. The compound is, however, an exceedingly unstable one at ordinary temperatures, and the bulk of it immediately undergoes decomposition at the electrode, reacting with the water and passing back to the normal acid with the liberation of oxygen.

$$H^2(SO^4)^2 + H^2O = 2H^2SO^4 + O.$$

This reaction, no doubt, forms part of the electrolytic series, and the energy liberated is restored to the circuit; but the small percentage of the acid that diffuses into the electrolyte, and there undergoes a more gradual decomposition, gives up its energy in the form of heat. In this case, however, the decomposition is not such a complete one, and generally takes place in two stages, hydrogen peroxide being the intermediate product, and afterwards breaking up into water and oxygen.

$$H^2(SO^4)^2 + 2H^2O = 2H^2SO^4 + H^2O^2,$$
$$H^2O^2 = H^2O + O.$$

Returning now to the case of ordinary storage cells, it becomes easy to see how the reactions just considered are modified by the introduction of lead electrodes; and the explanation takes the same lines as those already laid down by Dr. Armstrong and Mr. Robertson, who in their turn largely base their explanation on Prof. Marshall's researches into the formation of persulphuric acid and the persulphates.

To consider the positive electrode first. At the end of the discharge this consists very largely of lead sulphate, and the free sulphion first enters into combination with it to form lead persulphate [$Pb(SO^4)^2$],

$$PbSO^4 + SO^4 = Pb(SO^4)^2,$$

which then reacts with two molecules of water producing lead peroxide and normal hydrogen sulphate.

$$Pb(SO^4)^2 + 2H^2O = 2H^2SO^4 + PbO^2.$$

At the commencement of the charge, when a large quantity of lead sulphate is present, no doubt nearly the whole of the sulphion is absorbed in this way, and only a small percentage reacts with the hydrogen sulphate to produce hydrogen prosulphate as shown above. The latter reaction will, however, begin to increase in amount after a certain point has been reached, because, as the lead sulphate is gradually converted into peroxide, less and less remains for the sulphion to act upon.

When practically all the lead sulphate is reduced, and the electrode thoroughly peroxidised, it cannot be further attacked, and the whole of the sulphion then goes to form persulphuric acid, with immediate re-decomposition and liberation of oxygen; in fact, the usual phenomena attendant upon the electrolysis of dilute acid with platinum or other unattackable electrodes are observed.

It can now be seen that the amount of the difference between the curves of charge and discharge E.M.F. in Fig. 2 is really a measure of the proportion of persulphuric acid that is being produced at different periods, although no data are available that will enable it to be stated in absolute figures. As just explained, for the first two-thirds of the charge it remains fairly constant, then it goes on increasing till the cell is fully charged, and even after that it goes on increasing till a point is reached where the persulphuric acid decomposes just as fast as it is formed. The greater the density of the charging current the higher will the E.M.F. rise before equilibrium is attained, and this is exactly what in practice is found to occur.

The chemical actions that take place at the negative electrode present very little difficulty and are easily followed. Hydrogen in a "nascent" or highly active condition is liberated, and exerts a powerful action on the sulphate or other salts of lead that may be present, reducing them to the metallic state with the liberation of hydrogen sulphate.

$$PbSO^4 + H^2 = Pb + H^2SO^4.$$

Towards the end of the charge, when the reduction is nearing completion, the surplus hydrogen commences to pass off in a gaseous state, and in rapidly increasing quantities. Indirect evidence regarding the nature of some of the chemical changes that take place in storage cells may be derived from an examination of the variations in temperature during charge and discharge. In both cases, provided the whole of the reactions were absolutely electrolytic, no heat should be generated except that due to the electrical resistance of the cell, and any rise of temperature, beyond what can be accounted for in this way, must be ascribed to wasteful unelectrolytic heat-producing actions, including what is generally known as "local action."

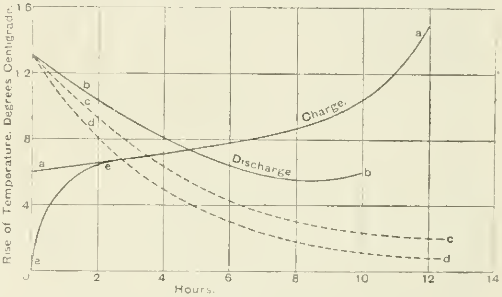

FIG. 3.

Unfortunately the data bearing on this question is extremely meagre, being comprised in a few experiments of Messrs. Duncan and Wiegand, and of Messrs. Ayrton, Lamb, and others. Curve *a*, Fig. 3, is taken from the published researches of the latter gentlemen, and shows the rise in temperature of a cell when being charged, while curve *b* shows the fall in temperature during discharge. Upon calculating out the amount of liberated heat to which this rise in temperature corresponded, it was found to far exceed that due to the electrical resistance of the cell, and in fact, it was equivalent to 17 per cent. of the total amount of energy put into the cell while charging. Thereupon the authors make the following very practical suggestion, which is best given in their own words:—"In order, then, to improve accumulators, what has to be especially sought for, and, if possible, then prevented, is that chemical action, which, in the case of the cells we were using, keeps the mean temperature of the cells about 0·7°C. above that of the air. This chemical action is very possibly quite distinct from the reversible one which accompanies the storing up of the electrical energy, and its subsequent liberation."

Now, all the evidence seems to be in favour of the action in question being the generation and subsequent decomposition of persulphuric acid, which has just been dealt with at some length in explaining the charging reactions, and, in fact, if this does occur it follows as an absolute necessity that it must be accompanied by an evolution of heat just such as is actually observed. It will be noticed how comparatively slowly the temperature rises during the first two-thirds of the charge when, as has been shown, the production of persulphuric acid is small; how rapidly it rises during the last third of the charge, and how, as might be expected, it still goes on rising after the cell is quite full, proving beyond a doubt that it is not due to any reactions taking place in the electrodes themselves.

Unfortunately, there does not appear to be much probability, or even possibility, of doing away with this wasteful reaction in question, as it appears to be a fundamental one involved in the electrolysis of dilute acid under any circumstances.

No conclusions can be drawn from the discharge curve *b* without the rate at which the cell would cool if no heat were being generated is known, or, better still, the rate at which it would cool if the only heat generated were that due to the passage of the current through the internal resistance of the cell. These are given, respectively, in curves *c* and *d*. It is now at once apparent that a gradually increasing generation of heat is taking place throughout the whole of the discharge, but that at no period is it as much as that generated while charging. The amount is far too small to be due to any of the main discharge reactions being merely heat producing; in fact, that so little heat is generated is one more proof of the impossibility of any such action. Another explanation that at first sight appears possible is that it is caused by the gradual breaking up of the hydrogen persulphate and hydrogen peroxide left over from the previous charge, which in these experiments only ceases immediately before the discharge begins. But, if this were the cause, the generation of heat would be greatest at first, and then gradually die away, instead of which exactly the opposite takes place.

It appears more probable that the heat is really due to a cause which was pointed out in the fourth article of this series as certain to produce such an effect—namely, imperfect diffusion. Every practical cell, however well designed, must suffer to some slight extent from this cause, and moreover, as the discharge proceeds and the active material becomes more and more choked up with sulphate, it will become more and more marked; and this is precisely what happens.

While the amount of heat liberated during the discharge does not under any circumstances appear to be large, the remarkable observation has been made that sometimes there is actually an *absorption* of heat during this process. In some of Prof. Ayrton's experiments the temperature of the cell at the end of the discharge, instead of being 0·6° above that of its surroundings, as shown in Fig. 3, had dropped to the same level or slightly below the surrounding temperature, and, as it will be seen from curve *c* that, even if the only heat generated were that due to the cell's internal resistance, its temperature ought still to be 0·2° in excess, this represents an absorption of heat. Unfortunately, beyond the temperature at the commencement and the end of the discharge, no other or intermediate readings were taken, so that it is impossible to say what was the form of the discharge curve in these instances, or whether the heat was being absorbed throughout the discharge. From the nature of the corresponding curve for the rise of temperature during the charge that followed (*see* curve *e*, Fig. 3) it would appear probable that this was not the case, and that it only began to take place towards the fag end of the discharge. If this is so, it would imply that the effect must be due to some reactions which commence about that time, and it is possible it may be in some way connected with the slight formation of lead peroxide that is sometimes observed to take place at the negative electrode. Great difficulty has always been experienced in explaining this phenomenon, and in deciding where the whole of the energy necessary for its accomplishment can be obtained from, but on the supposition of an absorption of heat the phenomenon becomes more explainable. Lead peroxide could not be produced without the formation of an equivalent quantity of persulphuric acid, and it has been already stated that this compound does absorb heat in the process, while the amount of acid generated would form too small a percentage of the bulk of the electrolyte to undergo immediate re-decomposition and give up its heat again.

The usual explanation of the cooling of the cells during discharge is to say that just as heat is generated when water is added to acid, so heat is absorbed when the acid is withdrawn from the water again; or, more vaguely, it is ascribed to the dissociation of fresh molecules of acid necessary to replace those used up; but these actions form part of the electrolytic reactions of the cell, and help to determine its E.M.F., and they cannot be used over again, therefore, to account for the cooling effects.

ELECTRICAL SCIENCE AT THE FISHMONGERS' HALL.

On Wednesday, October 24th, a large number of electricians were the guests of the Prime Warden and Court of Assistants of the Fishmongers' Company to meet Sir John Pender, G.C.M.G., M.P., at a dinner given at their Hall. Lieut.-General Sir Evelyn Wood, V.C., G.C.M.G., the Prime Warden, presided. Amongst those present were Sir F. Abel, Bart., Capt. Sir Douglas Galton, Sir H. Mance, Sir Albert Cappel, Mr. A. Siemens, Major-Gen. C. E. Webber, Mr. W. H. Preece, Prof. G. C. Foster, Prof. D. E. Hughes, Mr. S. D. Gladstone, Prof. W. C. Unwin, Mr. J. Bayly, Mr. W. Crookes, Mr. A. Brown, Mr. E. Cunliffe-Owen, Prof. S. P. Thompson, Mr. W. M. Mordey, Mr. J. W. Swan, Mr. W. H. Massey, Prof. J. A. Fleming, Prof. J. Perry, Mr. J. Denison Pender, Dr. J. Hopkinson, Prof. W. G. Adams, Mr. C. E. Spagnoletti, Mr. R. E. Crompton, and Prof. W. E. Ayrton.

In proposing the toast of Electrical Science, coupling with it the name of Sir John Pender, the guest of the evening, the Prime Warden said: "Some of you may remember that Burke wrote, 'Old impossibilities are modern probabilities.' Sir John Pender has outdone even 'modern probabilities,' having turned them into 'certainties.' We are too apt to accept the conveniences of a great achievement as though it were our rightful inheritance, but it is often the travail of one man's yesterday that makes the birthright of the many to-day. It is well that we should be sometimes reminded of what we owe to the pioneer who has made our track easy to us, and it is pleasant to feel that while we welcome our distinguished guest to-night, we are speaking not only for ourselves, not only even for this ancient and honourable Company, not only for our wide-stretching Empire, but for all the civilised world, and more especially for the great free worlds of America and Colonial England. There was no royal road open to the little Glasgow boy who first made his mark by winning a gold medal for drawing. It may be that Sir John's well-known love of Art, of which he has been a munificent patron, is the natural sequel of the early taste, the gratification of which had to be postponed while he fought the battle of commercial life, and, as we are glad to understand, successfully. There was no royal road for him then. There was sorrow and disaster before him to overcome and triumph over. but he lives to be the chief promoter, the sustaining force, of roads which were to bring together Royalties and their realms. Possibly many, but certainly not all of us, know how when the second Atlantic cable lay broken under mid ocean, and its promoters fell into deep waters of another sort, who it was that came forward with characteristic boldness, and by his personal guarantee of an enormous sum of money enabled the old cable to be replaced by a newer and better one. He had to face a special general meeting, a room full of irritated shareholders. There were cries of 'liquidate,' 'wind-up,' 'throw no more good money after bad.' Sir John replied, 'Yes, gentlemen, you may go into liquidation, we may wind up. but I will never allow the French or the Germans to lay the first Atlantic cable.' 'Wind up this Company, but I tell you fairly that I shall immediately start another, and I am good now at this moment for a quarter of a million.' Those of you who are engaged in commercial affairs will realise and appreciate the man's courage shown at that moment. For three years he bore this load of personal liability and that of an additional £50,000. He thus inaugurated his first of many great triumphs of communication. It is a marvel of commerce, science, and romance, for no wizard ever foretold a greater wonder; no poet could have dreamed of anything more far-reaching or inspiring than the long silent coil that lies deep down in the ocean, keeping us in quick and warm touch with our kindred in far distant lands. The whole of our Asiatic and Australian possessions are linked by that living chain. The whole of Africa is encircled by it. No one can over-rate this stupendous work; it is often difficult to thoroughly gauge all that it might be. The pall and darkness of distance are set at nought by the energy of a force formerly known only as an irresponsible destroying agent; but behind this force is the master power of genius, scintillant with an electric current which cannot easily be defined, since its gift is of Divine origin. It is the 'imperishable mind of man' which has set the lesser flame burning, and in this case the man is a notable instance of what genius and courage can effect. Personally I am deeply indebted to him for much thoughtful kindness, and he has enabled me and comrades to visit many historic battlefields on which our brave countrymen have bequeathed fame to our country; but it is as a public character that Sir John Pender will be remembered, since few men have done more to serve the public by large aims, and we cannot but admire the energy with which he has pursued them, and brought them to be monuments of national success.

Sir JOHN PENDER, in returning thanks for the compliment paid him, gave a very interesting account of the early history of submarine telegraphy and of its subsequent development.

ON ELLIPTICALLY POLARISED RAYS OF ELECTRIC FORCE.*

BY L. ZEHNDER.

By means of *two* wire gratings like those employed by Hertz to show the polarisation of his rays of electric force, elliptically and circularly polarised rays of electric force may be obtained in the following manner: In Boltzmann's interference experiment, let the two parallel plane mirrors be replaced by such wire gratings; if primary conductor, grating wires and secondary conductor are parallel, the wire gratings show nearly as beautiful interference phenomena as the plane tin mirrors. If now both gratings are turned in their own planes, through 45° in opposite directions, so that the directions of the wires are at right angles to each other, the ray of electric force splits up at each grating into two components at right angles to each other, normal and parallel respectively to the wires, of which components the former penetrates through the grating, while the latter is reflected. Hence the two gratings reflect two rays of electric force polarised at right angles to each other, and these two rays, under favourable circumstances, have equal amplitudes. If now we displace the one grating parallel to itself, as is done with the plane mirror in Boltzmann's interference experiment, we may impart to the two rays leaving the gratings, and polarised at right angles to each other, any desired difference of phase, and may thus produce elliptically or circularly polarised rays of electric force.

Since the wire grating placed in a slanting position with respect to the direction of polarisation of the incident ray only reflects the component of the incident ray which is parallel to its wires, while it transmits every component normal to it without perceptible absorption, the two gratings may be arranged *behind* instead of facing each other while keeping the wires crossed. The first grating reflects the component vibrating along the direction of its wires, while it transmits the component at right angles to it without impediment. The latter component—supposing that the distance between the gratings and the primary mirror is sufficiently great—vibrates exactly in the direction of the second grating, is therefore reflected by the latter, and again traverses the first grating without being seriously enfeebled. The ray reflected by this double grating may therefore be elliptically or circularly polarised according to the difference of phase attained between the two gratings. If both gratings are mounted movably upon the same axis, we may, by displacing the wire gratings with respect to each other, vary the difference of phase, and by turning them about the common axis vary the amplitude of the two rays reflected by the double grating; and thus we may change plane polarised rays into rays vibrating in any other given plane, or into elliptically or circularly polarised rays of electric force. The reconversion of such elliptically or circularly polarised into plane polarised rays of electric force may also be accomplished with this double grating, and hence the latter may, by analogy with Babinet's compensator for polarised light, be called a *compensator for polarised rays of electric force.*

Elliptically or circularly polarised rays of electric force may be tested for by the rectilinear secondary conductor with or without a secondary mirror, if it is mounted on an axis parallel to the direction of radiation. The secondary conductor reacts in every position about this axis with a different intensity in different positions in the case of elliptically, and with uniform intensity in the case of circularly, polarised rays. A wire ring lying in the wave plane as a secondary conductor must also act when exposed to such rays, and that equally well in case of circularly polarised light wherever in the circle the spark-gap may be. By some experiments I have found that the component of the ray which traverses the first grating, is reflected at the second, and then returns through the first grating, does after all suffer a considerable enfeeblement when compared with the component which is only reflected at the first grating. Thus we do not obtain circularly polarised rays by simply placing, as above detailed, the wires of the two gratings standing one behind the other at a distance of $\lambda/8$, at 45° to the plane of polarisation of the incident ray. But by turning the whole double grating about its axis each of the two components can be diminished to the vanishing point, by placing one or the other direction of wires at right angles to the direction of polarisation of the incident ray. Thus we may make the amplitudes of the two components polarised at right angles to each other exactly equal, and we may thus obtain not only elliptically, but also circularly, polarised rays of electric force as far as the regularity of the primary oscillation permits.

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* *Wied. Ann.*, No. 11, 1894. A short note on this method by Dr. Oliver Lodge appeared in our issue of August 3rd.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *October* 19, 1894.

Meeting of the American Institute of Electrical Engineers.—At the meeting of the American Institute of Electrical Engineers on Wednesday, two highly mathematical Papers were presented, one by Lieut. Reber, "On the Theory of Two- and Three-Phase Motors," and the other by C. P. Steinmetz, "On the Theory of the Synchronous Motor." In the former, elaborate equations are deduced for all of the various quantities concerned in two- and three-phased motor design and working, and some deductions drawn as to the effect of changes in various factors. One of the conclusions is that with a variable condenser in the armature circuit of a two- or three-phased induction motor, it can be made to run at a slow speed, and with increased torque without overheating, the speed can be made to increase to any extent up to synchronism, and there is no waste of power by the insertion of resistance to increase the torque. Another conclusion is that two- and three-phase motors have in general the same properties, and that the most important relation is that of the armature resistance to fL where L is the armature self-inductance and $\int$ is 2π times the complete period of the armature circuit. It is shown mathematically that high efficiency motors require a starting resistance, and that in such motors the torque can be readily regulated by adjustment of the armature resistance, enabling the point of maximum torque to be thrown at any speed desired. Another deduction from the equations is that it is an advantage to increase the frequency until the hysteresis heating becomes too great, or the motor runs too fast; also, that the high frequency motor will weigh less than a low frequency one and require less iron, but more copper. If the size of a motor is varied, keeping the magnetisation constant, the output and hysteresis are stated to vary directly as the weight, and the heating of the field and armature coils directly as the increase in size. Mr. Steinmetz, in the opening paragraph of his Paper, states that the theory of the synchronous motor therein given was written over a year ago, though not intended for publication, and is now published owing to the interest excited in the subject by Prof. S. P. Thompson's recent Paper before the British Association. It is pointed out in reference to the curves of synchronous motors running light, published by Mordey and others, that the two sides of the V-shaped curves are not straight lines, as usually assumed, but arcs of ellipses, the one concave and the other convex in curvature. It is shown that the maximum current through such a motor can be many times larger than the current which would pass the motor while at rest, having, in fact, the same value as if passing through a non-inductive circuit of the same resistance.

The American Street Railway Association.—The annual Convention of this body has been held in Atlanta, Ga., during the present week, and was one of the most successful of its history. But few of the Papers read, though almost all are of very great length, have much technical value, several being purely and simply commercial Papers. The report of the Committee "On a Standard Form of Street Railway Accounts," is the most important of the various reports. It classifies street railway expenditures under 52 heads.

CORRESPONDENCE.

UNFAIR COMPETITION IN BUSINESS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: It is exceedingly difficult to define what really constitutes unfair competition in business, though we all know when we feel unfairness.

Business is not like a game, for instance, or a race. No man is handicapped in business because he possesses advantages, no matter what they may be. On the contrary, a man would be thought foolish not to make the utmost use of any advantage that he might possess.

There is nothing, either, to prevent any man embarking in any business, except those connected with the medical or legal professions, for which he may have a fancy. If the fear of losing money and valuable time will not deter him, there is no law, no rule, not even an implied etiquette, to prevent him.

But there is a form of competition that may certainly be called unfair, and that may be compared to running with the hare and hunting with the hounds; and it is a form of competition far too common among electrical firms.

I allude to the practice so common with manufacturing electrical firms, almost without exception, of cultivating business with the distributor, the local firm, and at the same time supplying the consumer at the same price, and occasionally at a lower price than the local distributor is supplied at.

In many cases this practice is particularly unfair to the local man. He has, after spending many valuable hours, at last got a client up to the point at which he is prepared to spend money. Then the client either asks for tenders, or he writes to some of the firms who advertise in the electrical papers. One of these may be the very firm the local man would have purchased from if he had secured the order, yet the manufacturer will very probably quote the consumer the very best trade price.

This has happened to me again and again. Manufacturers sometimes say that if local firms will let them know they are quoting certain clients they will not interfere with them. But surely, as our American cousins would say, this is a little too thin. A local firm cannot send round to every maker about every transaction that he may possibly bring off. And, besides, why is not that necessary in other trades? There are very few articles, outside the electrical trades, that a consumer can buy at trade price, because manufacturers in other trades have the sense to see that they are undermining their own trade by undermining the pioneer distributor.

There are, of course, cases where consumers make statements that they are in the trade with the sole view of obtaining their apparatus cheaper. A watchmaker once gravely assured me that he was in the electrical trade because he had once bought an electric bell and fixed it himself. But these cases are rare. In nearly every case the initiative has been with the manufacturer, who has quite unnecessarily quoted trade price instead of consumer's price when an inquiry was sent to him. Of course, also, a manufacturer may elect to deal only with consumers directly, but in that case it is a little bit "off," as our American cousins would say, to send travellers out armed with the wonderful eloquence these men possess to try to persuade the local distributor to buy also. Yours, &c.,

Cardiff Electrical Works. Sydney F. Walker.

CONTRACTORS *versus* MANUFACTURERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I feel extremely gratified that you should have taken the trouble to criticise my letter *re* the above, but regret that I must differ from you in one or two of the remarks which you have been good enough to make. Your query as to what is unfair competition I would answer by saying that when a firm of manufacturers contract for certain work, a third of which comprises their own goods, and the remaining two-thirds is made up with the cost of labour, sundries, and possible profit, it certainly appears to me that this is the time to step in and say that the course is distinctly an unfair one.

You then go on to compare cable makers installing work with electrical sundries manufacturers, and suggest that the latter are likely to lose custom through doing so. How much more are cable manufacturers open to this possible disadvantage? as you seem to have overlooked the fact that they supply material to the value of over two and a-half times that of the electrical sundries manufacturer on an average installation. I have myself noticed the attempt to force a market which you speak of in connection with provincial electrical supply companies, and am also aware that as you say, in the majority of cases they have given up this branch entirely. As to capitalist competition, which you speak of as being an unqualified benefit to the customer, I am sorry I cannot agree with you on this point, as although it undoubtedly leads to cheap work and does not dimininish the number of workmen in the particular trade, yet it unfortunately increases their number with very inferior and unqualified men, and the customer generally discovers to his sorrow that having gone to the so-called cheapest market it ultimately proves itself to be by far the most expensive.

The question under discussion is undoubtedly one which is of most vital importance to the two classes of traders mentioned, and I now await with a considerable amount of interest further correspondence in your columns on the subject.—Yours, &c., Consulting.

LEGAL INTELLIGENCE.

Midland Lighting Company (Limited) v. Wood.

In the Queen's Bench Division of the High Court on Friday, before Justice Cave, sitting without a jury, the case of the Midland Lighting Company *v.* Wood and Co. came on for hearing.—This was an action brought by the plaintiffs, who carry on business at Birmingham, to recover £105. 4s. 1d., the balance of the price of certain electric fittings, which were specially made for the defendants, who were the patentees of certain electric lamps. The defence raised was that the goods were not according to sample, and that some of them were not delivered.—Evidence was given as to the delivery of the goods, and the defendants not appearing, his Lordship gave judgment for the plaintiffs for the amount claimed with costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices:*

Laboratory Notes and Forms.—With the above title, we have in preparation a set of Elementary and Advanced Notes and Forms for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. They are prepared with the object of saving the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

The 1894 Edition of "The Electrician" Electrical Trades' Directory and Handbook contains 1,000 closely-printed pages, and several new and useful features have been added. The price of this edition of the Directory and Handbook is now 5s. post free; abroad 5s. 6d. *The 1895 edition is in active preparation*, and subscription and advertisement orders should now be sent in.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, will be ready in a few days. It will contain the latest information respecting the application of electric energy to mining purposes, in which the author has had much experience. The book is well printed, on good paper, and will contain some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d., post free 11s. (abroad 11s. 6d.). Orders can now be received.

"The Work of Hertz."—The lecture delivered by Dr. O. J. Lodge at the Royal Institution on June 1st is reprinted with corrections and additions, and many original illustrations, price 2s. 6d. net.

"Electrical Engineering Formulæ," a pocket book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"Electromagnetic Theory," by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application.

New Volume.—The present issue of *The Electrician* is the first of a new volume, and this is, therefore, an excellent moment for commencing subscriptions to the journal.

Tenders Invited.—The Corporation of Sunderland invite tenders for wiring the Town Hall for the electric light, including the supply and fixing of cables, casings, switch and fuse boards, lamps, &c. Specifications, schedules, and general conditions may be obtained from the borough electrical engineer, and tenders must be delivered not later than 5 p.m. on Thursday, November 8th. Further particulars appear in our advertisement columns.

——— The Cheshire Lines Committee require tenders for the supply of telegraph material, instruments, wire, &c. Tenders are to be in by December 1st.

——— The National Telephone Company require tenders for the supply of various stores; and persons and firms desiring to tender must send in their names and addresses by Monday next to the head-storekeeper, at Oxford-court, Cannon-street, E.C.

——— Our advertisement columns contain an announcement that tenders are invited for the supply of various fittings and materials used in installation work. All enquiries are to be made in the first instance to "Electrical Contractor," office of this paper.

Tenders Accepted.—The following tenders were received by the Gas and Electric Lighting Committee of the Aberdeen Corporation for the wiring of the new police offices in Lodge-walk: Faraday Electrical Engineering Company (Limited), £265; Messrs. New and Mayne, £186; Messrs. Shirras, Laing and Co. (accepted), £143. 18s.——The following tenders have been received for wiring the premises of the Aberdeen Café Company:—Faraday Electrical Engineering Company (Limited), £120; Messrs. New and Mayne, £110; Messrs. Shirras, Laing and Co., £94. 14s.; Northern Electric Supply Company (accepted), £94.

——— The Islington Vestry have accepted the tender of Messrs. Macfarlane Bros. for the erection of the central station at Eden-grove, Holloway, at a cost of £23,785.

Sales by Auction.—Messrs. Wheatley Kirk, Price and Goulty will shortly sell by auction at the Deptford Central Lighting Station, Stowage Wharf, Deptford, S.E., a quantity of surplus plant and stock for the London Electric Supply Corporation (Limited). Catalogues are in course of preparation, and will be obtainable from the auctioneers. The sale will include engines, cranes, hydraulic accumulators, boilers, dynamos by the principal makers, new and second-hand cables, ropes and belts, copper tubing, &c., &c.

——— Messrs. Fuller, Horsey, Sons and Cassell will sell by auction on Wednesday, the 28th inst., at 1 o'clock, at their offices, 11, Billiter-square, E.C., some nearly new modern electric lighting plant, which is to be disposed of owing to the space being required for other purposes, current being now taken from the City of London Company's mains. Particulars are given in our advertisement columns, and all further information can be obtained of the auctioneers, 11, Billiter-square, E.C.; or of Mr. H. Cuthbert Hall, 46, Queen Victoria-street, E.C.

Bankruptcy.—The first meeting of creditors of Messrs. Woilliard, Scarborough and Co., lately carrying on business at Halifax as electrical and mechanical engineers, is called for November 5th at the Official Receiver's offices, Halifax, and the public examination will be held on November 12th at the County Court House, Prescott-street, Halifax.

Liquidations.—At meetings of the Crossley Telephone Company (Limited), held at Bradford, on the 1st and 18th inst., resolutions were passed and confirmed winding up the Company voluntarily. Mr. H. E. Jeffree, 30, Hallfield-road, Bradford, has been appointed liquidator.

——— The petition for the winding-up of Dalziel's News Agency of America (Limited) came before Mr. Justice Vaughan Williams on Wednesday. Mr. E. Pollock said the trustee obtained judgment against the Company for £18,750. In October last a meeting was called to pass a resolution for the voluntary winding-up of the Company, but he believed that resolution was never passed, and the Company was still carrying on business. The petition was ordered to stand for a month in order that an arrangement be arrived at, if possible.

——— Notice is given that a petition for the winding up of Reuter's International Agency (Limited) is to be heard at the Royal Courts of Justice on Wednesday next.

——— The application which was made on Wednesday at the Royal Courts of Justice, London, by the Bedford Engineering Company (Limited) for the winding up of J. G. Statter and Co. (Limited) was postponed. The business of the Company in the meantime is proceeding as usual, and we understand that a reconstruction of the firm is likely to ultimately result. Mr. F. J. Tingle, of 110, Cannon-street, E.C., has been appointed Receiver, and will furnish any required particulars.

Re Latimer Clark, Muirhead and Co. (Limited).—We understand that the newly-registered Wigston Electrical and Engineering Company (Limited) have, by arrangement with the Receiver appointed in the matter of Latimer Clark, Muirhead and Co. (Limited), acquired the premises recently offered for disposal without effect in Regency-street, Westminster, S.W., and have, in addition, taken over the books, patents, &c., of Latimer Clark, Muirhead and Co. The Wigston Company are commencing business under the management of Mr. F. Thornton, formerly with the old firm, who has retained the services of many of the late company's technical staff. Mr. F. V. Andersen, who was for some years with the Electrical Power Storage Company, and in 1884 joined Messrs. Latimer Clark, Muirhead and Co., and designed the "Westminster" dynamo, has been engaged as consulting electrician.

Electric Heating.—Messrs. Mappin and Webb, of Oxford-street and Queen Victoria-street, London, are the licensees from Messrs. Miller and Wood of a recently-patented device for heating by electricity. The illustrations herewith show a hot-water jug and tea-kettle. These are made by Messrs. Mappin and Webb in silver or electro-plate, and 8, 16, or 50-c.p. lamps are used. The 50-c.p. lamp will boil 2½ pints of water in 25 minutes; the 16-c.p. lamp will keep water at boiling point; and the 8-c.p. lamp will keep the boiling water sufficiently hot for afternoon tea. A number of other articles are made suitable for use with the electric fittings, including teapots, coffee-pots, &c. It is unnecessary to point out the richness of design of many of these articles, as the firm have a well-established reputation for all kinds of silver and electro-plated goods. The electrical fittings are interchangeable, and sets of utensils can be supplied for use with one electrical fitting. Fig. 1 shows the lamp water-heater with the water vessel

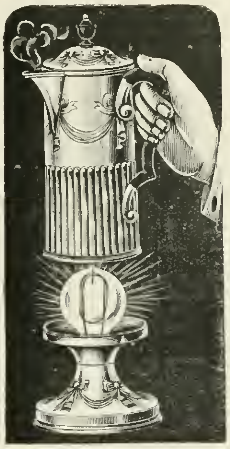

Fig. 1.

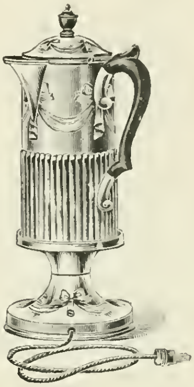

Fig. 2.

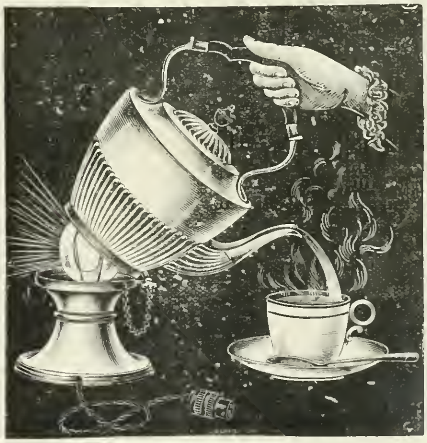

Fig. 3.

removed. Fig. 2 shows the complete set. The radiant heat crosses the vacuum of the lamp and the non-circulating air without loss, and then falls on and is retained by the blackened copper, and is so communicated to the water. The makers guarantee that 75 per cent. of the electrical energy is efficiently utilised in heating the water, and about 10 per cent. additional is retained in the metal. The electric water-heater is destined to supersede the out-of-date and dangerous spirit lamps until now frequently used for heating purposes in the drawing room, sick room, and many other places.

Agency.—Mr. Edward Maybury, of Chapel-street, Liverpool, has been appointed agent for Le Carbone, of London and Paris, for the sale of arc lamp carbons, carbon brushes, and other specialities.

———— Mr. Chas. F. Quicke, of 72, Finsbury-pavement, E.C., who was for some time London business manager for the Okonite Company, has been appointed by Messrs. Connolly Bros., of Blackley, Manchester, London agent for their cables, wires, tapes, &c.

"Engineers' Gazette."—Mr. G. N. Arnison, jun., of Sunderland, has been appointed editor of the above journal, whose head offices are situate at Prudential-buildings, Mosley-street, Newcastle-on-Tyne.

Oil Engines.—Messrs. Priestman Bros. (Limited) send us a new circular relating to the Priestman oil engine, which contains a large number of testimonials to the simplicity of the engine and the readiness with which unskilled labourers are able to adapt themselves to tending the engine. A list is given of users of the Priestman oil engine for electric lighting purposes only, and this list totals to nearly 840 H.P.

Worthington Pumps.—An action was tried last week in which the Worthington Pumping Engine Company asked for an injunction against the Naval Construction and Armaments Company to restrain the defendants from using the title "Worthington Pumps" in connection with pumps not made by the plaintiffs. The important question raised was whether the plaintiffs have or have not the exclusive right to the word "Worthington," the defence being that the word is used by engineers for the purpose of designating machines made under an American patent, which has expired. In the result the action was dismissed (by consent) without costs, the judge holding that there was nothing to show that purchasers for the defendants had understood that the pumps were supplied by the plaintiff company.

Electric Tanning.—Mr. L. A. Groth has removed to 88, Neckarstrasse, Stuttgart, Germany, and his system can now, we are informed, be seen in daily operation in various tanneries.

Bristol Batteries.—We learn that after prolonged experiments the new range-finding instrument invented by Profs. Barr and Stroud are fitted with Bristol accumulators.

Antwerp Awards.—Mr. S. Howes, of 60, Mark-lane, E.C., has been awarded a gold medal (the highest honour) at the Antwerp International Exhibition for his "Little Giant" double turbine and display of mill machinery. A gold medal and diploma of honour were also awarded the "Little Giant" at Chicago.——Messrs. Holland and Holland's exhibits of carriages at Antwerp took the grand prize. These carriages were fitted up with electric light by the Bristol Electric Safety Lamp Works.

Aberdeen.—Prof. A. B. W. Kennedy has reported to the Gas and Electric Lighting Committee of the Town Council that it is advisable to extend the electric light plant by the addition of two engines and dynamos, with steam and exhaust pipes, switchboard instruments and connections, &c., at an estimated cost of nearly £5,000. The Corporation have decided to introduce the electric light into the municipal buildings.——The electric light installation at the Aberdeen Joint Station is now complete, and the current was turned on for the first time last week. There are 22 Crompton-Pochin arc lamps on the platforms and approaches, current being obtained from the plant at the Palace Hotel.

Bath.—The Electric Lighting Committee reported to the Town Council at the last meeting that they had asked the electric lighting company to state the terms on which the company would continue the lighting of the city for one quarter of an hour, half an hour, and an hour each day during the months in the winter, or for five months from the 1st inst.

Bordeaux Exhibition, 1895. A meeting is to be held at the London Chamber of Commerce for the purpose of ascertaining to what extent British manufacturers and others are disposed to actively participate in the thirteenth National International and Universal Exhibition to be held in Bordeaux from May to November, 1895. Full regulations and other information as to the exhibition may be obtained on application at the offices of the Chamber, Botolph House, Eastcheap, London, E.C. It is proposed to nominate members of a British committee on lines similar to those adopted in regard to the Antwerp Exhibition of this year with satisfactory results.

Brechin.—At the meeting of the Police Commission on Monday the draft agreement between the Commission and the Scottish House-to-House Electricity Company (Limited) was approved and ordered to be signed.

The British Iron Trade.—A conference of the British Iron Trade Association, presided over by Mr. Jacks, M.P., was held at Glasgow on Tuesday, at which the elements which operate to occasion the serious depression in the iron trade were considered from various points of view. Several speakers and readers of Papers dwelt on the impossibility of coping with foreign competition, handicapped as British manufacturers are by high wages, heavy railway and steamship freights, and other conditions peculiar to this country. An eight-hours day was declared to be impossible if the trade is to be profitably carried on.

Burnley.—At the last meeting of the Town Council Mr. Alderman Lancaster, vice-chairman of the Gas and Electric Lighting Committee, stated that the use of the electric light was steadily increasing, and in a short time there would be 6,000 8-c p. lamps connected up.

Cable Orders.—Messrs. Connolly Bros., of Blackley, Manchester, have just received a large repeat order for vulcanised rubber main cable from the Manchester Corporation. The same firm have recently completed an order for the same type of cable for the extension of the Oldham Corporation's lighting scheme. In both cases the cables have been tested with satisfactory results.

Cardiff.—Neither of the candidates who applied for the situation of foreman to superintend the machines at the electric lighting station being considered sufficiently expert for the position, the Town Council have resolved to again advertise for a foreman, but to omit the previous proviso that the applicants must be residents in Cardiff.

Chapel Lighting.—The Wesley Chapel at Bolton will be the first place of worship in the town to be lighted by the electric current. The building has been fitted up by the Corlett Electrical Engineering Company, and the light is to be used for the first time on Sunday next. The gas fixtures have been retained and utilised as much as possible. In the chapel itself there are over 90 32-c.p. lamps, 20 of which are in the central corona; there are two 50-c p. lamps in the transept. The mission room below the chapel contains 67 8-c.p. lamps, and every part of the premises will now be well lighted.

Colliery Lighting.—The Ashington Coal Company and the Harton Coal Company have each decided to instal the electric light in their mines, and each Company has given an order for a dynamo to run 1,000 16-c.p. lamps.

The City Lighting.—The following retractation of an insinuation which recently caused some excitement in legal and electrical circles appears in the current number of *To-Day*, a journal which is, we think, taken much too seriously in this matter: "In our issue of October 20th we published a paragraph in which reference was made to the electric light suddenly going out in every City office during the fog of the previous Tuesday, and it was said that 'it might be well if some disinterested person would inquire from the City of London Electric Lighting Company why their cables have so rapidly worn out.' The paragraph went on to refer to a rumour that when the City of London Company called for tenders for their cable supply 'the tender made by one of the oldest and best of the cable companies was passed over in favour of that of a much smaller company, asking a considerably higher figure,' and that 'Now these cables have so signally failed, the older company has been called in to repair and make good their former rivals' faulty work.' The information upon which the paragraph was based came to us from a source—it did not come to us from a rival company in which we had every confidence, and before using it we received assurances that satisfied us that in referring to the rumour we were doing no injustice to the parties concerned. We are now satisfied that we were misled. The general manager of the British Insulated Wire Company has called upon us in relation to the matter, and he assures us that, far from the cables being worn out, the engineer-in-chief of the City of London Electric Lighting Company told him that they took advantage of the breakdown due to causes for which the British Insulated Company was in no way responsible—to make a test on the cables, which proved that they had gone up in insulation 15 per cent. from the tests last March. Further, the general manager of the British Insulated Company showed us a letter from the City of London Electric Lighting Company (Limited) which, unsolicited but in justice to the former company, we think it right to publish:

City of London Electric Lighting Company (Limited),
1 and 2, Great Winchester-street, E.C.,
October 24, 1894.

Messrs. The British Insulated Wire Company (Limited), Prescot.

Dear Sirs: In reference to the paragraph in *To Day* to which you have called our attention, I have to say that the statement contained in that paragraph is entirely without foundation. We have never had the slightest trouble with the cable you have laid down for us, and which now reaches to a total of 107 miles. Your cable was selected by us after sufficient trial, because we could get it to withstand a very much higher pressure than any other cable that has been submitted to us.—Yours faithfully,

The City of London Electric Lighting Company (Limited),
David Cook, Engineer and Manager.

We have also been shown a letter from Mr. A. J. Lawson, engineer and manager of the County of London and Brush Provincial Electric Lighting Company (Limited), addressed to the British Insulated Wire Company, in which he says that he is 'fully aware that the extinction of light in the City was not due to breakdown of your cables.' Under these circumstances we have no hesitation in expressing our regret that the paragraph in question appeared in our columns. We thought that the standing and knowledge of our informant warranted the acceptance of his statement, but by some means or other he was misled, and in turn misled us. The error has given the British Insulated Wire Company just cause of complaint; but, recognising our good faith in the matter, they have made their representations in a spirit of courtesy we gladly recognise, and which makes it doubly incumbent upon us to give this explanation, and to say how much we regret the mistake made by our informant."

Customs Dues on Electrical Plant.—It is stated that the Minister of Finance of the Argentine Republic has refused to entertain the petition of Mr. W. R. Cassels (representing the Electric Light Company of the River Plate) for a return of the duties paid on imported electrical plant, apparatus, and material.

Dublin.—Mr. Buckley has been elected Chairman of the Electric Lighting Committee of the Corporation, in the room of the late Mr. J. L. Robinson.

Electricity and the Production of Chlorate of Potash.—It is well known in the chemical trade that chlorate of potash can be easily produced by electricity, but hitherto, owing to the expense of production, the product has not been forthcoming in sufficient quantities to materially affect the market. The time has now come when this state of affairs will be modified, and the success which is attending the production of chlorate of potash in Sweden, under the patents of Mr. Oscar Carlson, bids fair to revolutionise the market in this product. A factory has been established within easy reach of the ports of Gothenburg and Stockholm, enabling the manufacturers to readily deal with large quantities of raw material, and to dispose of the manufactured article without heavy railway or steamship charges. The necessary power for driving a large plant of dynamos and turbines is obtained direct from water power in the form of a large and regular waterfall. The power thus obtained is utilised in converting an easily obtainable raw material into practically pure chlorate of potash, and water is present in a sufficiently large quantity to supply ten times the power at present required. The process is a very clean one, with little or no waste product, the chief item of cost being wear and tear, although this is, we understand, much less than the wear and tear of machinery in alkali works in this country working under the old systems, in which chlorine proves such a destructive element. Hitherto the production of chlorate of potash by electricity has been chiefly confined to laboratory experiment, but in the Swedish factory methods have been adopted for utilising electric current which are quite new and fully protected. One principal advantage of the new system is that the chlorine is dispersed at the initial stage instead of requiring treatment by successive processes, as is the case under the old method. The new treatment of the raw material, it is stated, practically excludes the possibility of any impurity in the article. This new departure in the production of chemicals seems likely to prove definitely that, if electric current be properly distributed over the article to be treated, water-power and electricity, at any rate so far as chlorate of potash and other chlorates are concerned, will prove by far a cheaper method of production than steam and coal, with the heavy labour entailed. It has been proved that the amount of labour required under the new system is very low compared with that of any chemical factory producing the same quantity of finished material under the old process. What is, however, especially necessary for working the Swedish patents is a regular and powerful water supply at a spot where the raw material can be delivered, and the finished article exported at a small cost. There are, unfortunately, only a few favourably situated spots where these conditions prevail, and the Swedish firm appear to have selected one of the best. The effect on quotations for chlorate of potash has, of course, already been serious, as the practicability of the new process has been recognised by the older makers, and it is doubtful whether present prices can be maintained. We learn that the price for delivery of chlorate of potash for 1895 is from £10 to £12 per ton below the price made at the same time last year for delivery over 1894, and this on an output of several thousand tons must materially affect the market. The Swedish factory appears to have started on the right lines. It is not overloaded with capital, which is is more than can be said for more than one of its competitors, and will, therefore, only require to be steadily at work to pay regular and improving dividends. There can be no doubt that the heavy capitalisation of several of the older concerns give the new process, with its reasonable capital, an excellent chance of success. Messrs. G. Boor and Co., of Artillery-lane, London, E.C., with whom the sale of this new make of chlorate of potash has been placed, and who have dealt in the article on a larger scale and for a longer period than any other distributing firm in London, anticipate that the factory's full output will be readily disposed of. Any of our readers interested in the matter and desirous of obtaining further information should communicate direct with Messrs. Boor and Co. The plant at present in use includes 8 dynamos of 220 H.P., and considerable additions are now being put down.

Electric Traction in Switzerland.—Plans have been prepared for the construction of an electric tramway between Baden and Zurich. Tenders have just been invited by the municipal authorities of Lugano for the establishment of a network of electric tramways in the town.

The Foreign Office.—With reference to a statement respecting the failure of the electric light at the Foreign Office on Monday evening, Mr. F. Iago, the Secretary of the Westminster Electric Supply Corporation, writes to say that the accident was caused by the melting of a safety fuse, which put out the lamps on one floor of the building, and was in no way attributable to failure in the Corporation's supply of the electric current.

French Customs Duties.—The French Customs authorities have recently decided that all machines imported into the country for the covering of wire for electrical purposes are to be classed under "Mécanique Générale."

Hobart (Tasmania).—Arrangements are being made to introduce the electric light into Hobart, and a Bill authorising the public lighting of the town by the electric current is to be introduced in the next session of Parliament. Messrs. Siemens Bros. and Co. will undertake the contract in the event of the Act being passed.

Hull.—During the quarter ended September 30th the Corporation electric light station delivered to consumers 20,149 units as against 10,740 in the corresponding quarter of last year. The expenditure for the quarter was £1,929, and the income £2,013, or a profit balance of £86.

Kensington (London, W.).—The Vestry have decided to give their consent to the proposed application by the Notting Hill Electric Lighting Company for a Provisional Order in respect of the northern part of the parish, the area recently abandoned by the House-to-House Electric Supply Company; this consent to be conditional on the terms of the proposed Order being approved by the vestry. The Commercial Electric Supply Company have also given notice of their intention to apply for an Order in respect of the same area.

Kingston-on-Thames.—At the meeting of the Town Council last week, the Market and Lighting Committee reported that they had instructed the electrical engineer to draw up a circular letter calling attention to the benefit derivable from the use of the electric light; that they had under consideration the question of laying mains for charging electric launches; that Messrs. Siemens Bros. and Co. had notified their willingness to extend their guarantee for the cables supplied by them for a further twelve months; that an additional boiler being necessary at the electric light works, one had been ordered from Messrs. Belliss and Co.; and they recommended the Council to apply to the Local Government Board for permission to borrow a further sum of £4,000 in addition to the £6,000 previously applied for, and for which an inquiry has yet to be held. The Committee's report was approved.

Lectures.—Prof. J. A. Fleming delivered a lecture last week under the auspices of the Local University Extension Committee and other auspices in the town of Scarborough. The lecture was given in the Circus to a crowded audience on the subject of "Applications of Electricity—the Universal Servant." The Mayor presided, and Dr. Fleming's lecture was listened to with great attention and interest by the audience. At the conclusion of the lecture the Mayor proposed a vote of thanks to Dr. Fleming, which was cordially accorded.

Leicester.—The Wigston Electrical and Engineering Company (Limited) have secured for their new works an excellent site at Wigston, near Leicester. Building operations are to be commenced at once, and are designed to enable the Company to work on the largest scale.

Limehouse (London, E.)—At the last meeting of the Board of Works, a question was asked as to the position of the electric light and what had become of the report which had been received from Prof. Robinson. The Chairman replied that the Committee appointed to deal with the electric light question had become defunct, and no report had been received from it.

Liverpool.—At the meeting of the Town Council on Friday it was resolved to refer to the Watch and the Health Committees the present position of the Liverpool Electric Supply Company for their observation and report.

Llangollen.—On Friday and Saturday last some successful experiments in electric lighting were made in this town under the direction of Mr. Roseburgh, representative of Messrs. Easton, Anderson and Goolden (Limited), and it is anticipated that the display of the capabilities of the light will lead to its being introduced into the town generally.

The New Decimal Association.—A general meeting of the members of the New Decimal Association will be held at the offices of the London Chamber of Commerce on November 20th. It is intended, as soon as possible after Parliament reassembles, to move the appointment of a Select Committee, and it is chiefly for supporting this action that the meeting now called is to be held. It is also proposed that endeavours should be made to secure energetic action in the United States.

Newhaven.—The electric light has just been installed along the wharves and in the sheds and offices of the London, Brighton and South Coast Railway Company at Newhaven, the work having been undertaken by Mr. J. W. Jackson, an electrician in the Company's services.

New Swindon.—The Local Board have resolved to apply for a Provisional Order.

Penrith.—At the last meeting of the Local Board it was proposed that the Board should apply for a Provisional Order, but the resolution was not seconded, and the matter dropped.

Portsmouth.—Mr. F. H. Tulloch last week held an inquiry on behalf of the Local Government Board in reference to on application from the Corporation for power to borrow £20,000 for the purpose of extending the electric light works. It was explained that it was only intended at present to borrow £6,000, in order to purchase an additional engine and dynamo and street transformers and cable connections to houses. In addition to street lighting, current had been already supplied to 5,200 16-c.p. lamps of private consumers, and applications had been received for over 1,500 additional lamps.

Presentation.—On Wednesday last, on the occasion of Mr. E. Putland's retirement from his position on the technical staff of Messrs. Johnson and Phillips, he was presented by his late colleagues and friends with a gold watch and other small items to mark the esteem and goodwill which he has so well earned during his 10 years' connection with the firm. Great regret was expressed by Mr. Putland's colleagues at his retirement, and he is followed by their best wishes. Mr. Brockie made the presentation on behalf of the donors.

Reading.—The laying of the underground mains for the Reading Electric Supply Company has been commenced by the contractors, the Callender Bitumen Telegraph and Waterproof Company, (Limited).

Rhondda Valley.—At the meeting of the Rhondda Local Board on Friday a discussion took place upon a proposal that the various streets and roads in the valleys now lighted by gas should be illuminated by electric light. Mr. T. Griffiths, the head manager of the Cymmer Collieries, Porth, stated that he was quite prepared to lay down an installation at his collieries to generate sufficient electricity to light the whole of Porth and the Cymmer district, as well as the collieries belonging to the company, at a cost not greater than that charged by the gas company. It was agreed that the clerk should write to the other colliery companies asking them if they were prepared to supply the other portions of the valleys in a similar way. It may be stated that the Cwmparc district, where the Parc and Dare Collieries (Ocean) are situate, is already lighted by electricity generated at the Parc Colliery.

Southampton.—The Hartley Council, at their meeting on Monday, instructed their Finance and General Purposes Committee to ascertain the cost of installing the electric light in the Hartley Institution. Mr. Le Feuvre, the Chairman of the Committee, alluded to the success of the self-contained installation at the Free Library, and said he was sure the similar plant at their building would effect a considerable saving in cost over gas.

Sunderland.—The Museum and Library Committee of the Town Council have had again under consideration the question of the electric light. It has been estimated that the cost of installing the current in the entire building would be £314, with an annual upkeep charge of £165. The Committee thought it would be better at first to apply the light only to the reading-room and library, and the question has been again adjourned for an estimate to be obtained for lighting these portions of the building.

Technical Education.—The Technical Education Board of the London County Council are issuing as an official circular the *London Technical Education Gazette*, which deals fully with the various educational schemes at present under the consideration of the Board, and sets out in tabulated form a list of the principal evening classes in science, art, and technology to be held within the Administrative County of London during the session 1894-95. The *Gazette* is of interest to all engaged in teaching work within the Council's district.——At Tuesday's meeting of the County Council the quarterly report of the Technical Education Board was submitted. It stated that since the last report the Board had made grants amounting in the aggregate to £3,905.

Wandsworth (London, S.W.).—The District Board of Works have disapproved of the plans submitted by the County of London and Brush Provincial Electric Lighting Company, respecting the construction of transformer chambers in the public streets, and are, we understand, supported in their action by the London County Council. The Company have recently submitted another plan, with a reduced number of these transformer chambers, but the Board of Works at their last meeting resolved to adhere to their former decision.

Worcester—. The Watch Committee of the Town Council held their fortnightly meeting on Monday, when the Electrical Exhibition Sub-Committee presented a balance-sheet showing that the total receipts amounted to £212, and that a credit balance was left of £49, without using the grant of £50 made by the Council. A letter was read from the Secretary of the Tramways Company asking the Committee to reconsider the tram bye-laws, as they proposed to introduce light one-horse cars. The Mayor, in moving that the matter be referred to the Sub-Committee, remarked that in reconsidering the bye-laws they might suggest to the Company that the cars should be run by electricity.

Wycombe.—The Mutual Improvement Society had a public debate on the propriety of the electric light being introduced into this town, and after a long discussion a motion was carried, "That in the opinion of this House the Corporation is not justified in incurring the expense connected with the electric light."

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

October 20, 1894.

20,017. A. G. New and A. J. Mayne. London. Improvements in the regulating mechanism of electric arc lamps.

20,043. W. Geipel. London. Improvements in arc electric lamps.

20,059. P. Scheidt and J. W. Tideman. Berlin. Casting by means of electric current.

20,081. C. Langdon-Davies. London. Improvements in rapid telegraphic transmission.

October 22, 1894.

20,105. B. Davies. Liverpool. Improvements in electric measuring instruments.

20,126. M. M. Bair. London. Improved system of fixing agglomerated manganese blocks to carbon or other electrodes.

20,127 M. M. Bair. London. Improved porous pot for primary batteries.

20,152. V. Fabris. London. Improvements in incandescent electric lamps.

20,170. H. Zerener. London. Improvements in electrical soldering and welding apparatus.

October 23, 1894.

20,223. R. L. Howard. London. Improvements in electrically worked pumps.

20,241. H. H. Lake. London. Improvements in alternating current motors. (E. A. Clark. United States).*

20,259. C. Kellner. London. Improvements in electrolytic apparatus for decomposing metallic salts.

October 24, 1894.

20,293. G. F. Sanders. Birmingham. Improvements in holders for globes or shades of electric, gas, or other lamps.

20,317. J. R. Mally. London. Improvements in electric glow lamps.

20,330. I. Vago. Glasgow. Improvements in electro-magnetic machines.*

20,354. P. Marino. London. Improvements in and connected with the electro-deposition of aluminium and aluminium alloys. [Date applied for under Patents, &c., Act, Sec. 103, May 31, 1894, being date of application in France.]

20,363. H. Gilbert and A. B. Gilbert. London. Improvements in rests or supports used with telephones for supporting the arms or elbows of persons using the telephones.

20,366. L. Epstein. London. Apparatus for applying electricity to regulate and control engines or machinery.

20,382. A. C. Brown and G. R. Neilson. London. Improvements in electric telephones and means of signalling thereon.

October 25, 1894.

20,397. H. P. Creffield. Erith. An improvement for cutting out electric arc lamps.

20,432. F. C. Allsop. London. An improved electric bell for mines and outdoor use generally, with damp-proof or hermetically sealed contact-breaker.

20,439. H. Tipping, H. A. Tobias, W. H. Cadman, and R. J. Crowley. London. Improvements in the production of electrical energy and in means or apparatus employed therein.

20,442. J. E. A. Gwynne and R. Kennedy. London. Improvements in and connected with arc electric lamps.

20,462. F. E. W. Bowen. London. Improvements in and connected with induced current telegraphy.

October 26, 1894.

20,482. H. A. Catmore. London. Improvements in junction couplings or clips for electric lighting installations.

October 27, 1894.

20,546. S. Butcher. London. Improvements in electric telegraph systems for working double-current translation.

20,548. H. Lea. London. Improvements in electrical motor fittings for transmitting motion to light machinery.

20,561. G. W. Lowcock. Manchester. Improvements in electric arc lamps.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1893.

19,251. Crawshawe and Battye. Electric indicator for colliery engine houses, &c.

20,384. Hookham. Electricity meters.

20,847. Scott. Carbon brushes, blocks, &c., for electric generators and motors.

20,975. Gregg. Voltaic batteries.

22,856. Fowden. Printing telegraphs.

23,477. Orme. Electrical signalling on railways.

23,478. Coehn. Electrolytic preparation of oxygen, &c.

1894.

16,425. Young (Hess Storage Battery Company). Storage batteries.

16,859. Coykendall. Electrical distribution.

COMPANIES' MEETINGS AND REPORTS.

Eastern Extension, Australasia and China Telegraph Company (Limited).

The forty-second ordinary general meeting of this Company was held on Wednesday, at Winchester House, Old Broad-street, E.C., under the presidency of Sir John Pender, G.C.M.G., M.P.

The SECRETARY (Mr. F. E. Hesse) read the notice calling the meeting and the minutes of the last meeting, which were confirmed by the present meeting. The report of the Directors was taken as read.

The CHAIRMAN said: Gentlemen, before asking you to approve the report I shall, as usual, make a few remarks. The gross receipts for the half-year under review have amounted to £247,681, against £257,986 for the corresponding period of 1893, showing a decrease of £10,305. During the half-year, however, the loss on exchange has been exceptionally heavy, amounting to £21,000, otherwise the revenue would have shown an increase. On May 1st last the rates of collection in the Straits Settlements and for certain of the China traffic were raised, and as soon as we are in a position to do so we shall adjust the tariffs for the rest of the China traffic so as to obtain the full currency equivalent of our sterling charges. The working expenses have amounted to £80,295, against £78,229 for the corresponding period of 1893, showing an increase of £2,066, which is practically due to the opening of new stations at Labuan and Soerabaya. The usual interim dividends at the rate of 5 per cent. per annum have been paid for the past half-year, amounting to £62,500, and the balance of £68,457 is carried forward to the next account. The third year's working of the Australian tariff guarantee arrangement expired on April 30th last, when it was found that the loss for the year amounted to £12,384, one-half of which was borne by the guaranteeing Governments and the other half by the associated Companies in terms of the agreement which is still in force. During a portion of last year, however, an abnormally large traffic was carried in connection with the reconstruction of many of the Australian banks, and as far as the figures at present show a much larger loss will ensue for the current financial year. As you are aware, things are not in a very satisfactory state in Australia at the present time. The Colonies have passed through a severe commercial crisis. They have had what is called a land scare, and altogether the banks have had rather a hard time of it: but the darkest cloud has its silver lining, and energy and power exist there which, after a time, will assert themselves, and I have no doubt that we shall then see things "booming" again in the Australasian colonies. At our last meeting I referred in considerable detail to the question of a Pacific cable, which is now apparently ripening. The Canadian Government are very anxious to see the scheme carried out, and there has been a meeting at Ottawa on the subject, attended by delegates from Great Britain, the Australasian colonies and the Cape. They were all very complimentary to one another, but, as far as I can learn, the result of that conference amounts to this, that they were by a thorough survey, to ascertain the best route along which to lay a submarine cable, and having done this, to invite tenders and submit particulars of the cost to the different Governments interested. That, gentlemen, is rather an important part of the business. We are not opposed in any way to the laying of submarine cables; but we want to see them laid in a way that will benefit the public generally—the telegraphing public and the commercial public—on both sides of the sea, and meet a decided want. At the present moment, however, the telegraphic communication with Australia is probably second to none in the world, and fully meets all reasonable requirements. Still, if it is decided by the Governments interested that a cable should be laid, it, it is not our business to oppose such a desire, beyond protecting ourselves, by seeing, if possible, that the cable is laid on principles which will not in any way destroy us. I have always said, and I now repeat it, that when the cable comes to be laid, the Governments will be wise if they consult us, and make use of the large experience we have gained in cable work. I may say that any manufacturer can lay a cable, but it is not everybody who can maintain one. The maintenance of a cable, in fact, is the great difficulty, and until we know the route and depths, we cannot form a reliable opinion as to what it will cost to maintain Those are my ideas on this subject, gentlemen. They are ideas of progress, but at the same time they are ideas of prudence. The Canadian Government are pushing on the matter; in fact, they are going a little beyond their instructions in inviting tenders, for when they get them—and no doubt they will do so—they cannot accept any tender until the programme has been carried out of ascertaining where the cable ought to be laid. We shall watch this question with the greatest care, and when it is solved, if a cable is laid, I think I may say, as I have said on more than one occasion, that we are likely to have something to do with it. At all events, if we have not, we shall use all our influence in order to protect our interests. Shortly after our last meeting we completed the laying of our new cable from Singapore to Hong Kong viâ Labuan. I have always said that an alternative line or a duplicate line, either for commerce or politics, is an absolute necessity. We have realised that on many occasions, and it was again brought home to us the other day, because had we not had this cable we should have been cut off from communication with Hong Kong through the Straits. We have now in the China seas a thoroughly efficient alternative line which, I believe, will be of great value to us in the future. This policy, which we have pursued from the inception of the Company, has so far proved a successful one. As long as cables are wanted, wherever trade goes and the British flag flies, you may depend upon it that if we see our way to carry our system there we shall do so; but in carrying out this work we have always to keep in view the question of ways and means. You would not like me to come before you every half-year and tell you that we cannot give you any dividend because we have spent all our revenue in laying cables; but if we can continue the policy we have hitherto adopted of duplicating our cables, extending our system, and strengthening the value of your property, while at the same time maintaining a fair dividend—what in these days might be called a good dividend—I think you will agree with me, that our policy is a success. (Cheers.) I have had only two letters from the great body of our shareholders on this occasion. One writer says, "You have got such a handsome reserve now that I think you ought to stop increasing it, and to give us a little more dividend." The other shareholder in his letter to us highly commends the policy of the Directors; and that policy, as you know, has always been sanctioned and approved by the body of the shareholders. This shareholder says: "You have done well, nursed what you have done and maintained the life and efficiency of the property, not only in the cables, but in the steady dividend which you have paid us. Continue that policy, and I am quite sure that every shareholder of the Company will thank you." Now, gentlemen, I need not read those letters to you. Sometimes I rather like to receive a letter, because it shows us how the wind is blowing among our shareholders, and I like to have an idea as to whether they are satisfied or not. I can only tell you that my Directors and myself feel pretty well satisfied that we are going on the right road, and we intend to keep to it. We think a reserve fund is the mainstay of our Company. (Hear, hear.) If we had no backbone in the form of a reserve fund such as we have now, we could not do the work we are doing. For instance, we laid the alternative cable the other day to Hong Kong. We did not require to go to the public and ask them for money—we borrowed some from our reserve fund, and we shall gradually pay it back to that fund. This is a useful system; it practically makes us our own bankers as long as we do not overrun the account. That, however, we take care of. Believing, as I do, that we are very carefully overlooked by extremely competent accountants, I think there is no great danger of our going wrong in that direction. Therefore, in answer to the first of the two shareholders whose letters I have referred to, I say that I cannot agree with him, nor do my Board, nor, I believe, does the body of the shareholders. We shall go on increasing our reserve fund, therefore. With reference to the second letter, I thank the writer for the confidence he places in us, and we shall go on following the same course in the future as we have done in the past, believing it is the sound course. It has been successful in the past, and there is no reason why it should not be equally successful in the future. I have now given you some particulars of our working and our policy: but there is another point which I desire to refer to and I think it was mentioned in one of these letters that we ought on an occasion like this to remember our staff. Well, gentlemen, we have done so. We have established a pension fund, which is appreciated by them all. We are endeavouring to make our service one which people will rather aspire to enter, and we are careful as to whom we select for our service, because, so far as my judgment goes, the better the men the better the service. The other day we had our festival, when we celebrated the twenty-fifth anniversary of the successful working of the Eastern and the Eastern Extension Companies, and we then gave all our men throughout the service, at home and abroad, a good dinner. That is not much, you may say; but our staff is a very large number to dine. This act of ours, at any rate, shows that while we are rejoicing here we do not forget those who are serving us, and, as I have said, all our staff, abroad as well as at home, participated in the joy which we all experienced here on the occasion of the twenty-fifth anniversary of our successful working. Some of us will not see another 25 years, but some of us will, and when that second 25 years has elapsed, I hope that those connected with the Company then will be able to look back to the present time and say, "After all, we built on a good and sound foundation." (Cheers.) I thank you for listening so attentively to my remarks, and I feel sure it would be appreciated by our staff if you would join with me in a resolution expressing appreciation of the work done by them at home and abroad during the last 25 years, and thanking them for their services. With these remarks I beg to move—

"*That the report and accounts of the Directors now submitted be received and adopted.*"

The MARQUIS of TWEEDDALE: I second that.

The CHAIRMAN: If any gentleman desires to make any remarks I shall be very pleased to answer him, but if not, I will put the resolution.

A short discussion then followed, in which Messrs. Newton, Burgess, and Walker took part, as to the development of North Borneo, the effect of a Pacific Cable and the Chino-Japanese War on the Company's earnings. It was also suggested by Mr. Newton that a bonus should be given to the staff to commemorate the Company's twenty-fifth anniversary, after which

The CHAIRMAN said: Your remarks, Mr. Walker, are perfectly correct, but just at the present time, when Canada is showing so much interest in this matter and has the Australian colonies to deal with, who may possibly differ among themselves as to where this cable should be laid and where it should touch, I think the less we say about it the better. We keep our eyes open, and shall watch the matter very closely, and if it comes to touch us "on the quick," you may depend that we shall be quickened by the touch. I have spoken about this question guardedly, as you may have observed, because I do not want to "go dead," as it is called, against any Government. If they want a cable let them have it, but I do not think any Government would deliberately attempt to destroy a system which has been so markedly beneficial to them and the world at large as ours has been—so successful that they think that out of our success they can create a system for a great deal less money than ours can be worked for. Let them try and find that out. As I have said, our experience is such that we can teach them something, although they do not yet believe that there is anything to teach them. Submarine cables, however, are not exactly things of to-day. They have cost a great deal of money to nurse. We know a good deal about them, and if another important cable like this is to be laid, if we are not consulted about it, the wisdom which ought to be shown in connection with such an important matter will not have been displayed. I have been asked a question about the China traffic in connection with the present war. War, as a rule, creates a considerable amount of traffic. It may limit commercial work pure and simple; but war creates a class of commerce which requires rapid transmission, and this can only be done through the telegraph. With regard to Mr. Newton's question about North Borneo, a short length of cable has been laid between Labuan and Borneo, and as soon as the land line which is in course of construction by the British North Borneo Company across North Borneo is completed, direct telegraphic communication will be given with Sandakan, the head-quarters of that company. As you are aware, a good deal of tobacco grows there; but that industry was, I believe, greatly checked by the McKinley tariff. That, in turn, has now been changed, and I think that better days are dawning for Borneo. There is one thing that you may rest assured about, and that is that wherever there is telegraphic communication, industry or commerce, if it exists, will be largely promoted by it. Regarding the jubilee, I should have said that our twenty-fifth anniversary festival was probably one of the most marked successes that has ever been seen. We had nearly 600 people at dinner, and about 10,000 to the evening fête. It went off with the regularity of clockwork, and the festival was just as successful in its way as the institution it was representing. I was very much pleased indeed to find that it was greatly approved by all our shareholders, and it was graced and honoured by the presence of the Prince of Wales and other members of the Royal Family. This fact shows how the whole matter is regarded by them; and I think you will agree with me that in these days a kind word or a little help, even in the case of a great institution like ours, is appreciated and rather adds to the position which we hold. I think I have answered all the points which have been put to me, and I will now ask you to vote on the resolution. Those who are in favour of it will signify the same in the usual manner. Those against it. Carried unanimously. That is all the business to-day. We have no re-elections on this occasion. I have only to add that we are delighted to see you, and that our prospects are very encouraging.

Mr. BURGESS: I do not think we ought to let this meeting go by without expressing our best thanks to our most excellent Chairman and the Board for the way in which they have managed this great system. I feel convinced that the shareholders will agree with me in this.

Mr. WILLIAM MORTER: I will second that with much pleasure.

The resolution was carried unanimously.

The CHAIRMAN: Gentlemen, I do not think that I have ever been absent from one of our meetings, and I believe that this is the forty-second meeting at which I have had the honour and pleasure of returning thanks to the shareholders for this vote. In our early days we did not know each other as well as we do now, and I hope that we shall learn to know and to respect each other more and more every year. We shall do our best to preserve your confidence, and to make your confidence show results which will be satisfactory to you.

The proceedings then terminated.

Monte Video Telephone Company (Limited).

The annual ordinary general meeting of this Company was held on Wednesday at the offices, 96, Gresham House, Old Broad-street, Mr. Herbert Ward presiding.

The SECRETARY (Mr. E. M. Reiss) read the notice convening the meeting.

The CHAIRMAN said: Looking at the results of the year's working you will observe that the net profit of £6,902 is just slightly in excess of the net amount of profit made last year. The subscriptions have increased by £460, and the item under this head to the credit of profit and loss account is still further increased this year by the rent received for subletting the lower portion of the central premises at Monte Video, which has been included therewith. Previously this rent, being of small amount, had been credited to the general rent account, and so went to the reduction of working expenses in Monte Video, appearing on the debit side of the profit and loss account; but it has been thought advisable in future to separate this item, and take it direct to profit and loss. This explanation will, of course, account for the apparent increase in working expenses this year, which, after allowing for this item of rent no longer credited to the account, are actually only £4 in excess of last year, when the expenses, as you will recollect, had been reduced to the lowest level compatible with efficiency. The increase in the London office expenses is mainly accounted for by the addition made last year to the number of Directors. The amount for income-tax is slightly lower than last year, and the loss in exchange last year of some £13 is turned into a gain this year of £48, which is a satisfactory feature. I come now to an important item the Board have had to deal with this year, and it is the value of the materials on hand. These have for some time been standing in our books at a higher figure than they are intrinsically worth, although amounts against them have from time to time been written off to a general depreciation fund. This stock of material includes a quantity of Gower-Bell instruments taken over from the old Gower-Bell Telephone Company, which are fast becoming obsolete; and in view of the large discrepancy between the value in our books and their actual value to-day, the Board had no alternative but to deal with this point in this year's accounts. After careful consideration, and acting on the advice of the auditors, it has been decided to write off £1,345 to profit and loss for this depreciation, and to take out of the depreciation fund a further £1,000 for this same purpose, thus bringing the value of the stock on hand to the exact amount it is run out at by our general manager, namely, £3,494, at which it stands as an asset in our balance-sheet to-day. Coming to the subject of bad and doubtful debts, I am happy to say that none have been made during the period under review, which is an evident effect of the improvement which has at last set in in Uruguay, and which, as it continues, will make itself felt in all branches of trade and enterprise connected with the country. The amount outstanding for subscriptions on July 31st last was slightly in excess of the corresponding amount last year, but our manager endorses the whole list as "considered good and recoverable." At the same time your Directors deem it only prudent to place aside £500 to provide for any future loss on this account. The number of our subscribers continues to be well maintained, and shows, in fact, an increase of 46 at the end of July, compared with the same period last year. Altogether I think it can safely be said that the Company is satisfactorily progressing, and that, with greater activity in business circles in Monte Video there is very little doubt but that everything will go ahead, our Company included. By placing to the reserve account this year £1,000, the position of the Company is still further strengthened by the possession of an actual liquid asset to this extent, and I think you will agree with me that the fact of our being enabled to pay, after putting aside this sum, a dividend of four per cent. compares very favourably with other South American enterprises at the present time. I now formally move:—

"*That the report and accounts as presented, be received and adopted.*"

Mr. F. W. JONES, in seconding the motion, said the majority of the Board were inclined to place a larger amount to the reserve fund and pay a somewhat smaller dividend than that proposed, but in view of the opinions expressed by some of the largest shareholders it was thought that on the present occasion they might pay four per cent.

Mr. TOUCH, referring to the item of securities in the balance-sheet, asked what they were?

The CHAIRMAN replied that they consisted of Terminal Railroad Association of St. Louis Four and a-Half per Cent. Gold Bonds; Atchison, Topeka and Santa Fe Railroad Four per Cent. Gold Bonds; New York Central Railroad shares, and Bank of New Zealand Four per Cent. Guaranteed Stock. These investments were now worth within a few pounds of what they cost.

The report was adopted unanimously.

The CHAIRMAN then moved—

"*That a dividend at the rate of 4 per cent. per annum on the Preference share capital of the Company be declared for the year ended July 31, 1894, and that the same be paid forthwith.*"

Mr. EDWARD F. POWERS seconded the motion, which was carried.

On the motion of Mr. JONES, seconded by Mr. C. LOCK, the Chairman was re-elected a Director.

The CHAIRMAN, in thanking the meeting for his re-election, said he received a letter on the previous day from Mr. Sanford, one of the Directors, at present in South America, who, in conclusion, said:—I cannot close this without saying that the management at present in Monte Video is as near perfect as it is possible to attain from a business point of view. This is strongly put, but my views have been increased after close observation. The great improvement is due to the manager's earnest efforts to give satisfaction to the Board. He thought that was a most gratifying piece of information.

Mr. HAROLD SMITH proposed the reappointment of the auditors (Messrs. Gérard Van de Linde and Sons), which was seconded and agreed to.

Mr. BALFOUR proposed as a friendly motion: -

"*That it is recommended that all available monies coming to London, and not for the time being required, be invested by the Board in trustees' securities.*"

Mr. HODGSON seconded the motion, and it was carried.

The CHAIRMAN promised that the motion should guide the Board in their future action.

The proceedings then terminated.

NEW COMPANIES, STATUTORY RETURNS, &c

[*In addition to the informatcon given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1894, pages 274-300, *&c., &c.*]

ARNETT BROTHERS (LIMITED).—This Company was registered on October 27th with a capital of £4,000, in £10 shares, to acquire a business carried on at Middlesbrough, and to carry on the business of iron, steel, and general merchants, bolt and rivet manufacturers, &c.

BAILEY AND GARNETT (LIMITED).—This Company was registered on October 27th, 1894, with a capital of £10,000, in £5 shares, to acquire the business carried on at Stalybridge by Roberts, Buckley and Company (Limited), and to carry on the business of machinists, engineers, tool makers, brass founders, metal workers, &c.

CONTINENTALE GESELLSCHAFT FUR ELEKTRISCHE UNTERNEHMUNG.—Under this title a Company, with a capital of 16 million marks (£800,000), has just been formed at Nuremberg, Germany. The object of the Company is to acquire and exploit undertakings, the contract for the electrical portion of which is to be carried out by Messrs. Schuckert and Company, of Nuremberg, who are largely interested in the new concern.

GENERAL EXPLOITATIONS (LIMITED).—This Company has been registered, with a capital of £20,000 in £1 shares, to carry on the general business of an exploration, development, exploitation, mining, mercantile, agricultural, commercial, land mortgage, and industrial company.

LONDON MATHEMATICAL SOCIETY.—This Company has been registered, with a membership of 250, each of whom undertakes to contribute towards the assets of the Company, in the event of the winding up of the same, a sum not exceeding £1. 1s.

MECHANICAL PATENTS SYNDICATE (LIMITED).—This Company has been registered, with a capital of £1,500 in 1,500 shares of £1 each, to acquire and develop certain patents, and to carry on business as mechanical and general engineers.

NEWPORT ELECTRICAL ENGINEERING COMPANY (LIMITED).—This Company was registered on October 29th, with a capital of £2,000 in £1 shares, to carry on the business of electrical and mechanical engineers in all its branches: manufacturers, workers, dealers in electricity, motive power, light, electrical apparatus and appliances, including metals, insulators, conductors, lamps, fittings, &c.: to generate, produce, store, accumulate and distribute electricity, electromotive force, or other similar agency, for the purpose of lighting omnibuses, tramcars, cabs, and other vehicles, and public and private buildings, and to acquire the right to use or manufacture and put up telephones, telegraphs, electric bells, phonographs, and other electrical apparatus. The subscribers (with one share each) are—George Bell, D. J. Griffiths, J. Boddy, M. J. Beavan, W. E. Thomas, E. Davis, and L. S. Abrahamson, all of Newport, Mon. The Company is registered without the filing of special Articles of Association, and no particulars respecting the management are, therefore, obtainable.

JOHN PILLING AND SONS (LIMITED).—This Company was registered on October 22nd with a capital of £50,000, in £100 shares, to acquire the business of an engineer, ironfounder, machinist, and manufacturer of machinery of every description carried on by John Pillling at Colne, Lancs.

REVOLUTION WOODEN PULLEY COMPANY (LIMITED).—This Company has been registered, with a capital of £20,000 in £1 shares, to carry on business as ironfounders and mechanical engineers.

HALL ELECTRICAL COMPANY (LIMITED). An agreement filed on October 16th provides for the sale to the Company of the business of an electrical engineer and contractor carried on at Liverpool as from October 25th for £1,400, payable by the allotment as fully paid of 1,400 shares, Nos. 1 to 1,400 inclusive. Loftus J. Barnacle and Herbert H. Hall are appointed managers for three years from the incorporation of the Company.

INTERNATIONAL ELECTRIC STORAGE (LIMITED).—An agreement, dated September 20th, states that whereas the Company is indebted to Arthur W. Stormont to the extent of £10,000, it has been agreed that 2,000 fully-paid shares of £5 each shall be allotted to him or his nominees in full satisfaction of such debt. A special resolution, passed August 29th, and confirmed September 14th, at meetings held at 73/75, Gresham House, Old Broad-street, London, E.C., is as follows: "That of the existing shares of the Company, the Directors be and are hereby authorised to issue 4,000 as Preference shares, entitled to a cumulative Preferential dividend of £6 per cent., and entitled to rank for dividend *pro rata* with the Ordinary shares after payment of £6 per cent. on the Ordinary shares for the time being issued." Another agreement, made on October 13th, with Arthur W. Stormont, provides for the allotment as fully paid of 6,000 shares of £5 each, in full consideration for the sum of £30,000 which the Company previously owed him.

IRISH HOUSE-TO-HOUSE ELECTRICITY COMPANY (LIMITED).—In reply to inquiries respecting the non-filing of the statutory returns, Mr. D. O'C. Miley, Assistant-Registrar of Friendly Societies, of 16, Dame-street, Dublin, writes that the Company is still in operation, and that a law suit is at present pending between this and another company as to the profits of the contracts for the Corporation's works there.

JONES BROTHERS AND CO. (LIMITED).—An agreement, dated September 10th, with Thomas W. W. Perry, provides for the sale to the Company of the business of a brass founder, manufacturer of electrical appliances, and electrical engineer, carried on by him at Birmingham, for £1,600, pay £300 in cash, £500 by the issue to the vendor or his nominees of £500 of Debenture stock, and £800 by the allotment as fully paid of 800 Ordinary shares of £1 each. The vendor agrees to remain in the service of the Company as the Managing Director.

LONDON AND LANCASHIRE ELECTRIC AND GENERAL ENGINEERING COMPANY (LIMITED).—The annual return of this Company, made up to July 13th, and recently filed, showed that 1,987 shares were taken up out of a capital of £20,000, in £5 shares. Of these, 1,000 were issued as fully paid to William Palmer and William R. Pryke, who were the vendors. Upon the remaining 987 shares a call of £2 per share has been made, resulting in the payment of £1,847, leaving £127 as yet in arrears. In addition, a sum of £2 has been paid on two forfeited shares.

LONDON REFUSE STEAM GENERATOR AND ELECTRICAL POWER CORPORATION (LIMITED).—An agreement, dated September 11th, made between this Company and the Atlas Contracting Syndicate (Limited), provides for the allotment of 200,000 fully-paid shares of £1 each to the said Syndicate. No reasons for such allotment transpire in the particulars filed. At the time of the last return only the seven signatories' shares were subscribed for.

CITY NOTES.

BERLINER ELEKTRICITATSWERKE. The annual report (1893-94) of the Berliner Electricitatswerke, of Berlin, shows the following figures up to the end of September, 1894: Consumption of current supplied to the cable 97,287 amperes; an additional 9,313 amperes on order will be shortly connected. The consumption of current during the year 1893-94 was equal to 92,055,000 normal lamp hours for private customers, and 424,290 for street lighting, and for motors 570,421 kilowatt hours were used. At the end of June, 1894, 380 motors were connected with an output of 1,364 H.P., and orders for 70 more motors, with an output of 300 H.P., are in hand. The total capacity of the station is 13,000 kilowatts. The Berliner Electricitatswerke were designed and constructed by the Allgemeine Elektricitäts Gesellschaft, of Berlin, whose sole agents for Great Britain are the Electrical Company (Limited), of 122 and 124, Charing Cross-road, W.C.

BRITISH NORTH BORNEO COMPANY.—This Company has received the following telegram respecting the progress of the telegraph line across North Borneo: "Eastern section trial trace, 117 miles; permanent 24ft. trace, 32 miles."

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ended October 28th were £948, as against £850 in the corresponding period of 1893, being an increase of £98. The total receipts for the half-year amount to £14,811, as against £13,806 for the corresponding period of 1893, an increase of £1,005.

THE HARVEY STEEL PROCESS.—Under the title of the Harvey Continental Steel Company (Limited) a new Company has been registered with a capital of £120,000 in £10 shares. Invitations for subscriptions for 8,000 shares close this day (Friday) at 4 p.m. for London, and to-morrow morning for the country. The object of the Company is to acquire from the Harvey Steel Company, of New Jersey, U.S.A., patent rights, secrets, and goodwill in the Harvey Steel Process. The offices of the Company are at 34, Victoria-street, Westminster, S.W.

LIVERPOOL OVERHEAD RAILWAY STOCK.—The correspondent who writes us from Glasgow concerning the stock of this Company is informed that on closer inspection of the Share List he will find that the figures given refer to the number of shares and not to the value. Both the Preference and Ordinary shares are of £10 each, and this will explain what appears to him an inaccuracy. The other points referred to in his communication have attention.

MONTE VIDEO TELEPHONE COMPANY (LIMITED).—Warrants payable on November 1st for the Four per Cent. dividend on the Preference share capital for the year ending July 31st were posted on Wednesday.

RUSTON, PROCTOR AND CO. (LIMITED) The Directors have declared an interim dividend of 5s. per share.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended October 26th (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited) were £2,975.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Oct. 24.		Price Wednesday, Oct. 31.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 31.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	9 0	Anglo-American	38	41	35	37	5 8 1	Jan., Apr., July, Oct.	38	37
£2,993,560	Stock	18 0	Do. Preferred	74½	75½	71	72	5 18 1	,, ,,	73⅜	71½
£2,993,560	Stock	5/0	Do. Deferred	6¾	7¼	6¼	6¾	..	..	6⅞	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 17 1	January and July	..	..
130,000	£10	4/0	Brazilian Submarine xd Bonus	12¾	13¼	12½	13	5 0 0	Mar., June, Oct., Dec.	12 15/16	12¾
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	110	114	110	114	4 8 11	June and December	..	–
10,000,000	$100	$1¾	Commercial Cable Capital Stock	135	145	135	145	4 17 9	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12½	13½	12½	13½	5 18 6	February and August	13	12¾
6,000	10	10%	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	,, ,,	..	..
12,931	5	1/8	Direct Spanish (£4 paid)	4½	4¾	4½	4¾	4 4 3	April and October	4⅝	..
6,000	5	10%	Do. Preference 10 per Cent.	9½	9¾	9½	9¾	5 2 7	,, ,,	..	–
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	..	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8½	9	8	8½	5 17 7	Jan., Apr., July, Oct.	..	..
400,000	10	2/6	Eastern	15¾	16	15¾	16	4 1 3	,, ,,	15 13/16	15¾
70,000	10	6%	Do. 6 per Cent. Preference	16¾	17½	16½	17	3 10 7	,, ,,	16¼	
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	118	121	118	121	3 6 2	May and November	120	119½
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	110	106	110	4 11 11	February & August	..	
250,000	10	2/6	Eastern Extension	16	16½	15⅞	16⅛	4 6 11	Jan., Apr., July, Oct.	16⅛	15⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	116	120	116	120	3 6 8	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	106	103	106	4 15 5	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	106	103	106	4 5 6	,, ,,	104½	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	104	107	104	107	3 15 6	February & August	104½	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	109%	112%	109%	112%	3 12 9	May and November	110	..
180,227	10	1/3	Globe Telegraph and Trust	8¾	9¼	8⅜	8⅝	4 15 9	Jan., Apr., July, Oct.	9¼	8 11/16
180,042	10	6%	Do. 6 per Cent. Preference	15¾	16½	15½	16	3 15 0	,, ,,	16	15½
150,000	10	5 0	Great Northern	20½	21½	20½	21½	3 19 1	Jan., April, and July	20¾	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	..	..
17,000	25	12 6	Indo-European xd	46	48	46	48	5 4 2	May and November	..	..
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent Debentures	107	110	107	110	5 10 1	March & September	107½	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	104	107	104	107	3 15 8	..	..	..
11,839	8	4/0	Reuter's	3	5	3	5	..	April and October	..	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	105	110	104	109	5 10 7	,, ,,	105½	..
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	100	103	100	103	4 17 10	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	2¼	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	101	106	101	106	7 10 11	June and December	..	..
88,321	10	9d.	West India and Panama	1¼	1½	1¼	1½	..	.	1¼	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11½	11	11½	5 4 4	May and November	11½	11 3/16
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	..	..
£80,000	100	6%	* Do. 6 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 11 6	June and December	..	..
64,242	15	7/6	Western and Brazilian	8½	9	9	9½	..	May and November	9½	8 15/16
33,129	7½	7/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	..	6⅞	6 11/16
33,129	7½	4/6	Do. 5 per Cent. Deferred	2¾	3½	3	3½	..	..	3¼	3
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	106	109	106	109	5 11 7	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	103	109	106	109	5 11 7	,, ,,	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115	120	115	120	6 0 2	May and November	–	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 16 6	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	..	..	..
224,850	10/0	2⅔d.	Consolidated Telephone Const. & Maintenance	⅛	¼	⅛	¼	..	May and November	..	..
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	7/16	9/16	7/16	9/16	..	Yearly	..	..
484,597	5	3/4	National	4⅜	6⅛	4⅜	5⅛	4 17 7	June and December	5 1/16	4 13/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	16	15	16	3 15 0	,, ,,	15½	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14	15	14	15	4 0 0	,, ,,	.	.
119,234	5	3/4	Do. 6% Non-Cumulative 3rd Pref.	5½	5¾	5½	5¾	4 6 11	..	5¾	5⅝
1,000,000	Stock	4½%	* Do. Debenture Stock, 4½% (red.)	110	113	110	113	4 0 9	January and July	..	..
58,000	5	1/0	United River Plate	2	3	2	3	–	,, ,,	..	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	88	94	88	94	5 6 5	,, ,,	..	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	13	14	13	14	..	..	13 9/16	..
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	14½	16	14½	15½	3 18 8	..	15	14 11/16
£100,000	Stock	5/0	Do. 5% Debenture Stock (red.)	131	133	131	133	3 15 2	June and December	–	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	..	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	4½	5½	4½	5½	3 12 9	–	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	..	..	..
8,322	£5	..	House-to-House Electric	..		..		–	–	..	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		–	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		–	January and July	..	–
45,000	£5	2/6	Liverpool Electric Supply (fully paid)	6 11/16	6 13/16	6⅝	6¾	–	..	..	–
111,000	5	..	London Electric Supply	½	⅝	½	¾	.	..	..	–
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	9½	9¾	9½	9¾	2 11 3	..	9½	9½
£150,000	Stock	4½%	* Do. 4½% Debs. (Bonds of £10, £20, and £10)	113½	114½	113½	114½	3 19 0	June and December	..	..
6,152	£10	..	Notting Hill Electric	5½	6½	5½	6½	–	..	..	..
19,980	£5	2 0	St. James and Pall Mall	7½	8	7¾	8½	..	..	7¾	..
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9½	8¾	9½	3 15 8	–	9⅜	8¾
59,900	5	2/0	Westminster Electric Supply (fully paid)	6½	7	6¾	7¼	3 2 1	–	7 1/16	7
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
60,000	3	1/6	Brush Electrical Engineering	2½	2¾	2⅜	2⅝	5 14 3	..	2 11/16	2⅝
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2½	2¾	2¼	2¾	4 7 3	..	..	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	111	114	111	114	3 19 6	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2	2½	2	2½	–	January and July	..	..
12,139	5	..	Edison and Swan United	–		–		..	..	–	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	..	–	..
120,000	2	.	Electric Construction	¼	½	⅜	⅝	..	–	⅜	.
12,845	2	2 9	Do. 7 per Cent. Cumulative Pref.	1½	2	1½	2	..	–	.	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1⅝	1⅞	1⅝	1⅞	..	–	1⅝	..
20,000	5	..	Fowler-Waring Cables (fully paid)	¾	1¼	¾	1¼	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	24½	25½	24½	25½	4 18 0	February & August	25⅜	24¾
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 7 10	March & September	..	–
15,095	£10	0/1	International Okonite Ordinary	..		..		..	.	..	–
16,000	£10	..	Do. 8 per Cent. Preference	–		–		–	December and June	–	–
20,000	9	.	Manchester Edison-Swan "A" (£1 5s. paid)	–	1	–	1	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	41	43	41	43	4 3 9	March and July	42⅜	41¾
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July	..	–
37,511	£5	..	Woodhouse and Rawson Ordinary (£3 15s. paid)	–		–		.	..	..	–
41,098	£5		Do. Preference (fully paid)	..		–		.	–	..	–
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	8	9	8	9	5 11 1	.	8 11/16	8¾
£30,000	10	..	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1%	City and South London Railway	36	38	35	38	1 16 [illegible]	May and November	36½	
7,000	10	5	Do. 5 Perpetual Preference	13	14	13	14	3 11 5		13½	13½
£67,130	Stock	4%	Do. 4 Perpetual Debenture xd	121	123	119	121	3 6 [illegible]	May and November	–	..
87,600	£10	1%	Liverpool Overhead Railway	7 15/16	8 1/16	8	8½	1 4 7	..	..	..
6,295	10	5%	Do. 5 Preference	13	13½	13	13½	3 15 6		–	..
£125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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NOTES.

An engineer responsible for the design of a certain central station in the heart of the West-end gave as his reason for running up an expensive smoke stack of glazed white brick that he found white bricks went down better with house-owners and vestry surveyors than the red variety. In much the same way it would appear as if the delegates at the forthcoming Board of Trade Conference on "Light Railways" would do well to taboo the word "railway" and substitute for it, as did Major Flood Page at the meeting on Friday, the modest dissyllable "tramway." To ensure their success these *in futuro* agricultural lines must be *tramways*, and the sooner they are regarded as such and talked of as such the better. The comparative failure of the Irish lines may, perhaps, be attributed to just such a misconception of the category in which they naturally came.

There was also a general consensus of opinion among the speakers at Botolph House as to the necessity for Government or parochial pecuniary aid. If the necessity be proved, we trust the assistance will take the form of a rigid control of the capital expenditure and working expenses and of a small guaranteed interest. We cannot help thinking, however, that if these lines really do meet a want they will ultimately be built, and will pay their way without any system of Continental coddling. A modicum of State aid may, perhaps, be required to overcome our native dislike of novelties; but, once started, the ball should roll by itself if it possesses any natural financial momentum. We are also glad to note that one speaker at least had the courage to insist on a 4ft. 8½in. gauge, and that several testified to the unequalled advantages of electric traction in connection with this proposed system of agricultural tramways.

The new standard of light, which has been officially adopted by the Reichsanstalt, and which is described in another column, will probably be ignored by those who have made most fuss about a standard of light—that is to say, by gas engineers; but it commands attention from physicists, and will prove of indirect value to electrical engineers, since secondary standards of light, such as glow lamps, may be referred to it. The method of taking the ratio between two amounts of radiation is very ingenious, and the determination of this ratio by means of a bolometer raises the operation at once from the doubtful accuracy of photometric estimations to that of ordinary physical measurements. Seeing that (*pace* Capt. Abney) the accurate comparison of two differently coloured lights is impossible by ordinary photometric means, and that spectro-photometric summation of the whole spectra is very tedious, and that pairs of red and green measurements are of no practical value, the hint in the concluding lines of the application of this method to such work is of considerable interest.

M. Hospitalier, ever to the fore in matters connected with symbols and nomenclature, publishes in the latest issue of *L'Industrie Electrique* a table of photometric symbols. An uncompromising opponent of block lettters for the magnetic quantities **B**, **I**, **H**, and **N**, M. Hospitalier brings himself to use this type for photometric purposes, and ingenuously excuses his inconsistency with the remark that the difficulty which *he* finds in writing these letters will not in this case amount to much, because photometry has not the same vogue as magnetism. In England we have now for some long time consistently used block letters for magnetic symbols, and have found them answer the purpose excellently well. It is in England, moreover, that of late years magnetic research has centred, and the symbols that have the approbation of Ewing, Hopkinson, Shelford Bidwell, and the many other English workers in this field might well be adopted and not first discarded as impossible and then quietly appropriated for quite another use. The country which has done by far the most work in modern "magnetics" should by courtesy and in virtue of the good work accomplished be given a predominant voice in the choice of symbols. The following are M. Hospitalier's proposals just as published:–

Quantité Physique.	*Symbole.*
Intensité lumineuse	**I**
Flux lumineux	**F**
Éclairement, éclat intrinsèque	**E**
Radiation intrinsèque	**R**
Lumination ou quantité d'éclairement	**L**
Quantité de lumière	**Q**

In another column a description is given of some remarkable experiments on rays of electric force carried out by Messrs. Garbasso and Aschkinass. Their research is of a novel character, and shows up a fresh connection between light waves and electromagnetic disturbances. It is especially suggestive in regard to the dispersion of light when undergoing refraction through a prism. As regards the two conclusions to which the authors allude at the end of their Paper, it does not appear certain that the first is really proved by their work. The fact that the resonating circuit responded over a considerable angular range in their prism experiment does not necessarily show that the waves emitted by the oscillator are compound like the waves of white light. Resonators will respond more or less, even when not properly tuned with the oscillator, and the point of resonance is only sharply marked when the dissipation of energy in the resonator is negligible. It has been shown that the rate of decrement is much less for Hertz's resonators than for his oscillators; but, nevertheless, it may be still large enough to prevent the positions of resonance being very definite. The diffraction phenomena, arising when long electromagnetic waves are refracted through a prism, would, moreover, be sufficient to account for the response of the resonator in its various positions.

The series of articles on the "Principles of Transformer Design," by Mr. Alfred Still, which we commence to publish this week, will, we hope, prove of practical value to students, if not to the benighted champions of continuous currents. We are well aware that much has already been published on this subject, and in our own columns, perhaps, more than in any other place. The lengthy series of articles from the pen of Dr. J. A. Fleming developed the matter very extensively and clearly. But we feel that the student has nowhere a short, concise account of the principles underlying the design of transformers and choking coils; and it is this want which it is the purpose of the present series of articles to satisfy. The proper understanding of the intricacies of this subject seems almost inseparably connected with a preface on ironless or air-core apparatus, invested with more or less unpractical or even unreal properties. But we are glad to say that Mr. Still has found it possible to do with the very minimum of these preparatory considerations, and quite early in his series has introduced the practical questions relating to iron, hysteresis, and eddy currents, which make the problems of real transformer design so diverse from the conceptions of ironless mathematics.

The American Street Railway Association has been holding a Convention in Atlanta, and accounts of the proceedings fill the recent issues of our American electrical contemporaries. It is very amusing to notice with what utterly opposite and antagonistic feelings our contemporaries regard these proceedings, and the preparations which were made to meet the needs of the railway men. The *Electrical Review* of New York says that "it was a highly successful convention. Atlanta has again added to her laurels as a hospitable and progressive city," and that "if the Montrealers are half as glad to see the street railway men as were the people of Atlanta, the American Street Railway Association's next convention will be a big success." But the *Electrical Engineer* of the same city has "no hesitation in saying that one or two such wretchedly arranged and mismanaged conventions would wreck the Association entirely and lead to a radical reorganisation. This is not merely our own opinion but that of a majority of those who watched the performance through." That paper has, it says, "never seen the time of a convention more shamefully wasted than it was at Atlanta. There seemed to be no regular time of meeting, people could not be got together owing to the distances to travel, and when they were caught, it was to squander hours in taking incomplete group photographs. That such was the case was due largely to the poor arrangements made by the local committee. It was impossible for people to travel nearly 12 miles and walk several blocks each day to attend the sessions, or if they did not do this they could scratch for a sandwich lunch in the dusty and noisy Exposition Hall." Our New York correspondent appears, however, to have applied the true standard to the meeting by regarding it merely as a sort of commercial "wayzgoose." Looked at from any other point of view, the Convention would appear to have been a B.A. meeting, plus several strictly aboriginal disagreeables.

Cable Interruption:	Date of Interruption.
Zanzibar-Mombasa..........	September 6, 1894.

Electric Motors on Men-of-War.—The success of the electric motors for moving the guns of H.M.S. "Barfleur" has, says the *Engineer*, been so complete, that it is proposed to employ them on H.M.S. "Renown."

Destruction by Fire of an American Supply Station.—The building of the Edison Electric Light Company at Hackensack, New Jersey, was destroyed by fire on Tuesday morning. The loss is estimated at $30,000.

Association Suisse des Electriciens.—Dr. A. Palaz, of Lausanne, has been nominated President of the Association for 1895, and the general secretaries for that period will be Dr. A. Denzler, of Zurich, and M. A. Aberegg, of Berne.

The Day Load all Taken.—A western newspaper comments on the satisfactory state of the electric light preparations at Newport (Mon.), and is rejoiced at the large demand for the private supply of power. "In fact," it says, "what is known as the day load has already all been taken!"

Electric Traction at Hammersmith.—The London United Tramways propose to run an electric tramway from Shepherd's Bush to Acton, and they have asked the Vestry for permission. The Works Committee considered the application, and on their recommendation the Vestry sanctioned the scheme.

Institution of Junior Engineers.—Mr. Alexander Siemens has accepted the Presidency of this Institution, formerly the Junior Engineering Society, for the session 1894-5, in succession to Mr. J. Wolfe Barry, and will deliver his Presidential Address on Friday evening, 16th inst., at the Westminster Palace Hotel.

Interurban Telephony.—On the 17th of last month the Préfet of the Department of the Maine and Loire inaugurated the telephone trunk wire connecting Paris with Angers *viâ* Saumur and Tours, a distance of some 200 miles. The line between Paris and Toulouse (480 miles) has been completed, and will shortly come into operation.

"Party" Cars.—The West End Street Railway Company, of Boston, has recently added to its equipment two special cars which may be chartered for "trolley parties" now so popular in the States, for excursions to any points of interest on the lines of the West End Railway or for special parties to balls, theatres, weddings, or similar events. The car bodies are 20ft. long by 7ft. 4in. wide, and are "sumptuously upholstered."

The Siemens and Halske Electric Company of America.—As our readers will remember, the Siemens and Halske Electric Company's factory at Chicago was destroyed by fire on August 1st. The Company made a lease with the Grant Locomotive Works on August 11th; they commenced moving into the new works on August 15th; they finished and shipped the first generator, built entirely at the new factory, on October 15th. Every available tool in the new works is now in operation and many of the tools which were destroyed in the fire have been duplicated so that from now on the Company is in a position to finish one direct-coupled generator each day.

Royal Institution.—The general monthly meeting of this institution was held on Monday. The special thanks of the members were returned for the following donations to the fund for the promotion of experimental research at low temperatures:—Mr. W. Morris Beaufort, £10; Mrs. Bloomfield Moore, £200; Prof. Dewar, £100; Sir Frederick Abel, £50; Mr. Edward Frankland, £21; Sir John Lubbock, M.P., £20; Mr. John T. Brunner, M.P., £50; the late Mr. Thomas Hawksley (per Prof. Dewar), £100; Mr. Charles Hawksley, £50; the Baroness Burdett-Coutts, £100; and Sir Andrew Noble, £100.

Appointment.—The Technical School Committee of the Birmingham Corporation have appointed Dr. W. E. Sumpner D.Sc. (Lond.), of the Battersea Polytechnic School, from among 75 candidates, as Principal of the new local Technical School. The salary is £500 per annum, and the duties commence on January 1st next. Dr. Sumpner is a Fellow of the University College, London, and of the City and Guilds of London Institute, a member of the Council of the Physical Society, and of the Institution of Electrical Engineers. Dr. Sumpner has been a frequent and valued contributor to the columns of *The Electrician*, and has its best wishes in his new field of work.

Society of Arts.—The 1894-95 session of the Society of Arts will be opened on November 21st with an address by Major-General Sir John Donnelly, K.C.B., Chairman of the Council. On December 5th M. E. Hermite will read a Paper on "The Electrical Treatment of Sewage." Mr. R. E. Crompton is down for a Paper on "The Use of Electricity for Cooking and Heating," and Major-General Webber is to read a Paper on "Electric Lighting of Ecclesiastical Buildings." Prof. Silvanus Thompson will deliver a course of three Cantor Lectures, beginning on January 14th, on "The Arc Light."

Niagara.—The *Buffalo Express* of September 23rd says:—"E. G. Acheson, president; William H. Arison, secretary; and Charles G. McIlrain, attorney, of the Monongahela (Pa.) Carborundum Company, are in the city and are meeting with the officers of the Cataract Construction Company to sign the contract for 1,000 electric horse-power to be used by the former company in their new factory, which will be located near the Pittsburg Reduction Company's plant on Buffalo Avenue. It is not known how soon the Company will begin the erection of its plant here, but the time is very close at hand, as by the time they can place themselves in readiness the Power Company will be ready to furnish them with the power."

Electric Lighting in Spain.—Circumstances especially favourable to the electrical engineer are said to exist in Seville. Owing to the high price of gas it is estimated that the electric light, supplied by meter, will not cost the consumer more than he pays at present for gas. Accordingly an electric light company has commenced laying cables, and it is expected that it will be possible to give the electric light at the end of May, 1895. This is all very well, but it is to be hoped that the Seville Municipality will not treat this electrical concern in the same way that the municipality of a large town close by has treated its gas company, which on asking for the payment of its little bill, some years overdue, was rebuked by having a concession given to an electric lighting company.

The Royal Society.—The following is a list of those who have been recommended by the President and Council of the Royal Society for election into the Council for the year 1895, at the anniversary meeting on November 30th:—President, Lord Kelvin; treasurer, Sir John Evans; secretaries, Prof. Michael Foster, Lord Rayleigh; foreign secretary, Sir Joseph Lister, Bart.; other members of the Council, Andrew Ainslie Common, William Crookes, Francis Darwin, Andrew Russell Forsyth, Sir Douglas Galton, Prof. Alexander Henry Green, Sir John Kirk, Prof. Horace Lamb, Prof. Edwin Ray Lankester, Prof. Alexander Macalister, Prof. John Henry Poynting, Prof. Arthur William Rücker, Osbert Salvin, Prof. J. S. Burdon Sanderson, Thomas Edward Thorpe, William Henry White.

The Calcutta Tramways.—The regularly recurring hot season brings in its train a list of casualties among the Tramway Company's horses in Calcutta, as well as other places where this system of locomotion is in vogue, which *Indian Engineering* says is heartrending. But, apart from this, there is much to be advanced from the public point of view against relying upon horses for regularity and certainty of transit to their places of business. In such centres as Calcutta, Bombay, Madras, mechanical power should be insisted upon for the working of tramways, since it is unaffected by weather, and journeys may be timed with fair accuracy, which is impossible when animal power is relied upon.

Electric Supply in Paris.—Our esteemed contemporary *L'Industrie Electrique* recently published a useful table and map relating to the electric supply business in "La Ville-Lumière." From these it appears that the electric lighting of the French capital is divided amongst six companies (as against 11 in London) and one municipal undertaking (as against 2 in London). The lamp connections of the stations is not given, but as their total power in kilowatts amounts to some 9,500, of which only 1,330 is alternating, it is permissible to estimate the total connection at something like 325,000 8-c.p. lamps (against 700,000 in London). Slow-speed engines, multipolar dynamos largely of the Desroziers type, and cables laid in paraffined wood casing, are characteristics of Parisian practice. A refinement introduced by the Société anonyme d'Eclairage Electrique du Secteur de la Place Clichy is worth noticing. It encloses all its junction-boxes in an outer box filled with chloride of calcium in order to dessicate the air contained therein.

Narrow Gauge Railways.—Our esteemed contemporary the *Engineer* is pleased to be extremely facetious over the Board of Trade "Light Railway" circular. According to our contemporary the Department says:—"Here are a number of worthy folk who want light railways. We do not know much about these things ourselves, but we believe that they are very cheap and nasty, certain to kill people, and to prove general and particular nuisances. However, we must give way to the popular desire. We must obtain some information, and for that purpose we cannot do better than have a Conference." This is all very well, but we are pleased to have our engineering contemporary's support in our advocacy of the 4ft. 8½in. gauge; as the *Engineer* points out, it is by no means certain that any very great benefit is to be gained by laying rails 2ft. 6in. or 3ft. apart instead of 4ft. 8½in., and there are undoubtedly many objections to the narrow gauge for agricultural purposes. Farm produce, if we except grain, is generally bulky; and the rolling-stock of a 2ft. 6in. road does not lend itself readily to the conveyance of fat bullocks.

Indian Telegraph Department.—The following extract from the *Indian Engineer* exhibits such an extraordinary state of things,—namely, a perfect telegraph service and the perfect satisfaction of the public with it—that it is worth quotation:—"It may be affirmed without fear of contradiction that the administration of this Department has attained a standard of excellence of which any civilised nation may well be proud. One of the most progressive countries in Europe, whether in the arts or sciences, did not disdain to accept a wrinkle or so from us only a few years back in the management of postal affairs, and others may equally come to us in the matter of the sister branch of the service—that of the telegraph. Every succeeding year marks some improvement over the previous one, and brings it as near perfection as any thing mundane can lay a claim to." The article concludes with the following reference to the services of Mr. Melhuish:—"If ever a specialist deserved to be rewarded for substantial services rendered to the State it is Mr. Melhuish, of this department. The Government of India, in noticing his invention, remarks: 'As regard electrical improvements, Mr. W. F. Melhuish's apparatus for long-distance telegraphy has fulfilled the expectations which were formed of it. The apparatus has been largely brought into use, resulting already in a reduction of establishment of three telegraph masters and 57 signallers, representing approximately a saving of Rs.64,000 per annum'; and, again, 'they also recognise with satisfaction the skill and ingenuity of Mr. Melhuish, whose improvements in electrical apparatus have resulted in considerable saving to the State and increased transmission of messages."

The Reichsanstalt.—The fifth report upon the work of the German Imperial Physico-Technical Institute appears in the *Zeitschrift für Instrumentenkunde.* Besides the electrical work, says *Nature*, which chiefly dealt with resistances, the principal subjects of investigation were connected with thermometers, manometers, barometers, pyrometers, standard Hefner lamps, and photometry, and the physical properties of various kinds of glass. The branch establishment at Ilmenau, in the Grand Duchy of Saxony, has been extended by the addition of a technical school for workers in glass instruments. Among the barometers tested were the aneroids employed by Dr. von Drygalski on his Greenland expedition. It appeared that low temperatures are capable of creating a temporary disturbance in the indications of these instruments. The chief optical work was connected with photometry. As regards the introduction of the Hefner lamp as a standard of illumination, the report points out that Germany is ahead of other countries in possessing a well-authenticated standard of light which answers all technical requirements. Recently the Institute has endeavoured to construct simple and portable photometers for technical purposes. Two such instruments have been constructed and found to work well. The photometry of the arc lamps illuminating "Unter den Linden" at Berlin, was also taken in hand by the Institute. The examination of different glasses which related mainly to their solubility in water, was found to give an indication of various other properties. The electrolytic precipitation of zinc and other metals from dilute solutions was investigated with a view to their preparation in a pure state. The examination of specimens of steel, of chronometer oils, and of coloured thermometer liquids, was among the many tasks allotted to this most useful and many-sided National Physical Laboratory.

The New Standard of Light.—Last Friday evening, Mr. W. J. Dibdin, the chemist to the London County Council, delivered a lecture on this subject before the Lewisham Camera Club. Having dwelt at considerable length on the respective merits and demerits of the English and German candles and the French Carcel lamp as standards of light, says the *Journal of Gas Lighting*, the lecturer proceeded to refer to the new standards brought out almost simultaneously by Mr. Vernon Harcourt and Mr. J. Methven in 1878. The pentane light of Mr. Harcourt was a useful standard and gave very good results. Mr. Methven's standard was also a good one so long as the light kept at the same height; but as the greater part of it consisted of coal gas it was found that its height differed very much according to the quality of the coal used. It was then proposed that the petroleum gas of Mr. Harcourt's lamp should be burned with Mr. Methven's standard, and then any slight difference in the coal gas would become inappreciable in the richness of the petroleum gas. Here, again, the difficulty of height had made itself felt; but at the same time the combination of the two had gone to the making of a very useful standard commercially. He held that an absolute standard ought to be a light which could be produced at any time, in any place, and under all atmospheric conditions, from either printed or written directions; and therefore coal gas would, of course, be perfectly inadmissible as an absolute standard—the quality of coal being so varied. One way of getting a standard which varied so little that for all practical purposes it was sufficiently steady, was, with the combination light already referred to, drawn from the standards of Messrs. Harcourt and Methven, and, by using an Argand burner and placing a screen in front of it, cutting off the top part of the flame. This gave a wonderfully constant light of about 18 candle-power. Mr. Dibdin then proceeded to show how the standard could be reduced and enlarged to different powers as desired.

Southport.—To-day the Mayor of Southport will, following his re-election to the civic chair, switch on the electric light for the first time. The work has been carried out under the direction of the Gas and Electricity Committee, with Mr. Arthur Ellis as electrical engineer. As it stands the outlay will be about £13,000, as against £28,000, which was at first contemplated. The generating station is near the gasworks, at Crowlands, two miles from the centre of the town, and is capable of supplying power equal to 4,200 8-c.p. lamps. The applications already made are equivalent to 4,700 8-c.p. lamps, so that the Corporation is in the almost unique position of starting with a full load. The Town Hall and Cambridge Hall, forming part of the municipal buildings, will be lighted by electricity. To-day the two halls mentioned will be outlined by incandescent lamps, and the boulevards and fountains in front will be similarly illuminated. At the supply station there are in all three alternators, with the armatures revolving and the magnets fixed, two of the machines for a capacity of 60 kilowatts, the current being 25 amperes at 2,000 volts, with a periodicity of 50 per second, and 500 revolutions per minute. These are rope-driven from 200-H.P. steam engines. The third alternator, driven by ropes from a 55-I.H.P. engine, gives an output of $12\frac{1}{2}$ amperes at 2,000 volts, at a speed of 750 revolutions per minute. This machine has eight poles, whereas the two large ones have 12 poles. Thus, the periodicity of all is the same, viz., 50. Each alternator has a direct-current exciter dynamo coupled direct to the shaft of the alternator. The exciters connected with the two larger machines are each for an output of 100 volts 25 amperes, and that connected with the smaller machine for 100 volts 15 amperes. The exciting current required for the full load of the larger machines is 5·75 amperes, and for the smaller machine 4 amperes. Both the alternators and exciters are manufactured by Messrs. Mather and Platt (Limited). It is a noteworthy point in connection with these machines that they may be short-circuited without detriment. The current passing through the armature, if absolutely short-circuited with the fields excited to their full extent, is less than double the normal output of the machine, which would not be injurious for a short time.

Light Railways.—A voluminous correspondence on this subject has been started in the columns of *The Times* by the Board of Trade circular alluded to in our leading article of last week. The following contribution to the discussion by "Light Rail" is worthy of attention:—

> SIR,—For the benefit of those who believe that light railways can be readily introduced into country districts in England, perhaps you will allow me to narrate a recent experience:—A light railway was projected in my neighbourhood, giving much-needed access to a good-sized market town doing a fair trade, but long isolated from railway accommodation. The line would have passed through a purely agricultural district, but would have opened up many excellent building sites. It would have been very inexpensive to construct, and great care was taken in selection of the route, so as to cause little or no severence. The landowners were approached, and were courteous and favourable, one landowner, indeed, offering to meet the promoters most liberally in regard to the land required. Everything pointed to a capital little enterprise being speedily carried out, when, at the last moment, an energetic opposition was started to the scheme by—Whom do you suppose, Sir? Why, by the "distressed agriculturists," several of whom petitioned the principal landowner not to give his consent to the railway being made. The result, of course, is that the whole scheme has fallen through. From some considerable observation of the British farmer, his ideas, and his ways of carrying on business, I have little doubt that the same experience would result in nine districts out of ten the moment that land, however little, was required. As to the alternative idea—that light railways could be taken along the country roads—it is, in my belief, an idle dream. Such a project would encounter the most bitter opposition from every one who drove or rode a horse, or owned so much as a pony and cart; and the proposition would be scouted on every country, district, or parish council before whom it was brought. There can be little doubt that light railways would be most beneficial enterprises, and would open up a new field of industry, which is needed badly enough in the present state of trade. But four things are absolutely essential to their introduction:—(1) That the permanent works should be cheap. For instance, level crossings should be allowed instead of bridges wherever possible, the gates being kept shut against the train instead of against the road. (2) That cheap fencing should be allowed throughout. (3) That all unnecessary paraphernalia, such as station masters, gate-keepers, signals, and signalmen, should be dispensed with. (4) That wide facilities should be given for obtaining compulsory powers to obtain land, or way leaves; and that if land be taken instead of a way leave, the compensation should always be by way of annual rent-charge, of course calculated on a full and fair basis of value to the landowner. (It may be mentioned incidentally that the amount of land required for a railway of $2\frac{1}{2}$ft. gauge would probably not exceed two acres to the mile.) The Board of Trade have taken a praiseworthy step in endeavouring to meet the first three conditions above mentioned; but their efforts will be futile unless the Legislature will provide the necessary facilities for dealing with opposition (arising from want of consideration or want of knowledge) on the part of the very people who would be most accommodated.

MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 6.)

Valve Quantities and Steam Distribution.—By means of a series of diagrams, such as the one which has just been described, the influence of each of the valve quantities, lap, lead, travel, and angle of advance, may be investigated. Reuleaux has devised a graphic method which, for simple slide valves, is more quickly followed than the method due to Zeuner; but the author has selected the latter for treatment because of its more perfect adaptability to more complicated valves. The reader will have no difficulty in constructing modifications of the Zeuner diagram for the most common forms of automatic valves. If the reader will study Fig. 31, or, better still, if he will construct for himself a series of such diagrams, he will be able to verify the following generalisations in regard to the influence of valve quantities upon steam distribution :—

(1.) Increasing the travel when the lap and the angle of advance are kept constant will cause later cut-off and compression and earlier release and admission.

(2.) Increasing the travel when the lap and lead are constant will cause later cut-off and release and earlier compression, and will require that the angle of advance shall be diminished.

(3.) Increasing the lap when the travel and angle of advance are constant will cause earlier cut-off and compression and later release and admission, and will reduce the lead.

(4.) Increasing the lap when the travel and lead are constant will cause earlier cut-off and compression and (very slightly) later release and admission, and will require that the angle of advance shall be increased.

The influences of varying lead, with constant lap and travel, may be investigated by the student as an exercise; but it is not common practice to vary the expansion in an engine by this method.

As will be shown more fully presently, one of the usual means of varying the power of an engine is to vary the point of cut-off and the ratio of expansion of steam in the cylinder. The valve is, in such cases, designed so as to be capable of variation in one or more of the four ways indicated in the above synopsis. In many cases the variation is effected automatically, by the action of a governor; but in some instances it is done by hand gear. Apart from mechanical considerations, the art in valve design, and the point where the element of economy enters, lies in so proportioning the valve quantities, and in so varying one or more of them, as that the desired change of cut-off shall not be accompanied by any prejudicial change in the other phases in the steam distribution. Thus, for example, by a judicious combination of (1) and (2), it is possible to obtain a variable cut-off with variation of travel without altering the point of release in any way. Or, again, the combined variations of lap and travel may give a variable cut-off without any prejudicial change in the period of compression. It is for this reason that many automatic valve gears are arranged to reduce the angle of advance in proportion as a decreasing travel with increasing lap causes an earlier cut-off.

Influence of the Temperature Limits.—That splendid but simple generalisation which is expressed in equation (67)† indicates that anything which reduces the temperature of the steam admitted to, or increases that of the steam rejected from, the engine, must act prejudicially on the theoretical limit of efficiency. But between the theoretical limit of efficiency and the actual realised efficiency there is a great gulf fixed; so that it is conceivable that a change in the condition of working, though prejudicially modifying the temperature limits, might actually raise the working efficiency of the engine by partially bridging over that gulf. The limitations which are put on the expansion of steam in any one cylinder are an example of the case in point; and many such examples have already been discussed. There are, however, numerous instances which commonly occur in practice where the alteration of the one or other of the temperature limits causes a distinctly prejudicial effect on the amount of indicated work which can be obtained from a given mass of steam; and these we will now consider.

Injurious lowering of the temperature of admission arises chiefly from wiredrawing, or from the cooling of the steam in the pipes and passages, both of which have already been discussed. Injurious raising of the temperature of exhaust arises from a great number of causes, among which we may specially notice: (1) Increase of back pressure due to re-evaporation, (2) increase of back pressure due to friction in the exhaust passages, (3) increase of back pressure on account of imperfect action of the condenser, and (4) excessive superheating. Some of these also have been considered in detail; the others require further discussion.

The friction of the exhaust passages may be divided into internal friction and external friction. The former, the friction of the engine ports, arises from the action of the valves, and from the necessity for limiting the section of the internal passages in order to minimise the clearance spaces. The size of engine ports is settled by the conflicting elements of loss due to friction and loss due to clearance. With regard to the external passages, the friction is more under control, and may be kept within reasonable limits by the use of sufficiently large pipes and by avoiding sharp bends. The interposition of exhaust steam feed heaters frequently adds largely to this element of friction; and it is necessary in all cases of this kind to set off the loss of indicated power in the engine (if any) against the gain in the boiler due to the heat supplied to the feed water. On the other hand, the condensing effect of an exhaust steam feed-heater will often more than make up for the increased exhaust friction.

Influence of the Condenser.—The primary function of the condenser is, as has been explained in a previous article, to lower the temperature of the exhaust steam below the lowest limit at which it could possibly be exhausted if rejected into the air. As exhaust steam is always saturated in practice, it follows that the effect of the condenser must directly be to lower the pressure of the exhaust by substituting the saturation-pressure of the steam for the pressure of air. The condenser must, therefore, perform two operations: (1) It must rapidly abstract the heat from the exhausting steam, so as to produce a very much lower temperature in a short space of time; and (2) it must prevent the air from entering the spaces into which the steam is to exhaust. In practice, the condenser performs these offices more or less imperfectly; and it is in this element of failure that the loss of economy noted in the previous paragraph lies. In the first place, the rapid abstraction of a large amount of heat from the steam immediately after release will necessitate the use of a considerable quantity of some cold substance, such as water or air, and the temporary or partial failure of the supply of this cooling agent will instantly react on the condenser pressure. In the second place, air will always find its way into the condenser chambers; and this, together with the accumulations of condensed steam, &c., will require to be continually pumped out. The air not only leaks into the condenser through the imperfectly air-tight joints, but it is also carried into it along with the exhaust steam, having originally entered the boiler dissolved in the feed water. The pump, usually called the *air-pump*, by means of which the air and water are removed from the condenser, will absorb a certain amount of power which must be set off against the value of the reduced pressure; and the power required for this pump, for any given degree of vacuum and size of engine, will depend on the extent to which air can be prevented from entering the boiler and the joints of the condenser.

Engine Friction.—The second great source of inefficiency in a steam engine, as indeed in all engines, is the loss of indi-

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† $$\eta = \frac{T_1 - T_2}{T_1} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \quad (67)$$

cated work in overcoming the frictional resistances to the motion of the engine. Not an unimportant fraction of the indicated work is always lost in the engine itself. The magnitude of this fraction varies with the size and type of engine and with the nature of the load imposed, as well as, of course, with the degree of skill and care expended in designing, building, and managing the engine. It is difficult to arrive at any exact conclusions, in regard to the dependence of engine friction upon these various influences, which can be regarded as being in any way in the nature of generalisations. The careful experiments of Prof. Thurston and others, and the results of a large number of reliable engine trials, however, warrant our drawing up a few statements of a general, though somewhat inexact, character. Firstly, in regard to the relation of the size of the engine to the percentage loss of power within it, it is invariably found that, other things being equal, the proportion of power wasted is larger in the smaller sizes. Lubrication of a kind adapted to the speed and size of the engine is assumed to be used; and the engines are supposed to be run at their normal speed and load. Very small engines, even in the best of conditions, have been found to absorb from 50 to 60 per cent. of their indicated power. Mr. D. K. Clark mentions an instance of a small non-condensing steam engine, of the vertical inverted type, which, when developing 0·730 I.HP. gave only 0·337 B.HP., or 43·2 per cent., at the pulley. Engines of moderate or large power absorb from 8 to 20 per cent. of their indicated power in internal friction, when running at full load and normal speed. Beyond a certain maximum size it is probable that the percentage of engine friction is not reduced by making the parts larger and the indicated horse-power greater. It seems likely that any claim that an engine absorbs less than 8 per cent. of its indicated power in internal work should be regarded sceptically, and even this low figure is not often to be credited, except in the largest sizes of certain well-balanced types of engine. The majority of types do not absorb less than 10 per cent. of the indicated power, in ordinary work. In regard to the influence of the type on the amount of friction, it may generally be assumed that friction will be greater in the horizontal types than in the vertical, and that in all cases a well-balanced engine has less friction than one in which the reciprocating and other parts are unbalanced. The cause for the excessive friction in horizontal engines, as compared with the balanced vertical types, lies principally in the fact that in the former the heavy pistons are exerting their weight on the cylinder liner and glands, while in the latter the weight is exerted on a crank pin which has a lower linear velocity, and which can be better lubricated. For equal power, too, the horizontal type usually runs at a lower speed, and has, therefore, a heavier piston than the vertical type. The piston velocity in the horizontal type is not usually lower than in the vertical; so that every influence tends to increase the frictional losses in the former class of engine.

Distribution of Friction in Some Direct-Acting Steam Engines.
(Thurston.)

Parts of engine where friction is measured.	Percentages of total Engine friction.				
	"Straight line." Balanced valve. (1)	"Straight line." Unbalanced valve. (2)	Traction engine. Locomotive valve gear. (3)	Automatic balanced valve. (4)	Condensing Engine. Balanced valve. (5)
Main bearings	47·0	35·4	35·0	41·6	46·0
Piston and piston rod	32·9	36·0	21·0	49·1	21·8
Crank pin	6·8	5·1	13·0		
Cross-head and wrist pin	5·4	4·1			
Valve and valve rod	2·5	26·4	22·0	9·3	21·0
Eccentric strap	5·3	4·0			
Link and eccentric	—	...	9·0	.	..
Air pump	—	...	. .	.	12·0
	100·0	100·0	100·0	100·0	100·0

Some attempts have been made by various engineers to analyse the distribution of friction in engines; but it is found that the distribution varies considerably with the type of engine and with the nature of the valve and other fittings. The preceding table is compiled from a number of experiments made by Prof. Thurston, and shows the approximate distribution in five cases.

(To be continued.)

PRINCIPLES OF TRANSFORMER DESIGN.

BY ALFRED STILL.

The self-induction of a circuit carrying an electric current, being the total amount of magnetism (or number of magnetic lines) enclosed, *due to the current flowing in the circuit*, it follows that it will change with the changes in the current. Hence, in the case of an alternating current in a circuit having appreciable self-induction, an E.M.F., called the induced E.M.F., or E.M.F. of self-induction, will be generated; and it is this E.M.F., together with the impressed E.M.F. (or potential difference at terminals), which will determine the exact nature and magnitude of the current wave.

For, whether we are dealing with steady or varying currents, Ohm's law must be fulfilled, and the current at any particular instant depends upon two things only, the resultant or effective E.M.F. in the circuit at that instant, and the ohmic resistance.

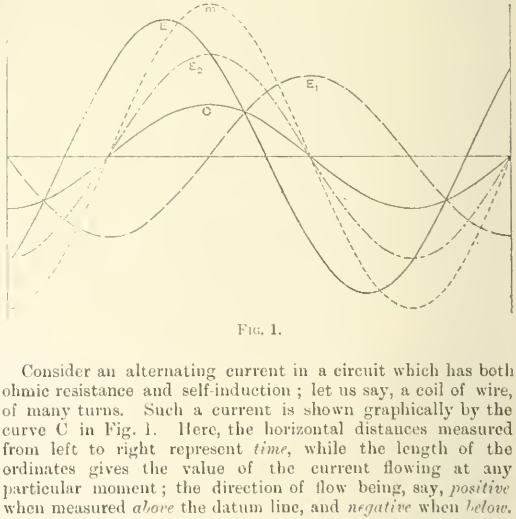


FIG. 1.

Consider an alternating current in a circuit which has both ohmic resistance and self-induction; let us say, a coil of wire, of many turns. Such a current is shown graphically by the curve C in Fig. 1. Here, the horizontal distances measured from left to right represent *time*, while the length of the ordinates gives the value of the current flowing at any particular moment; the direction of flow being, say, *positive* when measured *above* the datum line, and *negative* when *below*.

The point from which the curve rises to a maximum positive value, to the point where (after falling off and passing through a maximum negative value), it again crosses the datum line, includes one complete period, or alternation. In England a frequency of 80 to 100 periods per second is the usual practice in alternate current work.

Now, since the current C is flowing in a circuit having appreciable self-induction, magnetism will be generated which will vary in amount and direction in accordance with the variations of the current. It may be calculated in the usual way, for any value of the current, provided the cross-sections, lengths, and permeabilities of the various parts of the magnetic circuit are known, and the number of turns of wire in the coil. Let the curve *m* represent the rise and fall of this magnetism. The *induced* or *back* E.M.F. due to this varying magnetisation is proportional to the *rate of change* in the number of magnetic lines threaded through the circuit, and may, therefore, be easily calculated and plotted for any point in the complete period; bearing in mind that 100 million C.G.S. lines enclosed or withdrawn per second, generate one volt per turn of wire in the coil. In this way the curve E_1, which is that of the induced E.M.F., is obtained. It is now easy to determine the E.M.F. which must be supplied to the terminals of the coil in order that the current C will flow through the circuit. Draw the curve E_2 to represent the E.M.F. required to overcome the ohmic resistance. It will be in phase with the current, because its value at any point is simply $C \times R$, where R stands for the resistance of the circuit. Now add the ordinates of E_2 to those of an imaginary curve exactly similar, but opposite to E_1, and the resulting curve E will evidently be that of the *impressed E.M.F.*, or the potential difference which, if maintained at the ends of the circuit under consideration, will cause the current C to flow in it. Thus we see how the relation between the impressed E.M.F. and the resulting current may be graphically worked out for any given case.

From a study of the curves in Fig. I, it is evident that the effect of self-induction is to make the current lag behind the impressed E.M.F. If the E.M.F. required to force the current against the ohmic resistance is small compared to the induced E.M.F., the lag will be very considerable; it cannot, however, exceed one-quarter of a complete period, which limit is only reached when the E.M.F. of self-induction is so large, and the ohmic resistance of the circuit so small, as to render the E.M.F. required to overcome this resistance of no account.

The power at any moment being the product of the impressed E.M.F. and the current passing at that moment, the power curve (in watts) may be plotted, due attention being paid to the *sign* of this product, which will be *positive* when the direction of the current is the same as that of the E.M.F., and *negative* when the current flows *against* the E.M.F. If such a curve be drawn, it will serve to show that however much the self-induction be increased—and therefore the volts which must be supplied to the terminals in order to keep the current constant—the work done in a given time will remain the same. Also, if the circuit had no ohmic resistance, but self-induction only (in which case, as already shown, the current curve would lag behind that of the E.M.F. by $\frac{1}{4}$ period)—the area of the watt curve above the datum line would be exactly equal to the area below, showing that the energy given to the circuit is balanced by the energy given out by the circuit, and that the current is therefore *wattless*, *i.e.*, it is doing no work.

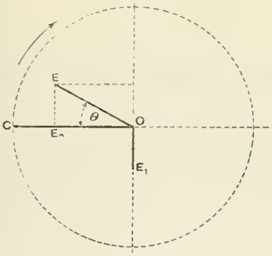


FIG. 2.

Graphic Construction.—The impressed E.M.F. in the circuit just considered, being the resultant of two other E.M.F.'s, always differing in phase by $\frac{1}{4}$ period, a very simple graphical construction may be adopted.

Let the line O C in Fig. 2 represent the maximum value of the current, and OE_2, the corresponding E.M.F. required to overcome ohmic resistance. Let OE_1 stand for the maximum value of the induced E.M.F., drawn at an angle of 90°—or $\frac{1}{4}$ of a circle—behind OE_2 (to represent the lag of $\frac{1}{4}$ period), then O E, which is the resultant of the forces OE_2, and a force exactly equal and opposite to OE_1, gives the maximum value of the impressed E.M.F., and its position relatively to the current; the angle θ giving, in the proportion it bears to the complete circle, the fraction of a period which separates the successive maximum values of the impressed E.M.F. and the current.

This rule is based on the assumption that the electromotive forces are subject to simple harmonic variation, and may therefore be represented by the projections upon a fixed straight line, of other straight lines supposed to be revolving at a uniform rate in the plane of the paper. But, although as regards the *maximum* values of variable E.M.F.'s, the above construction applies only to this particular form of variation, the principle of applying the triangle or polygon of forces in such a manner as described above, will frequently be found useful in alternate current work.

Effect of Iron in the Magnetic Circuit.—The curve of magnetisation in Fig. 1 is drawn on the assumption that no iron is present in the circuit considered.

No energy is lost in producing changes of magnetism when the path of the magnetic lines is through air only; but, as soon as iron is introduced to carry the magnetism, power is spent in magnetising and demagnetising the iron core, owing to what is called *Hysteresis.*

It is well known that all iron, even the softest and purest, retains some magnetism after the magnetising force has been removed. By applying a magnetising force in the opposite direction, this residual magnetism is destroyed, and the magnitude of this force, or, in other words, the amount of work which has to be done to withdraw this magnetism, depends upon the quality of the iron. Soft, annealed wrought iron retains most magnetism; but, on the other hand, it parts with it more easily than the harder qualities of iron and steel, and for this reason requires the least expenditure of energy to carry it through a given cycle of magnetisation.

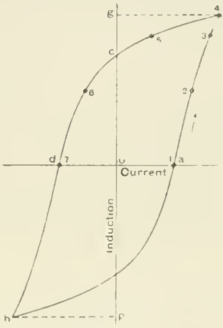


FIG. 3.

In Fig. 3 is clearly shown the effect of hysteresis, which is to make the changes in the magnetism "*lag behind*" the changes in the exciting current. This curve is the ordinary magnetisation curve of a sample of transformer iron, and gives the exciting force and corresponding induction for a complete cycle. The magnetising current is measured horizontally on each side of the centre line, and may be considered *positive* when to the right and *negative* when to the left of the latter. The length of the ordinates above or below the horizontal centre line is a measure of the induction or number of magnetic lines in the iron for any particular value of the exciting current; the direction of the magnetism will be *positive* for ordinates measured *above* this centre line, and *negative* when measured *below.*

Starting at *a*, and following the curve in the direction of the arrow, we see that it has required a certain definite *positive* current indicated by the distance *o a* to entirely withdraw all the *negative* magnetism. From *a* to *b* both current and induction rise to their maximum values; but from *b* to *c*, although the current falls from its greatest value to zero, the induction changes very little, in fact, the residual magnetism at *c* is not much below the maximum amount. However, as soon as a negative exciting force is applied, the magnetism decreases rapidly until, when *d* is reached and all the *positive* magnetism has been removed, it will be seen that the current has reached a *negative* value *o d*, exactly equal to its *positive* value at *a*.

In Fig. 4, the curve of magnetisation m has been drawn in the same manner as in Fig. 1, its maximum ordinate being scaled off Fig. 3. The current curve C has then been plotted from measurements taken on the curve, Fig. 3, which gives the current intensity corresponding to any particular value of the induction. Here is plainly shown the effect of hysteresis in distorting the magnetising current curve, such as that of a transformer with closed magnetic circuit.

In order to show quite clearly the manner in which the current curve in Fig. 4 is derived from Fig. 3, a few corresponding points on the two curves have been marked and numbered. Thus, in Fig. 3 the distance of the point 5 from the vertical centre line gives us the magnetising current for a certain definite value of the induction. This magnetising current is represented in Fig. 4 by the distance of the point 5 from the horizontal centre line, and the ordinate of the magnetisation curve which passes through this point will be found to be exactly equal to the ordinate of the corresponding point in Fig. 3.

By comparing Fig. 4 with Fig. 1, it will be seen that the introduction of iron in the magnetic circuit, by decreasing the lag of the current behind the impressed E.M.F., increases the amount of energy supplied during one complete period; for this is represented by the area of the watt curve, whose ordinates are the product of corresponding values of the E.M.F. and current. Also, it follows, that a wattless current is an impossibility in any coil having an iron core, unless hysteresis can be entirely eliminated.

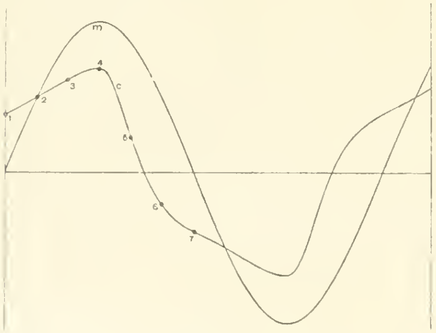


Fig. 4.

The method of plotting the current curve in Fig. 4 may be adopted in designing transformers, provided, of course, that the magnetisation curve (Fig. 3) is that of the actual iron used, and taken between the proper maximum limits of induction. Such a curve, if drawn in its proper position relatively to the E.M.F. curve, may be used, if desired, for calculating the exact open circuit losses, &c.; but the power absorbed by hysteresis is more directly obtained from the curve Fig. 3, the area of which is a measure of the energy spent in carrying the iron through a complete cycle of magnetisation between the limits of induction indicated by the curve. The following considerations will show the reason of this:

It is well known that no work is done by a current in maintaining a constant magnetic field except what is spent in heating the coils themselves on account of their ohmic resistance. But, although no energy is spent in *maintaining* a magnetic field, work was done in *creating* it, for, during the growth of the magnetism, the current in the exciting coil has had to overcome the opposing E.M.F. produced in the coil owing to the change in the number of lines passing through it.

Consider the rising portion of the curve, Fig. 3, from a to b. The current, which was represented by oa at the start, has grown to its maximum value gb, while the magnetism, or number of lines passing through the coil, has changed from zero to its maximum value og, which we may call N. Suppose this change to have taken place in the time t, then the induced back E.M.F. due to this change in the magnetism will be proportional to N divided by t. Also, since the product of the opposing E.M.F. and the current flowing against it will give us the watts spent, it follows, that the power required to produce this magnetisation N, may be expressed as $\frac{N\,c}{t}$ where c stands for the average value of the current between the limits oa and gb. But this is *power*, not *energy*; it represents the rate at which energy has been spent, and will vary according to the time taken. The actual *work* done is evidently obtained by multiplying the above *rate* by the time t, whereby we see that the work done is proportional to $N \times c$, and is therefore graphically represented by the area $oabg$. Thus we see that a distinctly appreciable amount of energy has been spent in producing this magnetism; none is required to maintain it, but if we now destroy it by removing the magnetising force, the whole, or a part of the energy originally employed in its production will be restored to the circuit, owing to the fact that the E.M.F. induced by the withdrawal of the magnetism will now be in the opposite direction to what it was before, *i.e.*, it will now *help* the exciting current instead of opposing it.

If hysteresis were absent, the magnetism would fall in the same way as it rose, thus restoring the whole of the energy to the circuit. In Fig. 3, where hysteresis is present, the magnetism falls from b to c along the curve bc, during the withdrawal of the whole of the magnetising force, thus only restoring to the circuit the amount of energy represented by the area cbg. By studying the complete cycle in this way, it will be found that the area enclosed by the curves is a measure of the work absorbed by hysteresis in the particular sample of iron considered when magnetised between the limits, og, op.

(To be continued.)

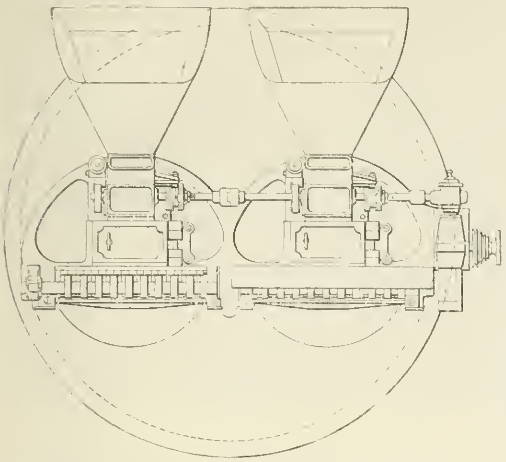
THE BENNIS AUTOMATIC SPRINKLING STOKER.

It is, comparatively speaking, quite recently that the attention of central station electrical engineers has been directed to the economy which lies in the use of the cheaper classes of coal and coke, or those which are generally known as slack or breeze, when stoked automatically by mechanical stokers. The invention of the automatic supply of fuel to a boiler furnace is by no means of recent date, the earliest form of apparatus for this purpose having been patented by a Mr. W. Brunton, in 1819, and even then having been in an experimental stage of development for two years. Quite early in the evolution of the automatic stoker it was recognised that two distinct ways of causing the solid fuel to be supplied to the grate were possible; with smoky fuels it being necessary to subject the fuel to previous coking, while with non-smoky fuels the direct scattering of the fuel over the grate was possible, or even preferable. Thus arose the distinction between sprinkling and coking stokers. Of the former class—the sprinklers—one of the oldest and best known is the Bennis stoker, which has quite recently been adopted for the boilers at the Hampstead municipal electric supply station. Two of these stokers, fitted to the front of a Lancashire boiler, are shown in the accompanying drawing.

The Bennis automatic sprinkling stoker scatters small coal or coke over the grate by means of a shovel situated over the door-way, the shovel being actuated by helical springs in such a manner as to distribute the charge evenly over the whole grate. For this purpose, four degrees of play or motion are given to the shovel, and the periodic recurrence of these causes a uniform distribution of the charges of fuel. Each charge weighs about six ounces. The firebars, which are in two sets, receive a reciprocating motion into and out of the furnace, thereby carrying the fuel towards the bridge; and at each travel one set of bars is lifted half an inch in order to break up any clinker which may have formed. The travel of the firebars is about 1½in. The fuel is fed into the fireplace by means of crushing rollers, placed immediately below the hoppers in which a supply of fuel is maintained while the stoker is in action. These hoppers are usually fed from an overhead channel, or conveyor, along which the fuel is passed by a spiral screw-propeller or by scrapers: but it is in some places the custom to shovel the fuel into the hoppers by hand.

The fuel is raised to the level of the conveyor—where it is not already at that level—by means of a bucket-and-chain elevator.

From some trials of boilers stoked by the Bennis automatic stoker, which were carried out by Mr. D. K. Clark, in 1882, it was abundantly shown that there is a decided economy over the use of hand stoking. With the class of coal known as burgey—coal in lumps, a little bigger than walnuts—the evaporative efficiency of one pound of the coal was, with the Bennis stoker, 10·29lb., while only 8·81lb. with hand firing. Using a smaller coal—that generally known as slack—the performance with the stoker was 11·33lb. of water per pound of coal, as against only 8·99lb. of water per pound of coal with hand firing. The regular firing when the mechanical stoker was used resulted also in an improvement of from 17 to 26 per cent. in the total hourly steaming of the boiler.



THE SEARCH FOR A UNIT OF LIGHT.*

BY O. LUMMER AND F. KURLBAUM.

Introductory.

In contrast to the electrical units of measurement there can be no question of an "absolute" unit of light, because the physiological effect of a source of illumination cannot be expressed in C.G.S. units. Every light-source may be regarded as a unit which has a constant strength, and can always be reproduced in the same way. We may still provisionally talk of a technical, or "working," and a physical unit; but these names have only reference to the accuracy which the unit is capable of giving. A working standard of light should, above all, be conveniently handled; and cheaply and easily produced, its accuracy being a question of more secondary importance, and determined by the character of the work to be done; while a physical unit must above all things be accurate, its capacity for easy reproduction being a secondary consideration. Out of all the proposed working standards submitted to or tried by the Reichsanstalt only the Hefner lamp has fulfilled all the requirements of a working standard, and the Anstalt has undertaken for some time back its standardisation.

This standardisation, however, necessarily presupposes an accurate physical standard of reference, and the Reichsanstalt officials have had to do the best they could with a series of glow lamps which had been compared among themselves, and whose current could be regulated to $\frac{1}{100}$ per cent.; but this was necessarily unsatisfactory, and to replace it by a definite and reproducible unit of light has long been the most important optical problem of the Reichsanstalt.

First, the platinum unit, proposed by Violle and accepted by the Paris Electrical Congress of 1884, was reproduced, both according to Violle's method and later by electrical heating. The experiments showed that the purity of the platinum and the nature of its surface influenced the results, and the Violle unit was provisionally abandoned. The Siemens platinum unit was also found inaccurate, giving, in hundreds of experiments, deviations from the normal of 10 per cent. and more. But these experiments led to the general result that absolutely pure platinum formed a very suitable material for the incandescent surface; but it was found, on the other hand, that neither the melting nor the solidifying point of platinum could be taken as the fixed temperature without considering the conditions, and a new method of attaining and preserving a constant temperature had to be sought, since it might fairly be anticipated that the light radiation at a given temperature of the surface would always be the same.

Of the several methods tried, the authors describe the one which led to the attainment of the desired end, although it somewhat falls short of the simplicity which would have been desirable, necessitating, in fact, the construction of complicated and delicate apparatus and considerable skill in use. But, as to its accuracy, the authors show that it can be sufficiently well reproduced, several standard apparatus having been constructed and agreeing within I per cent.

Definition of the Unit of Light.

The unit proposed is the light emitted by one square centimetre of platinum at a certain temperature, defined by the ratio of two amounts of radiation one being the whole radiation emitted by the platinum, and the other being that portion which is passed through a certain absorbing medium. It these quantities have, for example, the ratio of 10 : I, the temperature of the platinum may be thus characterised. The measure of the two quantities of radiation is to be the rise of temperature experienced by a bolometer placed in their path. The absorbing medium is defined as a quartz vessel with parallel sides of given thickness enclosed a volume of water also of fixed thickness. Means are employed to keep up a certain temperature, which need not be defined in degrees centigrade, it being assumed that at a certain temperature the platinum would always emit the same light, an assumption which was experimentally justified.

Principle of the Apparatus for Producing the Light Unit.

A piece of sheet platinum is made incandescent by electric current, and in front of it is a diaphragm with an aperture one square centimetre in area. Through this hole a bolometer is illuminated, first with the whole light, and, secondly, with that which passes the absorption vessel. The ratio of these two radiations is shown by the galvanometer deflections. The current which heats the platinum is varied until the two radiations have the ratio of 10 : I, and when this is attained, the light emitted by the platinum through the diaphragm perpendicular to itself, is considered as the unit of light.

Control for the Accuracy of Reproduction.

For comparison of the light unit thus obtained, another source of light was used, whose constancy was assured for a more or less long time—namely, an incandescent lamp, the current in which was kept accurately constant.

The next portion of the Paper is concerned with the means actually employed for the production of the unit of light, details of apparatus which need be very briefly referred to, if at all. Since other forms embodying the same principle may be devised, a few details may be noted. The platinum strips used are about 25 mm. wide, 60 mm. long, and 0·015 mm. thick, and are set up with their length horizontal. The current used is from 50-80 amperes at 32 volts, passing through an ammeter and regulating resistances.

Surrounding the strip is a water-jacket, kept at constant temperature by circulation of water, and the diaphragm is in one side of it, and is also provided with water circulation. The absorption vessel has quartz sides 1 mm. thick, and has a layer of water 2 cm. thick. The bolometer is that used by the authors in former experiments (see *Wied. Ann.*, Vol. XLVI., 1892, pp. 204-224), from which it differs only in having the bolometer strips coated electrolytically with platinum black, for reasons which will appear latter. A shutter, kept at the same temperature as the bolometer by a water circulation which also communicates with that of the diaphragm, is interposed between the bolometer and the platinum. The latter is arranged to turn on itself through a right angle, so as to illuminate a Lummer-Brodhun photometer, on which the lamp used for comparison is fixed.

Sources of Error.

(1) *Constancy of the Glowing Platinum.*—The water jacket is very successful in attaining this end, the air circulation inside it being of a perfectly definite character, as is shown by the curves on its inner surface caused by deposit of the evaporated platinum.

(2) *Galvanometer Deflections.*—To avoid working with very small deflections, the method of shunting the galvanometer for the larger amount was tried but abandoned. The best method was found to be to vary the distance of the bolometer from the scale, so as to make the two deflections equal; this was done by placing the apparatus on a suitable optical bench, where it could be slid backwards and forwards by amounts read on a divided scale.

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* *Elektrotechnische Zeitschrift*, No. 35, 1894, p. 474. Abstract.

(3) *Reproduction of the Light Unit.*—It was found that 1 per cent. alteration of galvanometer deflection meant a difference of 3 per cent. in the light measured by the photometer, and the deflection can be determined by a series of observations to 0·1 per cent. The limit of accuracy in the light in this direction is therefore about 0 3 per cent.

(4) *Surface of the Platinum.*—The chemically pure platinum becomes when glowing as smooth as a mirror, and gives errors not exceeding one half per cent.

(5) *Differences of Temperature.*—Differences of temperature in the upper and lower portion of the platinum do not affect the results for 1 sq. cm.

(6) *The Size of the Diaphragm.*—The size of the diaphragm must, of course, be very accurately known ; errors of about one-fifth per cent. come in here with most accurate measurements.

(7) *Position of Platinum.*—It is not necessary to have great accuracy in placing the platinum parallel to the plane of the diaphragm.

(8) *The Absorption Vessel.*—The chief point to note is that the vessel should be on the bolometer side of the shutter to eliminate any effect due to itself. The thickness of water must be very accurately known, 0·1 mm. making 1 per cent. difference to the value of the unit.

(9) *Selective Properties of the Bolometer.*—To avoid these, coating electrolytically with platinum black was found to be the best method, the maximum errors due to this cause being just over one-half per cent., a difference of 50 per cent. in the thickness of the coating having only an effect of 3 per cent. in the value of the light. Two bolometers with deposits of equal thickness behaved exactly alike. The initial temperature of the bolometer is also a fact to be considered and taken into account.

CONCLUSION.

After these preliminary experiments, and with the aid of the apparatus once constructed, the reproduction of such a unit of light is fairly simple, and its accuracy to 1 per cent. appears assured. Such a unit will in future form the standard of reference for the photometric work of the Reichsanstalt. It may be noted that such a unit may be easily adapted for different coloured sources of light by suitable choice of the ratio of the amount of light absorbed to the whole.

ON THE REFRACTION AND DISPERSION OF RAYS OF ELECTRIC FORCE.*

BY A. GARBASSO AND E. ASCHKINASS.

H. von. Helmholtz has assumed, as the basis of his mechanical theory of the absorption and dispersion of light, the hypothesis of the sympathetic vibration of the particles of ether or matter respectively. Now it is a remarkable fact that the equation by which, in Helmholtz's theory, the motion of the material particles is represented, has the same form as the equation derived by M. Poincaré for electrical resonance. This agreement indicates that the influence of material molecules upon ether waves may be regarded as a phenomenon of resonance. H. von Helmholtz has, in fact, in his electromagnetic theory of chromatic dispersion,† expressed this view in the most unmistakeable manner.

In connection with Hertz's discoveries it was easy to imagine that a space filled with Hertz resonators would behave towards electrical waves as does a ponderable body towards light waves. One of us has, indeed, succeeded‡ in completely reproducing in this manner the phenomenon of the selective absorption of light and of surface colours. At the same time these experiments contribute to the solution of the question of so-called multiple resonance.

Opinions on this subject are known to be very diverging. While MM. Sarasin and De la Rive adopt the view that the primary circuit contains oscillations belonging to a continuous spectrum, MM. Poincaré and Bjerknes have arrived at the conclusion that the generator emits strongly damped oscillations of a single period. But, strictly speaking, these views, apparently so diverse, are quite identical, since a damped sine oscillation may be represented as an integral over an undamped one. We cannot, therefore, speak about a decision of this question, yet it is of some importance to point out that it must be possible to treat the rays proceeding from a Hertzian primary conductor in all cases by the same physical method as, say, the heat rays of a hot body. In particular, it necessarily follows that it must be possible by the employment of suitable means to produce a continuous spectrum of the rays of electric force emitted.

But with a prism of ordinary matter we cannot expect any dispersion of electric rays. For it is established that a perceptible dispersion cannot take place unless the period of the transmitted waves is of the same order of magnitude as that appertaining to the proper oscillations of the molecules of the medium in question. But it is very probable that the molecules of ponderable matter act as resonators for waves of the order of thermal waves, a view which has recently* been confirmed by Herr Rubens's experiments. From this it follows at once that between molecules and Hertzian waves no resonance is possible, and that, therefore, no dispersion of rays of electric force can be observed with a prism of ordinary matter. Theory, on the other hand, shows in what direction we may arrive at a solution of our problem.

The same method as that by which structures can be produced which behave like coloured bodies towards rays of electric force, will also offer the possibility of forming media in which the velocity of propagation of electric waves depends upon the rate of oscillation. If the prism consists of resonators of a single period, we may predict that by analogy with optical phenomena the dispersion must be specially great near the absorption band.

We have sought to put this idea into effect, and the results have completely justified our expectations. For we have succeeded in obtaining, by means of a prism of resonators, refraction of the rays of electric force, and we have further found that the amount of deviation depends upon the dimensions of the resonator with which the transmitted radiation is observed. The following is a short report upon the details of the method of observation, and the results of the experiments.

The primary conductor E (Fig. 1), consisted, according to Sgr. Righi's† data, of four spheres 1·36 cm. in diameter ; the chief period of oscillation of this apparatus corresponds to a wave length of 7·5 cm. The exciter was placed at the focus of a spherical brass concave mirror S_1, of focal length 14 cm. ; the aperture of the mirror was 50 cm. Three different secondary resonators, also constructed according to Righi's data, were employed for the measurements ; they are referred to as A, B, and C. On the basis of experiments conducted by one of us,‡ and of a recent work by Zehnder§ we placed our resonators in the focal line of cylindrical parabolic mirrors S_2, made of thin cardboard, upon which were stuck numerous tinfoil trips in horizontal rows parallel to the focal line of the mirror. On each mirror the strips of tinfoil corresponded by their length and breadth with the resonator attached to the mirror, so that the mirror itself consisted of a number of resonators. In the Table I. following the constants of the mirrors and the resonators are given in centimetres.

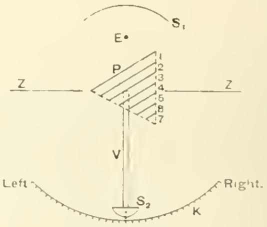

FIG. 1.

Table I.

Resonator.	Length.	Breadth	Height.	Aperture.	Focal length.	Number of rows of resonators on the mirror.	Number of resonators in a row.	Distance between two consecutive resonators.
	Of the resonator.		Of the mirror.					
A	3	0·2	13	10·5	2	3	35	0·2
B	4	0·2	13	11	2	3	38	0·2
C	6	0·3	13	12	3	1	23	0·3

The secondary mirror was carried by a stand capable of rotating about a fixed point by means of a rigid bar V. To the stand was attached an indicator enabling the observer to read, on a circle K divided into degrees, the angular displacement of the resonator. When the resonator was just opposite the exciter, the distance between the two conductors was 75cm.

The prism P consisted of seven panes of glass of a uniform height of 35cm. ; their breadths were 35, 30, 25, 20, 15, 10, and 5cm. On each pane were stuck numerous resonators (strips of tinfoil 1·5cm. long and 0·2cm. broad) in twelve parallel rows. The distance between two successive rows was 1cm., and the distance between two adjoining resonators of the same row 1·3cm. Hence the number of resonators in each row was different on different plates (21, 18, 15, 12, 9, 6, 3). The prism was placed so that the longer side of the resonators stood vertical, *i.e.*, parallel to the plane of oscillation of the primary and secondary conductor. The plates were fastened parallel to each other in a vertical position on a frame of wood, so that the resonators filled a space of the form of a right equilateral prism. The three lateral surfaces had an area of 35 sq. cm. The position of the prism was the same in all the experiments, as shown in Fig. 1. The angle of incidence was 40°, the mean distance of the prism surface facing the exciter from the latter itself was 18cm. To the right and the left of the prism we had placed two zinc plates, Z Z (squares of 40cm. edge), so as to cut off the direct rays.

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* Wied. Ann. No. 11 1894.

† Wied. Ann., 48, p. 389, 1893.

‡ A. Garbasso, Atti di Torino, 28, 1893, and Journal de Physique, June, 1893.

* Wied. Ann. 53, p. 267, 1894.

† Rendiconti dei Lincei, 2, 1893.

‡ A. Garbasso, loc. cit.

§ L. Zehnder, Wied. Ann. 52, 1894

The observations were conducted by determining the positions of the resonator with the prism (m_r, m_l) and without it (o_r, o_l) in which the secondary sparks just disappeared. The deviation a cannot be deduced at once from the numbers thus obtained. For, quite apart from the refraction, an absorption effect is exercised upon the transmitted ray, in consequence of which an apparent deflection a^1 towards the centre line is produced. Now it is clear that with our arrangement the effects of refraction and absorption must be of the same sign on the left, and of opposite signs on the right hand side. Thus we obtain

$$a + a^1 = m_l - o_l,$$

$$a - a^1 = m_r - o_r,$$

and hence

$$a = \frac{(m_l - o_l) + (m_r - o_r)}{2},$$

$$a^1 = \frac{(m_l - o_l) - (m_r - o_r)}{2}.$$

We give one of our series of observations as an example.

Table II.

Resonator.	$m_l - o_l$	$m_r - o_r$	a	a^1
A	15° 18′	1° 30′	8° 24′	6° 24′
B	12° 6′	2° 12′	7° 12′	5
C	6° 24′	3° 36′	5°	1° 24′

Hence it follows that "both the refraction and the absorption decreases as the wave-length increases." The same holds good for light and heat rays if we proceed from the absorption band in the direction of the longer waves.

As might have been expected, the different series of observations did not agree perfectly. For a complete series consisted of twelve single observations, which together took at least a quarter of an hour, and during an interval of that length the exciter does not work quite uniformly.

We will add several series of observations of the deviation a to show the limits of accuracy of our observations :—

Table III.

Resonator.	1.	2.	3.	4.	5.	Mean value.
A	9° 18′	9° 36′	9° 24′	8° 24′	8° 36′	9° 6′
B	7° 24′	7° 24′	7° 12′	7° 12′	7° 12′	7° 18′
C	6° 36′	5° 24′	5° 12′	5°	5°	5° 24′

It will be seen that the phenomenon is well established as regards direction of increase and order of magnitude.

We made a point of showing by a special test that a medium consisting of electric resonators as described above is capable of exercising a refracting effect upon a ray of electric force in a form different from the prismatic. For this purpose we arranged the seven plates comprising the prism in the manner shown in Fig. 2. As before, all the plates were parallel to each other; their respective distances also had the same value. But the resonators, arranged in four equal square surfaces, occupied the space of the form of a rectangular parallelpipedon, which might be regarded as a plane-parallel layer of the matter which composed the prism, of a thickness of 12cm. The structure was placed in such a manner that the angle of incidence of the electric rays amounted to 40°, as before. From the prism observations the approximate value of the refractive index of the substance could be calculated. From this, from the thickness of the plane-parallel layer, and from the angle of incidence, the parallel displacement could be determined which the transmitted ray would have to undergo. Our measurements, performed in the same manner as in the case of prismatic refraction—viz., by finding the limits of effective radiation—showed a satisfactory agreement with the calculated value.

The arrangement last described also permitted the repetition of the chief experiment in a specially pronounced form. On placing the resonator exactly opposite the exciter, and then placing the plane-parallel layer between them in such a manner that the line joining them bisected plate five, the zinc plates remaining as before, beautiful secondary sparks could be observed. On taking away plates 5, 6, and 7, and thus making the body prismatic, the sparks disappeared at once, and the rays were deflected towards the right. Had they not suffered prismatic refraction, the sparks, in opposition to the observed phenomenon, would have had to become more intense by the removal of three of the absorbing plates.

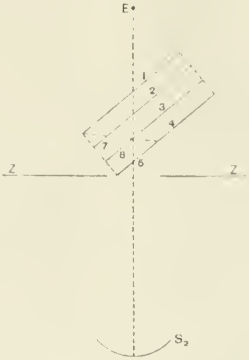

FIG. 2.

Finally, we ascertained by a further experiment that in the case of our principal experiments the prismatic form of the medium was a necessary condition of the occurrence of the phenomena described. On removing the plates 5, 6, and 7, and placing the seventh plate beside the third, thus increasing the latter by three vertical rows, and giving the arrangement the form shown in Fig. 3, no definite prismatic refraction was obtained.

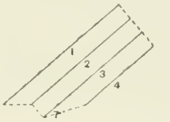

FIG. 3.

We may sum up the conclusions arrived at by our work as follows :—

We have shown that the rays proceeding from a Hertzian primary conductor may be analysed into a spectrum by a prism made up of resonators, and hence we draw the two deductions : (*a*) The emitted rays of electric force may be regarded from a physical point of view, not necessarily as monochromatic, but as composite with about the same degree of justification as white light ; (*b*) Helmholtz's theory of chromatic dispersion gains further support by our results.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, November 9th.

PHYSICAL SOCIETY.

7 p.m. Meeting at rooms of the Chemical Society, Burlington House. The following Papers will be read : (1) "The Photographic Action of Stationary Light Waves," by J. Larmor, F.R.S. (2) "Vapour Pressure," by Prof. S. Young, F.R.S. (3) "The Luminescence of Glass," by John Burke.

MONDAY, November 12th.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

7 p.m. Council Meeting at the Palatine Hotel, Hunt's Bank, Manchester.

8 p.m. Ordinary General Meeting. The following Paper will be read : "Lighting Installations," by H. A. Henderson.

TUESDAY, November 13th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Presidential address by Sir Robert Rawlinson, K.C.B., and presentation of medals.

FRIDAY, November 16th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. The following Paper will be read : "Economics of Direct Current Central Stations," by John F. C. Snell.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel. Presidential address by Alexander Siemens.

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NOTICE.

In a small portion of our last issue the first block illustrating Mr. E. T. Carter's article on "Motive Power and Gearing," owing to an accident, was not shown. Any subscriber who has received a copy with this fault, and who will return it, will have a complete copy sent him post free.

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THE SCIENTIFIC SOCIETY SEASON.

"There is occasions and causes, why, and wherefore, in all things," and thus it comes about that we enjoy our Silly Season, our Society Season, and our Scientific Society Season when we do. The middle member of the group, being in a manner compounded of the other two, a mixture of reason and unreason, appropriately commences when the season of scientific activity is at its meridian, and expires at the moment when the season of long letters to *The Times* has almost attained maturity. Notwithstanding this evident fitness, it is, we think, to be regretted that the miseries of London life in November should be aggravated by the painful process of accustoming the brain to assimilate the contents of the very varied weekly bill-of-fare offered to such electrical engineers as may happen to be possessed with the inconvenient ambition of keeping themselves in that uncomfortable position known as abreast of the times, and who have a turn for the scientific side of their calling. The mental and physical frame becomes more or less inured to the strain after a while, but a tax upon the organism it always must remain, and it is for scientific societies to see to it that nothing is omitted that may conduce to their meetings being fully worth the time and attention of busy men.

To this end tend all rules of procedure based not on the custom of this or that ancient institution, but on common sense; and it is with no small satisfaction that we observe the way in which, not only a transatlantic body like the American Institute of Electrical Engineers, but also the Physical Society of London has freed itself from the solemn absurdity called reading a Paper, the abolition of which has long been advocated in these columns. Not only so, but another reform, often urged by the technical Press, has been adopted by these two very dissimilar societies; we refer to the early printing and the early distribution to members and all others whom it may concern of every Paper about to be discussed. It is not everyone who is gifted with the power of making plain his meaning even in print, and still smaller is the number of those who can read a long lucubration aloud before a critical audience with sufficient elocution and sufficient emphasis to enable the majority to so much as hear what is being said or to grasp the main points. Again, Papers that are mostly mathematical or statistical do not lend themselves to "reading"; and all Papers worthy of the name require at least a modicum of study before it is possible to get upon one's legs and usefully discuss them. The custom of the Institution of Civil Engineers is worthy of imitation, where mere audibility is all that is aimed at. The acoustic peculiarities of a hall are soon mastered by anyone whose duty it is to continually read papers in it; and the requisite degree of solemnity, emphasis, or ridicule could be imparted to the appropriate passages by judiciously besprinkling the reader's copy of the Paper with marginal symbols. But notwithstanding this *via media*, authors of Papers still have, as a rule, to actually read their Papers; and in too many cases listeners are called upon there and then to get up and hold forth upon a contribution to contemporary science they have only half heard, and but dimly understand. In the happy days, when Papers were short, and dealt with small and definite points, when audiences were as diminutive as they were select, and postal communication was expensive, slow, and uncertain, the custom was tolerably rational; to-day, when all this is altered, its retention is decidedly irrational. It may result in the regulation number of meetings being held every session, but it gives many a member a journey for nothing. Sensible people mostly stay away on the nights when Papers are down for reading, unless the subsidiary purpose of a meeting, to-wit, light conversation over the teacups, is of itself an adequate attraction. It is by no means easy to see why it should be deemed more disastrous for a society to occasionally omit, if need be, one of the meetings announced on the annual programme when the supply of papers runs short, than to call its members together to assist at a wearisome formality. There is a well-known German scientific publication which exhibits in this respect more common sense than is usually to be found in such matters. Whenever sufficient copy has been received to make up a number of the regulation size, a number is published, and when the regulation tale of numbers has been completed, a new volume is commenced. We venture to think this excellent system might be copied with advantage in many directions; indeed, technical journals, when they have nothing to say, might well be excused if they refrain from saying it.

To conclude: When the author has made any explanatory remarks he may wish, let the debate commence at once; and, provided those taking part in it have had an adequate opportunity of studying the Paper complete with diagrams, and have a claim to be heard with respect on the subject under discussion, the society, if it be an electrical one, will have done in this regard what it can for "the general advancement" of electrical science, and the facilitating of "the exchange of information and ideas amongst its members." As to the exact value of government by discussion there is naturally a great diversity of opinion; but the inestimable value of a thorough discussion of scientific theories or engineering difficulties is universally admitted. Indeed, a Paper read before an Institution of standing, but inadequately discussed, may often do more harm than good. It may very possibly be as full of fallacies as an egg is of meat, and unless its shortcomings are exposed and its assertions countermined in debate, the author and his Paper go forth to the world with the *imprimatur* of the Institution stamped upon them—a consummation to be avoided.

REVIEWS.

Electric Lamps and Electric Lighting. By Dr. J. A. Fleming, M.A., F.R.S. (London: "The Electrician" Printing and Publishing Company, Limited. 1894.)

When one comes across a reprint of a series of afternoon Royal Institution lectures he expects an elementary book, with its contents strung together to connect a lot of experiments that the author was anxious to show to an audience already jaded with a variety of subjects no one human brain could take in. Dr. Fleming has given us nothing of this sort, but a concise account of incandescent and arc lamps, followed by a short sketch of electric lighting generally. It is by no means a mere popular book, however, and few electricians, no matter how well up in their subject, will find they can afford to pass it by. The chapter about glow lamps is especially interesting, as it contains a great deal of valuable information on all sorts of related physical points, and clear treatment of photometric questions. It is, perhaps, a pity to go into elementary matter, such as iron filing curves, to explain the dynamo; but it is difficult to know what else to do. Though there is a great deal too much in it for the purpose, this work is just what is frequently asked after by men who have had scientific or technical training in other branches, and want a book which will give them some knowledge of electric lighting and will not treat the reader as an ignoramus or a child, and is also written by a man who thoroughly understands the subject himself.

It is strange, considering the amount of work that has been done upon the incandescent lamp, that people never know what they mean by candle-power. The candle-power of an incandescent lamp is almost invariably taken by measuring emission in a horizontal direction only. The result is that the whole of the tests depend, among other things, on the shape of the carbon, which should be eliminated to make the tests of any value. Probably 99 out of 100 of the curves of the lives of lamps at different efficiencies are rendered useless by this error, and by its being assumed that lamps kept under a pressure varying from 95 to 105 volts will stand as well as if they had 100 volts kept constant.

Dr. Fleming is generally anything but a loose writer, and he sins in very good company when he writes "strength of current," meaning current; but he should not have tarnished his book by such expressions as "10 h.p. of electrical energy": he must have been reading one of the million odd useless books on the electric light popularly explained, and been infected. Such a slip does not really hurt this excellent book, however; in fact, it is a merit, as it gives the reviewer something to write about.

The binding, printing, and general get-up is admirable, half-tone illustrations printed with letterpress coming out like platinotype photographs. J. S.

THE USE OF THE BOOSTER ON ELECTRIC RAILWAY CIRCUITS.*

Messrs. J. H. Vail and S. H. Wynkoop, in a Paper read at the Atlanta Convention, on "The Use of the Booster on Electric Railway Circuits," advocate the use of Mr. W. S. Barstow's system of maintaining a constant voltage in a multiple electric circuit, consisting in the employment of an auxiliary apparatus called a "booster." They state that, owing to the drop of potential on street railway lines, the commercial efficiency of the street railway motor, which is normally about 78 per cent., becomes much reduced, at two-thirds normal being only 52 per cent. With direct feeding the loss in transmitting energy is overcome only by incurring the heavy cost of copper as a first investment. With the booster system, the loss in transmission is overcome by incurring the cost of operation of a machine which shall automatically raise the initial voltage above that of the bus bars by an amount which may exactly equal the drop in potential on the feeder at that instant. When using this machine, the feeder is calculated for ampere capacity only, and the pressure constantly maintained at the service end of the feeder equal to the pressure at the bus bars, irrespective of the length of the feeder or location of the load.

---

* From the *Electrical World* of New York.

In any instance, the cost of a direct feeder increases as the square of the distance, while the cost of the booster feeder is stated to be directly proportional to the number of miles. The authors state that these characteristics of the latter system result in a reduction in first cost of from 25 to 75 per cent. as compared with the first cost of the ordinary direct-feeding methods of present practice; and it thereby becomes possible for numerous electric street railway companies to extend their lines into suburban localities from 10 to 20 miles distant from the power station, at the same time retaining the investment within reasonable limits.

The following equations are given by the authors to enable the two systems to be compared :—

Let :

C_1 = Current delivered to trolley wire.
V = Voltage at generator.
V_1 = Voltage at trolley wire.
V_2 = Voltage of booster.
f_1 = Efficiency of generating apparatus.
f_2 = Efficiency of booster.
K_1 = Operating expenses for direct feeding—coal, oil, water, waste, engineers, firemen, and interest on so much of the steam generating and transmission plant as is due to the feeder under consideration.
K_2 = Operating expenses for booster feeding—details as before.
L = Length of feeder in miles.
l = Circular miles of feeder.
A = Initial cost of as much of the steam, generating and transmission plant as is due to the feeder under consideration.
a = Per cent. interest on investment.
d = Per cent. depreciation on investment.
S = Cost of steam plant per horse-power.
G = Cost of generating plant per kilowatt.
B = Cost of booster per kilowatt output.
W = Cost of insulated wire per lb.
R = Cost of placing 5,544ft. No. 4-0 wire, including insulators, pins, cross-arms, sundry hardware and labour; 5 per cent. allowance for sag.
P = Cost of supplying 1 H.P. per year, in quantities of over 100 H.P.

Then, for direct feeding :

$$A = \frac{\frac{C_1 V_1}{746} + \frac{C_1 (V - V_1)}{746}}{f_1} S + \left\{ \frac{C_1 V_1}{1,000} + \frac{C_1 (V - V_1)}{1,000} \right\} G \quad . \quad . \quad (1)$$
$$+ \frac{2,315,488\, L^2 C_1}{V - V_1} W + \frac{\cdot 5664\, L^2 C_1}{V - V_1} R.$$

And for booster feeding,

$$A = \frac{\frac{C_1 V_1}{746} + \frac{C_1 (V - V_1)}{746} + \frac{C_1 V_2}{746\, f_2}}{f_1} S + \left\{ \frac{C_1 V_1}{1,000} + \frac{C_1 (V - V_1)}{1,000} + \frac{C_1 V_2}{1,000\, f_2} \right\} G$$
$$+ \frac{C_1 V_2}{1,000} B + 0{\cdot}019318\, l\, L\, W + \frac{l\, L}{211,600} R. \quad . \quad . \quad . \quad (2)$$

Substituting the following values in (1),

$$\begin{array}{ll} C_1 = 200 & G = 25 \\ V_1 = 500 & W = 00{\cdot}13 \\ V = 550 & R = 75 \\ S = 45 & B = 50 \\ f_1 = 00{\cdot}95 & \end{array}$$

we have

$$A = 9,735 + 1,374\, L^2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Substituting the same values in (2), assuming 211,600 as the value of l, taking $f_2 = 0{\cdot}90$, and finding an expression for V_2 in terms of L, we get

$$A = 8,723 + 2,857\, L \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

In order to graphically represent the relation between initial investments in the two methods of feeding under discussion, (1) and (2) have been solved for varying values of L from 1 to 30, and the results plotted on Fig. 1. An inspection on this diagram shows at once the superiority of the booster system over direct feeding in cases where first cost is the essential feature. It will be noted that the curves have been carried out for the entire 30 miles without regard to the practical voltage limit in direct-current machines, or the point at which the cost of operating an independent station becomes less than operating from the main station. Fig. 1 shows that for distances greater than one and one half miles it will cost less to instal a booster system than to place copper and machinery in the usual manner for feeding direct. In cases where the motive power is water, costing little or nothing per H.P., these curves give at once the relative economy of the two methods; but ordinarily, on account of the consumption of coal, the loss in the line (represented in the new method by the power required to operate the booster) becomes an important factor in the discussion; and it is necessary to establish equations for the operating expenses, taking into account the fixed charges of interest and depreciation on the investment, as well as the cost of furnishing the required power.

The following equations will enable these values to be determined for different distances :

Direct feeding :

$$K_1 = \frac{\frac{C_1 V_1}{746} + \frac{C_1 (V - V_1)}{746}}{f_1} P + A\,(a + d). \quad . \quad . \quad . \quad . \quad (5)$$

Booster feeding :

$$K_2 = \frac{\frac{C_1 V_1}{746} + \frac{C_1 (V - V_1)}{746} + \frac{C_1 V_2}{746\, f_2}}{f_1} P + A\,(a + d). \quad . \quad . \quad . \quad . \quad (6)$$

Making the same substitutions in (5) and (6) as were made in (1) and (2), placing $(a + d) = 0{\cdot}10$, and remembering that A varies according to the method and distances under discussion, we get :

$$K_1 = 155\, P + \frac{A}{10}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

$$K_2 = (139 + 36\, L)\, P + \frac{A}{10}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Fig. 2 represents these equations plotted for varying values of L, P being taken at 40. The intersection of the upper curve with the upper straight line is the point at which the booster system costs as much to operate as does the direct system. This distance we find to be 12½ miles. For shorter distances, direct feeding is more economical, while for longer distances the booster system has an absolute advantage. Now, the assumption upon which (5) and (6) were solved is a feeder constantly loaded to its maximum capacity. The absurdity of this assumption is apparent when one considers the actual conditions which obtain in railway work; the average load on the feeder during the entire year will be more nearly one-third or one-quarter of the maximum. Equations have, therefore, been established and plotted similar to (5) and (6), for three-quarters, one-half and one-quarter load, and the resultant curves are shown in Fig. 2, in order to afford ready means of comparison.

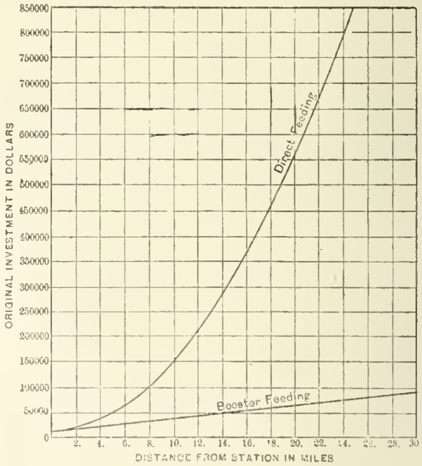

Fig. 1

All calculations have been based upon the most recent methods of rail bonding and track feeding; and the assumption that the resistance of the return circuit is equal to that of the outgoing circuit is therefore perfectly safe.

While the method outlined may seem like robbing Peter to pay Paul, it must be remembered that in direct feeding there is a large amount of capital invested in the pole line, accruing interest day and night, and irrespective of the traffic on the line; while, with booster feeding, the interest on copper investment is nominal, and the power required to drive the booster itself is proportional to the load on the line. Thus it can be understood why, under the conditions given, with an average load of one-quarter the maximum, the booster system is more economical than the direct feeding system for distances over four and a-half miles.

It may occur to some that the installation of a special high voltage generator to supply the feeder in question would be a simpler method of reducing the copper; but a consideration of the enormous variations in drop under extreme changes in load on a long feeder calculated for ampere capacity only, leads at once to the discarding of such a scheme until such time as manufacturers can furnish efficient generators over compounded from 50 to 150 per cent.

Fig. 3 gives a specific comparison between direct and booster feeding, showing the investment saved in copper by the latter. The resistance of the return rail circuit is considered the same as the resistance of the feeder; the allowance for weight of insulation is 0·15, and for sag 0·05.

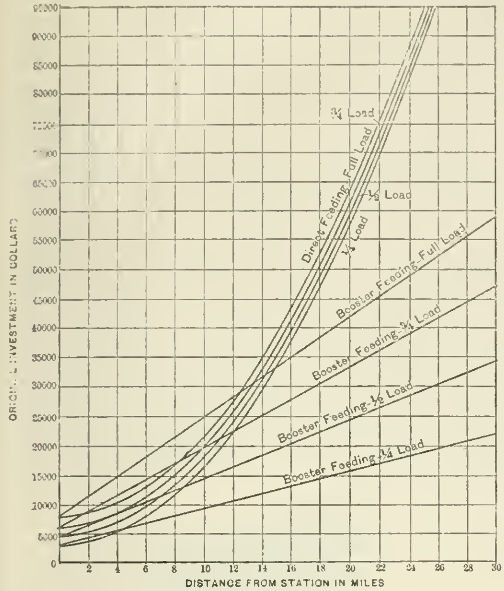

Fig. 2.

Ordinarily in calculating copper for distribution, special features influencing traffic are obliged to be allowed for, such as ball grounds, race tracks, picnic groves, &c. As there is seldom any necessity for bunching cars at all these points simultaneously, and as the various features are usually scattered, it follows that at all times one or more of the feeders is lying comparatively idle.

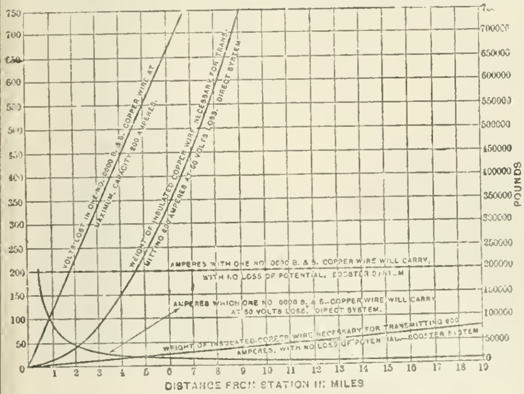

Fig. 3.

Under the plan suggested, the copper is figured for average conditions, and a booster, placed in the station, is arranged to be thrown immediately upon any feeder which may become burdened with an excessive load.

Another feature of this system entailing economy becomes prominent on long suburban lines forced to run an infrequent schedule late at night. On such a road the booster may be shut down and cut out of circuit entirely when the load on the long-distance feeder drops to, say, one-quarter of the maximum, depending upon the amount of copper in the line. If this suburban line extends to a park or pavilion which is open only during the summer months, the advantage of the booster over direct feeding is great, since the investment on a booster lying idle is a small fractional part of the interest on the idle copper of a direct feeder.

In the progress of electric railways, as in the growth of cities, development frequently fails to follow the lines predicted for it. It therefore happens that many a road to-day is worrying along, the victim of misplaced judgment—and copper. In many instances the adoption of a booster, and a re-distribution of the present copper, will remedy the evil in the most economical manner. In large cities, such as Boston, Brooklyn, and Philadelphia, the purchase of tons of copper could in this way be obviated, with a gain at the same time in uniformity of pressure.

MUNICIPAL ELECTRIC LIGHTING.

The members of the Association of Municipal and County Engineers visited the Hampstead Vestry Electric Light Station on Saturday afternoon, when Mr. W. H. Preece, who has acted as consulting engineer, showed the visitors over the works, and gave a description of them.

Mr. W. H. **Preece** said: This electric lighting question in Hampstead has followed the usual history of electric lighting everywhere. Corporations and vestries have desired to prevent the possibility of the introduction into their midst of another monopoly, and they have all rushed very readily into the possession of Provisional Orders. It is one thing to get a Provisional Order; but it is quite another thing to persuade the Corporation or the Vestry to spend a large sum in carrying out the requirements of that Provisional Order. In this district, although we are very fortunate in possessing a very far-seeing and able gentleman on the Vestry, there has been a very large body of opponents raising the point of opposition to an alarming extent. We got over those difficulties, estimates were prepared, contracts were accepted, and the work has been carried out in a way which reflects the very greatest credit on the firm who received the contract—the firm of Messrs. Siemens. The name of Messrs. Siemens is a guarantee for the work being well carried out. The buildings are admirably constructed and very well designed. We do not offer you anything very novel; but we do claim that the works are fairly well up-to-date. We are still on the threshold, in the very infancy of electric lighting, but these works are as complete as any other in the country. Here we have to deal with a very scattered district. The population is principally centred in the neighbourhood surrounding these works, then there is old Hampstead where it is very much centred; but the outlying district spreads in a scattered way. It was only possible by the introduction of the high-pressure alternating system to meet the demands of all parts of the district. We have introduced the system here, so that there is not a single inch of the district which cannot be served from the building in which we are at the present moment.

After describing the station at some length, Mr. Preece went on to say:—I have always been a tremendous advocate for electricity for street lighting, but then only to light on a large scale and as well as you can. The chief advantage of the electric light in the streets is as an advertisement; it attracts the attention of the whole parish to the merits of the light. At Bristol the whole of the main thoroughfare from the railway station through the town to the Victoria Hall, Clifton, has been lighted by arc lamps—there are 100 of them. Along that route the electric light has been taken up with such avidity that there are 33 per cent. of the shops lighted by electricity, while in other parts of the town there are only 5 per cent. This is very largely due to the introduction of street lighting on a very brilliant scale. Our only misfortune here has been with the street lighting. On October 11th we lighted up for the first time, and everybody was pleased; but no sooner had our masters, the Vestry of Hampstead, disappeared than first one fault and then another developed itself, so I have not started the light yet in the streets. In about a fortnight's time our arrangements for street lighting will be complete, and then it will go with the same success as everything else. There is a rumour throughout the parish that the whole thing has broken down; a meeting of the Ratepayers' Association has been held; and the first resolution passed was that my commission should be stopped. I do not mind these little things. A man can only do his duty, and cannot do more. Here we are very successful. I am perfectly certain of this, that the electric lighting industry in Hampstead is going to be financially a very great success, and I am quite satisfied that there will never be any demand upon the rates for any assistance at all. I think we shall pay our interest on borrowed money the first year. We have only been open three weeks, and we have 2,176 lamps fixed, 1,218 in hand, and we have orders for 4,475 lamps; so that in less than a month we have got practically a load of 7,869 lamps. We only started with the idea of getting 10,000 lamps in two years. My impression is we shall have 20,000 lamps in less than twelve months. I have here a load curve showing the way in which the current is distributed. This is one of the greatest difficulties with electric lighting. You have between the hours of four and twelve at night a very good load, and a paying load, but you have during the rest of the 24 hours practically nothing. At Worcester we are trying a very important experiment indeed. At Worcester we have some water power available and we are going to use this water-power during the day in working pumps at the waterworks and also in pumping sewage up to a higher level. The result is this, we will have during the day a load which will compare very favourably with the night load. And we shall have a continuous curve which will pay our expenses day and night. With this curve (at Hampstead) we are paying during the night but not during the day; but if you can use the power during the day you reduce your expenses and the cost of the light. We started at Worcester with an exhibition; and, what with street lighting and the local exhibition, the thing was so well advertised that the people are pouring in to be first in the field for the light. We have been within our estimates. That is an unusual thing for an engineer to say. It is rather a compliment; at any rate, I think so. We are within our estimates in the contracts and under our estimates in the business. I am quite sure the electric lighting is going to be practically and financially a great success.

Mr. **Cockrill** (Great Yarmouth): What price are you charging for the light?

Mr. **Preece**: The charge per unit is 6d., and we have a sliding scale according to the amount of current taken by our customers which varies from 6d. down to 4d. We have one very large customer indeed—the North-Western Hospital—if it takes 70,000 units it will be 4d., 50,000, 4½d., and 40,000, 4¾d.

Mr. **Cockrill**: That is, for lighting purposes?

Mr. **Preece**: Yes, that is for lighting. We shall reduce the price for current supplied during the day for power purposes, it will be 3d. probably.

Mr. **Cockrill**: I believe you consider arc lighting in the streets is an incentive to people in shops using the electric light?

Mr. **Preece**: Yes, it attracts attention. Then, when they find it comes out cheaper than gas, they take the light.

Mr. C. **Jones** (Ealing): Can you give us the entire cost of the installation?

Mr. **Preece**: I cannot tell you with accuracy. I think we have spent something like £30,000.

Mr. **Mann** (Sevenoaks): In estimating that there will be no charge upon the rates, do you allow for maintenance and depreciation?

Mr. **Preece**: We are borrowing money redeemable at 25 years, and we have to pay interest that includes repayment of capital. In electrical apparatus of all kinds you must maintain up to the hilt; you cannot allow depreciation to take place. The only point in which depreciation comes in is the boiler, and that is a small matter. The electric plant must be maintained up to the hilt; it is always under renewal.

Mr. **Cockrill**: Can you give us any idea what effect the destruction of refuse for the creating of electrical power will have upon the cost of production?

Mr. **Preece**: As a very cautious engineer, I am going to wait to see the results of the experiments made by the municipal engineer.

On the motion of the **President** (Mr. A. M. Fowler, C.E., Manchester), seconded by Mr. **Lewis Angell**, West Ham, a hearty vote of thanks was accorded to Mr. Preece for his description of the works.

ELECTRIC TRACTION, WITH SPECIAL REFERENCE TO THE INSTALLATION OF ELEVATED CONDUCTORS.*

BY ROBERT W. BLACKWELL AND PHILIP DAWSON.

In conversation with Mr. Wilkinson a few days ago, the suggestion was made that some supplementary memoranda relating to electric tramway practice collected during the past six months, which we have passed in studying construction on the principal American lines, and in visiting the late large Continental installations might meet with your acceptance; and it was also thought that an exhibition of apparatus employed in erecting and working elevated conductor lines would be of interest at this juncture. The marvellously rapid and successful introduction of electric traction in the United States is now an old story. That 600 electric tramways are there operating nearly 9,000 miles of track and 20,000 cars—that nearly three-fourths of the tramway movement of the country is electrical—that £45,000,000 is there invested in electrical tramways, and that this tremendous result has been, to all intents and purposes, effected within five years, cannot but appeal pleasantly to the electrical engineer. Germany, France, Belgium, Austria, Switzerland are already investing millions in electric traction, and there seems every reason to believe that England will shortly join the march of progress.

Probably no practical point in electric traction was less understood a few years ago than "rail-bonding," and a few words may be added to what has been said on that subject. Its importance has but recently been appreciated, and it is of *first* importance. It may be taken that the bonds connecting rails should be, as nearly as possible, of the same current capacity as the metals themselves. If a 70lb. rail be used, the sectional area of copper bonds should be as nearly as possible seven-sixths of a square inch, the ordinary steel rail having approximately one-sixth as much conductivity as commercially pure copper. This would exceed nine No. 0 copper wires. When electric roads were first constructed, a No. 4 galvanised iron wire was considered sufficient!

The contact surface of bond and rail should be as large as possible. With heavy bonding and insulated return-circuit feeders, the danger of corroding gas and water pipes (a danger that has been greatly and unnecessarily exaggerated) is practically nil. The Toronto, Baltimore, Salt Lake City, and many other systems may be cited in support of this statement. In cities earlier equipped, where the lightest of rail-bonds and return feeders were employed, and very heavy current dealt with, serious results undoubtedly ensued, as at Boston, where electric traction was first installed on a large scale. By the use of modern appliances the trouble there has almost ceased to exist. The tramway company employs special workmen to accompany gas and water construction gangs, and to connect all water and gas pipes laid in the neighbourhood of the power house to heavy bare copper cables returning to the stations. It must, however be borne in mind that in that city an approximate total of 13,000 E.H.P. has to be dealt with by the three power stations of the West End Street Railway Company. The following are the figures of January 27, 1894, on which day 577 cars and 71 snow ploughs were running:—

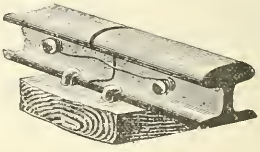

Fig. 1.

Stations.	Hours run.	Mean current for the day.	Maximum current.
Aleston	16	1,203 amperes.	1,580 amperes.
Cambridge	18	4,088 ,,	5,425 ,,
Central	24	12,706 ,,	14,400 ,,

The average monthly car mileage of this line in 1893 was 1,325,000 miles.

Prof. Jackson, of the University of Wisconsin, has found by experiment that the chemical composition of the soil has a great influence on corrosion. The most favourable to it, and having the smallest resistance, is that in which there is the greatest proportion of chlorides. Nitrates come next, and sulphates last. If, after all ordinary precautions are taken, corrosion still continues, bare copper cables are connected to the negative terminal of the generators at the switchboard, and to all pipes in the neighbourhood of the station. So far as possible the use of earth for the return circuit should be avoided. In conversation lately with Mr. Sprague, he laid great stress upon the advisability of laying the rails upon good stone ballast, and coating all bonds and connections with insulating and preservative compound.

The practice of laying bare copper wires along the whole length of the track, once regarded as indispensable, is now practically abandoned. It has been found that wire so laid rapidly deteriorates and wastes away. All the copper is put into the bonds, the rails are cross-connected approximately every 90ft., and where the volume of current exceeds the economical carrying capacity of the bonded rails insulated return-circuit conductors are employed. A number of rail bonds of approved make are on the table. It is interesting to compare them with this galvanised iron bond-wire of a few years ago. This "Brooklyn" rail bond, as its name implies, has been extensively used in that city. It is a simple strip of copper, so bent as to provide for expansion and contraction. A drive-fit tapered iron rivet at either end holds it to the rails. This "West End" bond is largely employed by the Boston tramways. An iron taper is brazed on to the copper wire at the points where the bond is driven through the web of the rails, and a soldering sleeve connects the free ends of the wire. This "Vail" bond is composed of flexible stranded copper cable, welded into heavy terminals, which are provided with copper riveting projections to be forced through the web. This "Chicago" rail-bond is more elaborate and effective. The tubular terminals, with slotted ends, are passed through the rail and the tapering drift-pins thoroughly driven home, so as to swage or swell the terminals to completely fill the space. It must be noted that the enlarged terminals are of sufficient diameter to avoid any choking of the current as it passes from the rail into the bond. As has been before said, the contact between rail and bond should be as near as possible seven times the sectional area of a bond wire sufficient to carry the given current. The sections shown exhibit the construction very fully. While the solid copper bond possesses all the flexibility found to be necessary, it is made, when desired, with flexible stranded copper cable between the terminals.

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* Paper read before the Institution of Electrical Engineers Thursday, November 8th.

Mr. Wilkinson has fully described and illustrated other types of bonds, to which it is unnecessary to again refer. Whether electric welding will eventually take the place of all bonding is still an undecided question. It has not yet stood the test of practical use on a large scale for a sufficiently long period to pronounce an opinion. When first introduced in Boston it was not successful, many rails breaking near the joint after some months' use. The process has since been improved, and a trial section of line was in course of being welded when the "West End" Street Railway was visited last June. Seven miles of welded track have given satisfaction for some months in St. Louis. Over 100 miles are now being welded in Brooklyn, and the result of this trial will demonstrate, after a year or two, the value of welding. At present it takes from 10 to 15 minutes to make a welded joint, and, on an average, a current of about 250 amperes at 550 volts is necessary, which is transformed into an alternating current at 2 to 3 volts pressure. Approximately, each joint costs 12s. to 15s. It is said that the pioneer company in electrically welding rails has already invested over £120,000 in experiments.

It is worth mentioning that modern American practice is to butt the rails, allowing nothing for expansion, wherever the streets are paved. The result is a nearly perfect joint. With heavy cars, having at least four to five tons load on each axle, this is of the highest importance.

A number of sections of standard American tramway rails are shown, and you will see from them that the highway authorities there are not quite so strict as they are in England, and allow of the use of a rail which presents much less obstruction to the easy running of a tram-car wheel.

Mr. Wilkinson refers to the possible adoption of the three-wire system for electric tramways. That system has been in satisfactory use in Portland, Oregon, for the past four years. Compound-wound generators, working at 500 volts without load, and 550 volts with full load, are used. The success of this system depends upon the load of the various sections being nearly balanced. At Milwaukee, where local conditions did not allow of proper balancing, the system was tried, and given up as a failure. The three-wire system was introduced at Portland because the generating station was three miles away from the nearest point of the line, and the cost of feeders would have been necessarily heavy. By the three-wire system 1,100 volts could be used, − 550 and + 550, between each two sections of trolley wire. The rails were connected to the neutral terminal at the switchboard. The average load on this station is 1,500 H.P. It is located near a huge lumber mill, and the fuel is carried by automatic conveyers directly from the waste lumber yard into the furnace. Several tramways derive their power from this station at a cost of about 25s. per horse-power month, 18 hours' daily work. Thomson watt-meters register the current used. The station pays about 40s. a day for its supply of fuel.

The enormous carrying power of an electric tramway, at a pinch, is an interesting feature. The following figures, given by Mr. Bowen, of the Chicago City Street Railway Company, show the work done by his electric line on "Chicago Day" at the World's Fair :—Fifty-one double-motor cars, 10 single-motor cars, and 73 trail cars were in operation over 26 miles of track. During the day 208,575 passengers were carried, and 11,271 car miles run. The maximum output at the power house was 17,000 amperes, and the average for 20 hours about 1,050. The minimum current registered was 750 amperes, and the average station pressure 540 volts. The ratio of expenses to receipts on this line is 40 per cent.

The following figures we have already published in a communication to *Engineering*. They are, however, sufficiently interesting to be placed before you.

The largest electric tramway equipment in the world is that of the West End Street Railway in Boston, U.S.A. Its adoption of electrical motive power practically established the economic value of that method of operation. The following figures are extracted from its annual reports :—

To Nov. 30 of ..	1888.	1889.	1890.	1891.	1892.	1893.
Total miles track	..	233·21	234·69	244·00	259·80	268·33
Miles electrically equipped	..	..	65·46	81·23	148·04	182·50
No. of horse cars	1,584	1,794	1,694	1,662	1,226	826
,, electric cars	..	47	237	469*	1,028	1,346¶
Tot. rev. miles run	15,431,758	16,573,831	17,66[illegible],369	17,462,572†	17,498,060‡	18,669,809§
El'ctric rev. miles	..		.	4,588,186	9,622,000	14,189,054
% of expenses to earnings .. .	82	82	77	74·4	70·8	68
Investment in electrics, dols.	..	412,600	1,510,321	.	5,752,694	7,698,069

* The long cars introduced at this time, and now almost exclusively used on the company's electric lines, are almost twice the size of the regular two-horse car.

† Electric mileage......	26·27 per cent.	Horse mileage.... .	73·73 per cent.
‡ ,, ,, ...	48·63 ,,	,, ,,	51·37 ,,
§ ,, ,, ...	76·17 ,,	,, ,,	21·83 ,,

And 25 additional miles partially electrically equipped.

¶ And 24 electric snow ploughs.

Attention is especially directed to the decrease in percentage of working costs to gross receipts, which has varied almost directly in proportion to the introduction of electric plant. This reduction has been made notwithstanding the fact that the additional investment required for the introduction of electric plant had to be provided for, and that such part of the Company's former plant as was rendered useless, or disposed of at a loss, had to be written off.

A comparison between the tramways of London (population, 4,306,411 in 1893) and Boston (population, 417,720 in 1890) is interesting :—

—	London.	Boston.
Miles of street operated	125⅔	—
Miles of single track	250 approx.	268⅓
Number of cars	1.080 *	2,172
Car miles run	21,924,290 †	18,669,809
Total working expenses	£885,967	£910,147
Total receipts........................	£1,070,578	£1,338,515
Net receipts	£184,611	£423,468
Percentage of expenses to receipts...	82·7 ‡	68
Total capital invested	£3,533,177	£4,435,000
Rate of interest paid on ord. shares...	3·32 per cent.	9 per cent.

* London uses top-seat cars, Boston does not. Boston has to keep a double set of cars ; open for summer, closed for winter.

† London has the greater number of car-miles run. The majority of Boston cars are much larger than the London ones.

‡ Boston investment includes £1,500,000 spent during the past five years on re-equipping electrically.

If London's percentage of expenses to receipts could be reduced from the present 82·7 to 70 per cent., net receipts would be increased to £321,174 ; if to 60 per cent., net receipts would be £428,231.

It is almost unnecessary to call attention to the fact that the cost of material and labour involved in the re-equipment electrically of a tramway is much higher in America than in England.

In the early days of electric traction no greater annoyances fell to the lot of the much tried tramway constructor than those which seemed inseparably connected with the suspension and effective insulation of the conducting wire. No material was obtainable possessing the happy combination of strength, durability, and high insulation with inconspicuousness ; interchangeability of parts was unknown ; and unsightly, rough-and-ready expedients were used wherever difficulties in erection were encountered. From 1884 to 1889 no insulator better than paraffined wood or porcelain could be obtained. This is the best device the Bentley-Knight Electric Railway Company could evolve to support a bar copper conductor in its conduit system laid in Boston in 1888. As you will see, it is composed of a block of porcelain leaded into a malleable iron holder, and having a brass support for the conductor leaded into it. All of the earlier elevated conductor lines were dependent for their insulation upon the wooden poles by which they were supported, and in wet weather the resultant leakage was a very serious factor. With the introduction of iron poles and the development of motors and power plant something better and more permanent became a necessity.

The wide extension of electric traction is largely due to the enterprise of independent manufacturers, who, seeing a great and growing need, undertook the elaboration of a system of electric tramway supplies to meet the demand, and relieved the electrical companies of constant consideration of the details necessary for safe and economical transmission of current from power house to car motor. The taut and workmanlike overhead line of to-day, in erecting which the lineman has had at hand a compact and appropriate device for every insulating or supporting point, differs widely from the unsightly webs which were the rule in earlier years.

Your attention is called to the various appliances on the Table. They fairly represent the best known and most widely used apparatus. You will note the strong external resemblance between the various makes wherever an appliance for a specific purpose is in question. We will not go into the question as to whether any one insulating material has greater merit than another. The specimens shown include several distinct makes of homogeneous and fibrous insulating substances, the composition of which is a manufacturers' secret : and also insulators of compressed mica, and of solid sheet mica ingeniously compressed between metallic parts, and supplemented externally by a special insulating compound.

(To be continued.)

LIGHT RAILWAYS AND TRAMWAYS.

A meeting of the Engineering, Electrical and Allied Trade Sections of the London Chamber of Commerce and others interested in the construction of light railways and of steam and electric tramways was held at the offices of the Chamber, Botolph House, Eastcheap, on the 2nd inst., to consider a circular letter received from the Railway Department of the Board of Trade in reference to "a movement recently set on foot with the object of obtaining further powers and facilities for the construction of light railways and steam or electric tramroads," and to "the requirements which are imposed by the Board of Trade upon new railways."

Mr. R. E. CROMPTON, who was voted to the chair, having stated the immediate object for which the meeting had been called, as set out above,

Mr. ALEX. T. PENNEY observed that the subject of light railways was of very great interest. Many years ago they unfortunately lost the control of the canals, which a great many of the powerful railway companies got hold of, and they were not now available in many cases where they might be. He believed that light narrow-gauge railways would answer the purposes of canals. They were in use in India, France, and other countries, although they had not been a success in Ireland. He advocated a system of 25lb. or 30lb. rails, and expressed his belief that such a system might be constructed, laying the lines along the road, for from £1,200 to £1.500 a mile, including equipment, with a gauge of 2ft. 6in. Of course, this was not exactly the kind of railway that one would see in Ireland, but it would answer the purpose. The object would be to carry agricultural produce, and, after all, this was very important to every one in England. There was more capital invested in agriculture than in any other industry in this country, and he thought the matter deserved their most serious consideration.

Mr. A. F BOLLING remarked that he knew something of the subject on which they had met from experience obtained abroad and in this country. What was needed was a road railway constructed simply for the purpose of picking up and putting down traffic. In Belgium and many other places they could see the extent to which this system of road railways was carried out. He was quite convinced that at the present level of prices—which they might hope would not last—such a road could be laid at £1,500 a mile. It would be on one side of the road, of 2ft. 6in. in width, and the road would be made for it. Whether electrical or steam tramways would supply what was wanted in the cheapest form was a matter he would not go into on that occasion. Besides the question of carrying produce they should remember what such roads would do for towns four or five miles out, which could be served in this manner cheaply. Complaint was made of the agricultural population going up to the towns, but where were these people to go to? Many towns would not exist but for tramways working with ½d. or 1d. fares. It was absolutely necessary, however, in connection with the light railroads in question, for the Board of Trade rules and regulations to be relaxed. Slow travelling—say 10 to 12 miles an hour—would provide all that was wanted for many purposes, and such traffic could be conducted at the very lowest scale of price. He doubted if at this moment money could be found for constructing such lines, but the County Councils or the parishes might assist. In a small country like Denmark the parishes gave half the money and the Government the other. If £100,000 were expended they could estimate how many miles of line they would get for 3 per cent. per annum divided between the Government and the parishes. If there was any profit beyond the Three per Cent. guaranteed it might go to the shareholders or the parishes.

Mr. J. G. L. STEPHENSON said that as long ago as 1882 he was advising the Privy Council in Dublin on the subject of light railways ; and he found on going to the Board of Trade that they knew so little about what they were going to do in Ireland that he thought he would go into the matter with them ; and he suggested that he should go and see the working of the Halton and Sutton line, in the eastern counties. This ran alongside of the road, and was constructed for between £1,500 and £2,000 a mile. He gave evidence on this line before the Privy Council in Dublin, and if the lines had been constructed in Ireland on the same system they would have been a great success. The Halton and Sutton line ought not to have been called a light railway : it was really a tramway running alongside the road, and on a slightly raised level. In the case of most of the light railways in Ireland the land was bought and other expenses were incurred, and the Board of Trade insisted on the usual requirements for railways in almost every instance. This was a point upon which they must now get relief. What they wanted to get rid of were, in the first place, the expensive signal arrangements, which were not at all necessary for such light railways. A speed of 12 to 20 miles an hour would be amply sufficient, and as much as would be run on many such lines. There was a clause in the Irish Light Railways Act which had always amused him very much. The clause stated that under no circumstances whatever should any whistling be allowed on any light railway in Ireland ; but at the same time it said that every engine should be fitted with an automatic arrangement by which the whistle should be opened, and a signal given whenever the speed exceeded 16 miles an hour. He certainly thought that additional legal facilities were required for obtaining powers to construct tramroads and light railways. In Ireland almost all the light railways had been constructed under what was called a baronial guarantee, which was a very simple arrangement. A baronial guarantee was a rate on the ratepayers of the district through which the proposed railway or tramway went. A general meeting of the ratepayers themselves was first held, and they passed a resolution in favour of or against the line. If against it, there was an end of the whole business ; but if in favour, the matter went before the Grand Jury of the county, who discussed the whole of the *pros* and *cons*, called evidence, and came to a conclusion whether the line was advisable. If it were deemed advisable they determined to give a guarantee of so much per cent. on so much of the capital. The whole matter afterwards went to the Privy Council in Dublin, and he never wanted to give evidence before any fairer body of men. These gentlemen, who were all lawyers, looked into the legal aspect of the case, and were very much guided by the opinions of the Grand Jury of the county through which the proposed line was to go. If there was no real legal difficulty they confirmed the decision of the Grand Jury, and then the 2 per cent. or 3 per cent., whatever it might be, that was guaranteed came out of the county rates if the line did not earn sufficient profit to pay a dividend. In most cases in Ireland the charge had come on the county rates ; but he thought the reason for this was very simple. The lines had been expensively constructed for two reasons. In the first place, there were the wretched Board of Trade restrictions ; he said "wretched" advisedly, for they were unnecessary. The second reason why they had not paid was the extremely disturbed state of Ireland, which rendered it impossible to finance anything in that country at anything like a reasonable rate. He thought they ought to make a strong effort to induce the Board of Trade to reduce their requirements all round. They must make it clear that the lines which they had in view were really tramways, and they must have them, if they had them at all, without any more restrictions than the tramways had at present. They would then pay, be an immense advantage to England at large and to the railway companies as "feeders," as well as to every man, woman, and child in the district.

Major-General WEBBER did not think that those present ought to go away under the impression that in no case had light railways in Ireland paid. In two or three instances, owing to their having been constructed between points with sufficient traffic to carry, they had paid, and the baronial guarantee had not been called for. With reference to the railway in Lincolnshire, to which allusion had been made, he had something to do with it for some years, and the reason it was not extended was that the expenses were so great after the £2,000 a mile was paid. That was a sample of the railway which was required for agricultural districts in England. He thought that the meeting in comparing Ireland with England in this matter ought to remember one point—that there was very little waste land along the sides of the roads in Ireland, and therefore it was necessary to construct the lines across country, and to take land where it was necessary. In England, on the other hand, there was a considerable amount of waste land along the roads, and it had always struck him that Parliamentary powers were required to enable these roads to be used. It was a question of using the surplus that was now waste. The County Council of Cambridge had tested the use of this kind of land by cutting the grass, whereupon there was a friendly action, and it was decided that the County Council had no right to use such land except for the deposit of stores. There was a great deal of this kind of waste land, which was now under the control of the lords of the manor, and one of the things to which those present ought to direct their attention was the obtaining of a Bill which would provide that provisional orders could be obtained by "undertakers." Of course, it would be under the control of the County Councils of the several counties. Those who were connected with electric lighting and other undertakings were aware that Provisional Orders had given power to interfere with the soil to a far greater extent, though not in the use of the surface. He went into the question of the construction of a light railway for carrying fruit at Gloucester, and it was clearly proved that under the existing powers given by the Board of Trade, this line, which would have had a very heavy traffic in fruit for about four miles, feeding the railway station at Beckford, on the Midland railway, could not possibly be made to pay, because no one would recognise that the Board of Trade regulations could be fulfilled. He thought if they could see their way to constructing lines of this kind, with 26lb. rails, they would cost a good deal less than £2,000 a mile, leaving out bridges. He believed that about £1,100 a mile for their construction would provide the means of carrying the agricultural produce, which they now knew could not get to a railway station for anything like what it ought to do, namely, a farthing per ton per mile.

Mr. B. J. JENKINS said he had lately returned from South Wales, where he had been giving this subject great attention. He had found that the poor farmers were obliged to haul their lime and coal for distances of 12 or 15 miles, and he asked them to imagine what this meant in these days if a profit had to be made. He had studied the question more particularly as regarded Brecknockshire, where there was a large amount of waste land, which could be taken in by parishes on either side provided they were not required for the ordinary accommodation the road, as defined by the Act of Parliament under which that road was made. He had no doubt that this could be turned into a right of user for tramways or light railways. He was speaking of a district where he knew that 40 or 50 miles of such lines could be laid, and the bulk of the money would be contributed in the district. They were ready to do this for the purpose of getting their tenants relief from the expenses they were put to, but they thought that the Government could raise the necessary funds much cheaper than they themselves could. He thought that a 2ft. 6in. railway would be about the gauge that was likely to be useful, and in his opinion a speed of about 10 miles an hour would be quite sufficient. The regulations of the Board of Trade were no doubt a serious matter, which no system of light railways such as those in question ought to be called upon to comply with. They ought really to call them tramways and not railways. The Sutton tramway to which reference had been made was, he believed, the pioneer line, and could not be taken as *data* for the future. He hoped that the meeting would strongly support any gentleman who attended the Board of Trade in trying to bring about a relaxation of the regulations all round in connection with the construction of such lines as they were discussing, while the Government should assist by some financial operation in lending money at a rate not exceeding 3 per cent. Whether such lines should be electrical or steam was a matter of competition between the two systems. For his own part, he believed that the electrical tramway would be the thing in the future.

Mr. HEAD remarked that he had lately returned from America, and he might allude to the tendency of thought on that side of the Atlantic as regarded cheap railways. He had had to do there with both ordinary-gauge and narrow-gauge railways. Formerly there were several gauges in use in the United States, but they were all coming down to our gauge of 4ft. 8½in. There were still some 3ft. gauge mountain railways, but these were all being changed to 4ft. 8½in. The street tramways, on which the electric tram-car ran, were also 4ft. 8½in. wide. Everything, therefore, became interchangeable. Cheap railways were now being made there, where the country was not unusually unfavourable, for between £3,000 and £4,000 a mile, including the equipment; but this cheapness was dependent partly on paying very little, if anything, for the land, and little, if anything, for litigation, and by following as much as possible the surface of the country. The subsidiary appliances were all brought down to a minimum cost. The whole of the rolling stock was on bogey frames, enabling them to travel round the curves much quicker than was done in this country. With respect to street railways or tramways, every system they had tried was giving way to the trolley-car or electrical system. They went through the street with a wire overhead, of course, and they seemed to be more under control than anything he had seen. They could start very quickly, and stop in about 10 yards. When they got a little out of town they would run at a speed of about 20 miles an hour. The economic effect of these lines on the value of land and property generally was most marked, and the development of the places where they were running was very great. He thought it ought to be known that the tendency on the other side of the Atlantic was to do away with small locomotives altogether, and to run the trolley system.

Mr. ALEXANDER VON GLEHN remarked that he attended the meeting as the representative of the Decauville Portable Railway, but his object in coming was not so much to speak as to answer inquiries which might be addressed to him. He thought they had every possible information on the subject, especially with respect to the lines in agricultural districts which already existed in France. Having referred to the restrictive nature of the Board of Trade regulations in connection with light railways or tramways, he remarked that the light railway which was working at the Paris exhibition carried as many as 10,000 passengers an hour; and throughout the period of the exhibition about 5,000,000 or 6,000,000 passengers were carried without a single accident, and without the railway being fenced in. He believed that this railway had a 24in. gauge only.

Mr. JENKINS inquired the maximum speed that was run.

Mr. VON GLEHN replied that they generally calculated from eight to ten miles. It seemed to him that the great point they had to attend to in the matter under discussion was to get the Board of Trade restrictions removed, and to let all the systems compete and see which was the best. He understood that the great object sought was to facilitate agriculture in this country, and this system undoubtedly would be an enormous economy if it should be adopted without restrictions in thinly populated districts. This was far more important than the question of carrying passengers at all. He had particulars in his hand of the exact cost of a railway in France 19 miles long; and, including equipment, stations and everything, the cost was £1,960 per mile.

The CHAIRMAN pointed out that the object which the meeting had more particularly in view was to consider how far the restrictions of the Board of Trade could be relaxed. The question of speed was also very important, because they must remember that *maximum* speed was so very different from average speed.

Mr. VON GLEHN replied that the experience in France as regarded light railways was that the speed never exceeded 8 or 10 miles an hour.

Mr. A. MACDONELL desired to say to the gentleman who referred to the clause from the Irish Light Railways Act—a clause which had afforded him so much amusement—that it was probably drawn by an Englishman, although for the benefit of Irishmen. They had several points to consider regarding the matter under review; among others, the restrictions of the Board of Trade, the construction of the lines, the rolling stock, and the method of working. He did not think it was very difficult to see why the Irish narrow gauge lines had not been very successful. In the first place there was a great tendency in Ireland in starting anything, such as the construction of a railway, to consult persons who knew nothing whatever about it. The first person consulted in such a matter would probably be the Catholic priest or the Protestant Archbishop of Dublin. He himself knew a good deal about Irish railways, and was in the country about 18 years, but no one ever asked him anything about the matter, directly or indirectly. In Ireland, too, they had allowed an enormous number of these railways to remain, and the fixed charges were therefore very high. Then Irish railways had been allowed to have any rolling stock they liked. If these lines had been intended to pay they ought to have been furnished with rolling stock of identically the same character. They had heard from Mr. Head what America had been doing in regard to this matter, and he had himself just come from Australia. In Melbourne they had an exceedingly good system of tramways; but it was not adapted, any more than the electrical system was, for a small branch line of railway, where the traffic was very small. The Australian railways had come to grief partly from their not having been made on the same gauge and partly because they were made with borrowed money and on monstrously extravagant terms. The gauge of the Victorian railways was 5ft. 3in., and on New South Wales lines it was 4ft. 8½in. In going from Melbourne to Sydney he had to change carriages. The average cost of a single line in Australia, over, as a rule, generally flat country—or undulating, at the worst—had been between £10,000 and £12,000 a mile. In Sydney the local tram lines were worked by steam, which was not so clean or convenient as the other system, although there was the advantage of being able to extend such a line into the country. Steam tramways were working in all directions throughout the towns without accident, and he had seen as many as five carriages being drawn by one engine, and conveying people home from their offices. His own opinion was that although the rules of the Board of Trade were restrictive to a very large extent, it was really the working of the lines that was the main point that ought to be considered.

Major-General WEBBER desired to point out in regard to what the last speaker had said, that in connection with the Irish light railways, the Irish Government acted under the advice of a committee of which Sir Henry Oakley was chairman, and whose report was very long and carefully worded. All the other members of Committee, too, were representative men.

Mr. MACDONELL, continuing, stated that he had also seen a good deal of Brazilian railways, and where they had the 3ft. 3in. or metre gauge they were cheaply worked, and they would have paid if those conducting them had not gone in for gambling.

Major FLOOD PAGE ventured to think that a resolution might now be considered after the discussion which had already taken place, and he proposed the following motion: "That this amalgamated meeting of the Engineering and Electrical Sections of the London Chamber of Commerce, having considered the letter of the Board of Trade, is of opinion that the increase of steam and electric tramways would exercise a great and beneficial influence upon the internal trade of the country, is glad that the Board of Trade is about to call a conference, and trusts that the result will be a considerable relaxation of the existing regulations, so as to help and facilitate the construction of steam and electric tramways throughout the kingdom." It was a matter of great and pressing importance that they should be able to "tap" all the agricultural districts of the country, so that produce might not be grown and then have to be thrown away on account of the railway charges—a subject with which members of the Council of the London Chamber of Commerce were very familiar. Day after day at their meetings this question came up, and they owed a great debt of gratitude to the Board of Trade for approaching the various parties concerned in this matter. He was speaking in the presence of the late and of the present chairman of the electrical section, and of many members of that section, and their experience of the Board of Trade was this—that as regarded their electrical business, they had found the Board of Trade always willing to meet them. There was a notion abroad that the Board of Trade were rather an obstacle to improvements, but the experience which the Electrical Section had had was that the Board were willing to adopt common sense reasons if such reasons could be advanced. The Board of Trade were fully alive to the immense importance of developing trade. The subject of light railways did not apply only to England, but they were also very important in India. He did not know if any one had seen the letter in the City article of *The Times* of the previous day from General Trevor, who was a man of great experience in such matters. General Trevor gave them this encouragement. There were over 2,000 miles of railways referred to by him. On one railway of over 1,600 miles, the earnings last year were 10 per cent. on the capital of the Company: in the case of another railway of 300 or 400 miles 6 per cent. was earned on the capital; and in the case of another line, still shorter, 7 per cent. was earned. On something like 2,400 miles of these light railways in India the earnings on the capital were about 7 per cent. We required in this country to encourage trade and commerce, and he knew nothing better for effecting this purpose than steam or electric tramways. In answer to a question he added that it was advantageous to leave out any reference to railways. The Volunteers had had to go from Wimbledon to Bisley, and they made an arrangement with the South-Western Railway to construct a line from their main line up to the camp. They had various difficulties, and the matter fell to the ground; but when they asked for authority for a tramway no difficulty was experienced:

Mr. PENNEY desired that the words "light railways" might be inserted in the resolution before the words "steam and electric tramways."

Major PAGE having inserted the words,

Mr. STEPHEN SELLON said he thought it was legislation which was at fault in connection with the construction of light railways, because the Board of Trade had not at present sufficient powers. He believed that if the Board of Trade were made more autocratic they would get what they required. Many sins were laid to the Board of Trade which ought to fall on the shoulders of promoters, for many failures were attributable to over-capitalisation. He was connected a good deal with all the arrangements under the Act of 1883, and had a great deal to do with the promotion of various railways in the West of Ireland. Very few lines were made under that Act, which was a ridiculous one. He thought that the great point for them to put to the Board of Trade was the question of reducing the costs of promotion. The Provisional Order of the present day put them in the hands of every landowner whose land was required. What they must have was the power of an Act which gave authority to take land.

The CHAIRMAN said that they all agreed with Mr. Sellon's remarks: but the delegates who were to be appointed under another resolution which was to be submitted to the meeting would discuss with the Board of Trade the points which Mr. Sellon was dealing with. He thought that Major Flood Page had proposed a resolution which would meet the object they had in view.

Mr. SYDNEY MORSE said it was most important that means should be devised for getting the powers that were required without the necessity of incurring the expense of going to Parliament.

The motion was seconded by Mr. E. GARCKE, and, as amended, was carried. Mr. Garcke afterwards proposed the following resolution:—"That a committee, consisting of the following members of the Chamber, be constituted for the purposes: (1) To consider the whole subject of the Board of Trade circular on light railways; (2) to determine the points and suggestions to be submitted to the Board of Trade; and (3) to select, subject to the approval of the Council, two delegates to represent the Chamber at the proposed conference." It appeared to him that this was the most satisfactory way in which to proceed in this matter. If they attempted to appoint the two delegates at that meeting there would probably be some difficulty, and the matter might not be settled to the satisfaction of everyone. It was necessary that they should formulate clearly the points which their two representatives should be instructed to put before the Board of Trade, and he feared that this could not very well be done at such a meeting as the present. After all, the questions would resolve themselves into matters of legal technicalities and financial details, which required a very close amount of consideration. There would also have to be considered the questions of what were to be the relations to the local authorities, the relations to the Board of Trade, and the parliamentary procedure in regard to obtaining the necessary powers. There was, further, the important question of what should be the relations to the railway companies. Railway companies had not given that assistance to the development of light railways which was necessary for the complete success of the latter.

Mr. STEPHENSON seconded the motion, which was carried.

The following gentlemen were afterwards appointed as a committee:—The Chairman of the Engineering Section (Sir Edward Carbutt), Gen. Head, Gen. Webber, Mr. Stephen Sellon, Mr. Bolling, Mr. Garcke, Mr. Crompton, Mr. Jenkins (Deputy Chairman of the Engineering Section), Mr. Shelton, and Mr. Stephenson.

On the motion of Major FLOOD-PAGE, seconded by Gen. WEBBER, a vote of thanks was passed to the Chairman, and the proceedings then terminated.

PHYSICAL SOCIETY.

The meeting was held in the rooms of the Chemical Society, Burlington House, on October 26, 1894, Prof. A. W. Rücker, F.R.S., President, in the chair.

In opening the proceedings, the President said the occasion might be regarded as another sign that the boundary between Chemistry and Physics was breaking down. On behalf of the Council he tendered the thanks of the Physical Society to the Chemical Society for the use of the rooms.

Prof. H. E. ARMSTRONG, President of the Chemical Society, said his Council offered a cordial welcome to the Physical Society. The change, he thought, would prove of much greater importance than a mere removal. Now that the childhood of the Physical Society was passed, its manhood involved new responsibilities, and great opportunities for good presented themselves. The Physical Society of London ought now to become the head-centre of Physics in the United Kingdom. He (Dr. Armstrong) was pleased to learn that the society had undertaken the preparation and publication of abstracts of physical Papers appearing in foreign periodicals, and said the matter was of such great importance that it should be done thoroughly. In a work of such a magnitude he regarded the co-operation of other societies, such as the Institution of Electrical Engineers, as absolutely necessary.

The PRESIDENT, in acknowledging the welcome, said the Physical Society was extremely obliged to the President and Council of the Chemical Society for the great benefits conferred. Dr. Armstrong's advice to go ahead would not be forgotten. He then announced that at future meetings tea would be provided for members at 4:30.

The exhibition of a voltameter by Mr. Naber was postponed.

Mr. E. H. GRIFFITHS, M.A., read a Paper on

"The Influence of Temperature on the Specific Heat of Aniline."

After pointing out that most observations of specific heat depend on water, whose capacity for heat varies considerably with temperature, the author said large differences existed between the values obtained by different observers as to the latent heats of evaporation of water and other liquids, and these differences were probably due to the variability of the water standard, which had been erroneously assumed constant. Precise measurements in calorimetry were of such great importance that the exact relation between the capacity for heat of water and its temperature should be completely determined. With apparatus such as he had used with aniline, this could be done in six months, provided someone could be found who could devote his whole time to the subject. The results of his own experiments were expressed in terms of the capacity for heat of water at 15°C. (at which $J = 4{\cdot}198 \times 10^7$ ergs), and hence were referred to a definite standard.

A great desideratum in calorimetric work was a calorimeter whose surroundings could be kept at a very constant temperature. This he had obtained by using a tank holding about 20 gallons of water in which a steel vessel shaped like a hat-box, with hollow sides and bottom, was immersed. The cavity was filled with about 70lbs. of mercury, and served as the bulb of a thermometer; a tube communicating with this bulb acted as a regulator to control the gas supply which heated the water in the tank. The tank water was circulated rapidly by a screw propeller. Under ordinary conditions the temperature of the outside of the steel chamber could be kept constant within $\frac{1}{100}$°C. The calorimeter itself was of brass, and suspended by glass tubes from the lid of the steel chamber. A stirrer worked by an electromotor kept the contents in rapid motion.

In the experiments on aniline, heat was supplied to the liquid in the interior by maintaining known potential differences (equal to some multiple of the E.M.F. of a Clark's cell) between the ends of a coil of German silver wire placed inside. The rate of rise of temperature of the inside over the outside was measured by platinum thermometers, one of which was placed in the calorimeter and the other embedded in the walls of the steel vessel surrounding the calorimeter. By this means differences in temperature of $\frac{1}{1000}$ of 1°C. could be detected with certainty. A special method of adjusting the potential difference between the ends of the German silver wire was employed by which the constancy could be maintained within one part in 10,000.

To minimise corrections arising from heat generated by stirring the liquid and that lost by radiation, &c., from the calorimeter, the experiments were made about temperatures at which these corrections balanced each other. The rise of temperature was then due to the electric supply alone. The specific heat S_1 of the liquid at temperature θ_1 could then be determined from the formula

$$\frac{d\,\theta_1}{d\,t} = \frac{E^2}{J\,R_1\,(S_1\,M + w_1)},$$

where $\frac{d\,\theta_1}{d\,t}$ = rate of rise of temperature at temperature θ_1,

J = mechanical equivalent of heat,
E = potential difference between the ends of the coil,
R_1 = resistance of the coil,
M = mass of liquid,
and w_1 = water equivalent of calorimeter at temperature θ_1.

Experiments were made with different values of E, and two widely different masses of liquid were used. The author was thus enabled to find S_1 without knowing w_1. Having found S_1, the water equivalent of the calorimeter could then be determined.

Many important details of construction and manipulation of the apparatus, and the method of reducing the results, are given in the Paper. The final values for s_1 and w_1 at several temperatures are given below:

Temperature. C.	Specific Heat of Aniline.	Water equivalent of Calorimeter.
15	0·5137	79·82
20	0·5155	80·11
30	0·5198	80·90
40	0·5244	82·19
50	0·5294	83·39

The aniline employed was supplied by Messrs. Harrington Bros. as "pure colourless," but had initially a light brown tinge. After being in use some time the colour had darkened considerably, but its specific heat had not sensibly changed. Recently he had tried a hydro-carbon liquid which promised to be still more satisfactory as a standard liquid in calorimetry.

In the course of his remarks, the author said a name for "capacity of heat per unit volume" was greatly needed, and invited suggestions.

Dr. ARMSTRONG thought the author had made a particularly happy selection in aniline, for it could now be obtained in any quantity absolutely pure. When pure it did not discolour on exposure, and would probably be very satisfactory as a standard liquid. He doubted whether any hydrocarbon could be better.

Prof. AYRTON congratulated the author on the extreme accuracy obtained. Recently he had arranged an experiment for determining the mechanical equivalent of heat by the electrical method, which gave very accurate results without any corrections whatever being necessary.

Prof. S. P. THOMPSON thought the whole phraseology of specific heat required revising.

Prof. PERRY agreed with Mr. Griffiths that a name for "capacity for heat per unit volume" was greatly needed, and Mr. LUCAS suggested "heat density," but this was not satisfactory.

Dr. SUMPNER said most text books on physics attributed the advantage of the mercury thermometer to the low specific heat of mercury, whereas the capacity for heat per unit volume was the important factor.

Mr. WATSON inquired to what temperature the alloy which the author had used to connect glass to metal had been tested?

The PRESIDENT said the Paper was of great importance, because it dealt with the application of electrical methods to thermometry. The mercury thermometer had been quite superseded for work such as had just been described.

Mr. GRIFFITHS, in reply to Mr. Watson, said the alloy had been used successfully between 10° and 62° C. It gave way at 71 C. He was glad to learn from Dr. Armstrong that aniline could now be got pure. Prof. Ramsay had written to say he did not think the slight impurities in ordinary aniline would have much effect on its specific heat.

Mr. BLAKESLY asked if aniline could be taken as pure if it did not change colour on exposure.

Dr. ARMSTRONG, in reply, said: "Yes! if the boiling point was also constant!"

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *October* 26, 1894.

The American Street Railway Association.—The recent meeting of the American Street Railway Association at Atlanta was one of the most successful in its history. The exhibition of street railway supplies was very complete, and the results doubtless satisfactory from a commercial standpoint. It may be said, however, that neither the electric light nor street railway conventions would amount to much without this commercial feature, for, as a rule, the Papers read have little technical value, being mostly mere perfunctory compositions, and the less said about the platitudinous discussions the better. In the earlier days of electric lighting and street railways well-known inventors and others contributed Papers and took part in the discussions. With the growth of the electrical industries, however, the professional and commercial branches became more differentiated, and the former now reaches its audience through the periodical Press and the Institute of Electrical Engineers; while the conventions of electric light and street railway associations have more the character of an annual fair where the professional side of the industry is subordinated to the commercial one. Of the dozen or more Papers read at Atlanta all but two related to questions of management, the road bed, brake-shoes, &c. Owing to various financial reasons, many *ex parte* arguments were adduced for the T-rail, which, however, will probably continue to grow in disfavour with municipal authorities, who almost invariably require the English grooved rail or one of its American substitutes to be laid in the streets. A discussion on "The Best Method of Treating Accidents and Complaints" was notable for its disregard of ethical considerations. One manager stated that the policy of his company was to keep damage cases in court for as lengthy a period as possible in order to finally force a satisfactory settlement, and that it had been found "wise to use its influence to get such men on the jury as would give a corporation justice." Mr. W. E. Harrington read a Paper on the "Destructive Arcing of 500-volt Fuses," in which, after describing various experiments, the deduction is made that a fuse wire on such circuits does not, when it melts, break a circuit, but establishes a condition, though for a limited time, such that the terminals act to furnish a gas through which the circuit is continued. The conclusions of the Paper are that a fuse block should have protected terminals that will not be burned under conditions approaching a short circuit across the bus-bars of a 500-volt power station, and that magnet cut-outs are immeasurably preferable under all circumstances. Messrs. J. H. Vail and S. H. Wynkoop read a Paper on "The Use of the 'Booster' on Electric Railway Circuits," in which they advocated the maintenance of the potential at distant points of the line by the employment of the auxiliary apparatus used in the central lighting stations to obviate the affects of drop. The authors claim a great saving in first cost by the employment of this system—from 25 to 75 per cent. in copper saved in feeders; they also claim a saving in the operation of motors, owing to the great decrease in the amount of drop which, under ordinary circumstances, may cause a loss of 30 per cent. or more. The style in which the Paper is written is so involved, however, that it will require considerable labour to determine if the authors in it sustain their rather startling claims.

CORRESPONDENCE.

LIGHT RAILWAYS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—A point of primary importance in connection with the light railways, or, rather, tramways, which are now engaging the attention of the Board of Trade is the question of the gauge. Although on isolated lines, with perhaps one train a day, steam locomotives will in all probability be used; wherever the traffic is considerable, or where many lines converge to one centre, and can be fed from a common power station, electricity will certainly be the motive power. Now, in America, where the cheap, rapid transit of persons and goods has received much more attention than in this country, narrow-gauge lines are steadily being abandoned, and the standard 4ft. 8½in. gauge adopted.

The reason is, I think, clear. All those who have ever actually had to design or erect electric tramways will agree that the difficulty is to find room between the wheels for the motors, and that if this is a matter of difficulty on full-gauge lines it becomes practically an impossibility on narrow ones. Nothing is more conducive to failure than the attempt to cut down the machinery, and pack it into a space really too small for it. It therefore behoves those responsible for the new lines to see that the gauge is not settled first and the method of propulsion decided afterwards; but to adopt a gauge which not only allows proper space for machinery, but enables the cars, though of light build, to run where needed on to any railway lines already laid down.

The present moment seems opportune to call attention to this point, as there seems to be a tendency to overlook the fact that the gauge of the line affects the form of traction to be employed.—Yours, &c., A. H. DYKES.

Westminster Chambers, 5, Victoria-street,
London, S.W., November 7, 1894.

ALTERNATING ARC-LIGHT CARBONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We have read with interest the review of the second edition of our work entitled "Alternating Currents: an Analytical and Graphical Treatment for Students and Engineers," which has appeared in a recent issue of your esteemed journal (*The Electrician*, Vol. XXXIII., p. 489). It would ill become us to discuss any criticism of our work where such is a matter of opinion; but we beg to call your attention to one statement in the review of the first edition of the book (*The Electrician*, Vol. XXXI., p. 124), which is obviously a slip on the part of your reviewer. This being again referred to in the present notice, we venture to make mention of it. Your reviewer states:—

"A long proof is given, in Chapter XI., of the fact that the heating effect of an alternating current may be greater while the current is flowing in the positive direction than while it flows negatively. This happens even when the area of the positive part of the curve is equal to that of the negative part, provided the shapes of the two portions differ from each other. Such currents, no doubt, do occur in arc-lamp circuits, perhaps; but they are rare, and hardly merit much attention. In any case, however, the suggestion made by the authors, that the inequality of the heating effects of the positive and negative parts of the current 'may afford an explanation for the fact that in many cases one carbon of an alternating-current arc lamp is consumed more rapidly than the other, depending upon the way it is connected up,' is curiously erroneous. Whatever may be the law of variation of the alternating current, this certainly passes through both carbons of the lamp. If the positive portion of the current only passed through the lower one, the author's suggestion would apply."

It is well known that in an arc lamp supplied with a direct current the consumption of the two carbons is unequal, notwithstanding the fact that the same current and the same quantity of electricity pass through both. The positive carbon is consumed the faster, and for the purpose of illustration we will assume that the positive is consumed twice as rapidly as the negative carbon. This being the case, consider the alternating arc lamp, with carbons A and B supplied with an unsymmetrical alternating current, such that the *energy* in successive semi-periods is not equal, being greater when A is positive. If the frequency is 130 complete periods per second, then one-half of a period lasts $\frac{1}{260}$th of a second. During the first $\frac{1}{260}$th of a second, when A is positive, we may regard the lamp as a direct current lamp, and suppose that A now loses 6 units of carbon. During the same time B therefore loses one-half as much, or 3 units, as in a direct-current lamp. During the next $\frac{1}{260}$th of a second the current reverses and B is now positive. Under the assumption that this semi-period is unsymmetrical with the first, so that the energy is less now than during the first semi-period, of course B will lose less carbon than A did before. Suppose B now loses four units. Regarding the lamp as a direct-current lamp during this semi-period, A will lose one half as much as B, or two units. Evidently during the whole period, or during the $\frac{1}{130}$ part of a second, A loses $6 + 2 = 8$ units, while B only loses $3 + 4 = 7$ units, and so on during every successive period A loses more than B.

It therefore follows that this is a possible explanation of the phenomenon, known as the result of experiment, that in many cases the two carbons in an alternating arc lamp are consumed unequally.—Trusting that this correction may prove of interest, we are, yours, &c.,

FREDERICK BEDELL,
ALBERT C. CREHORE.

October 23, 1894.

TO THE EDITOR OF THE ELECERICIAN.

SIR,—The argument in the above letter is only true on the assumption that the waste of carbon is determined by the energy of the current, and not by its mere magnitude. With any ordinary alternate current, whatever the law of variation may be, the quantity of electricity passing round the circuit in the first half-period, when the carbon A is positive, is always equal to the quantity circulating in the opposite direction during the second half-period, when the carbon B is positive. This equality exists even when the current curve is unsymmetrical, and I know of no experimental justification for assuming, as the writers do, that, because the energy expended *between* the carbons is greater when A is positive than when B is positive, "*of course* B will lose less carbon than A."
—Yours, &c.,

THE REVIEWER.

THE MICROPHONE AND THE ELECTROMOTOGRAPH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I suppose it is now generally agreed that the action of the microphone depends mainly on the small arc or invisible discharge between the points of carbon or other conductors. Some experiments made by Mr. Augustus Stroh and myself in 1883 (*Journal* Society of Telegraph Engineers, Vol. XII., pp. 131, 144, 226) tend to prove that besides the sonorous vibrations of the points there is an attraction and repulsion due to the current and varying with its strength. The arc, as I have said, appears to act as an elastic buffer between the vibrating points (p. 228), and the microphone is reversible—that is, can be used as a receiver and transmitter. This attraction and repulsion can be seen on a large scale in the jumping of carbons in an electric arc lamp, and it helps to account for the pressure needed in working telegraph keys, dynamo brushes, &c. I do not think it has ever been pointed out that the mysterious electromotograph of Edison and the "physiological telephone" receiver of Elisha Gray are probably based on the same phenomenon; namely, the microphonic arc, or, rather, the arc conjoined with friction. The current passing between the revolving cylinder of lime and the metal stylus in the one case, and between the moving metal and the rubbing finger in the other, produces, no doubt, a repulsion, causing the stylus and the finger to slip on the surface. Perhaps Mr. Stroh will look for it? I will not occupy your valuable space further, except to draw attention to a thoughtful Paper by Dr. S. Tolver Preston in *The Electrician* for August 14, 1891 (Vol. XXVII., p. 408), wherein a theory of the electric arc is given that to my mind explains the buffer action of the microphonic arc. Dr. Preston supposes that the ether column between the carbons—in other words, the arc—is in a state of resonance or stationary vibration; in fact, that it dilates and collapses radially. In the microphonic arc this movement varies with the current and the length of arc, that is, with the vibration of the points.—Yours, &c.,

November 1st.

J. MUNRO.

RHUMKORFF OR RUHMKORFF?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On page 329 of Vol. XXXIII. (July 20, 1894) the reviewer of Prof. Roiti's "Elementi di Fisica" insists that Rhumkorff is the correct and Ruhmkorff an incorrect mode of spelling a well-known name. A little research or appreciation of the German tongue would lead him to correct this view.—Yours, &c.,

ROBERT E. BAYNES.

SIR: Mr. Baynes' letter is an illustration of how most misspellings of foreign names originate. Your correspondent supposes the name to be of German origin, and spells the first syllable like the German word for glory. But a little research would show him that the combination "rff," and, indeed, the combination of any double consonant following another, is unknown in the German language. It indicates a Slavonic origin, with which the combination "Rh" would be more consistent. The only way of finally deciding the question would be by reference to an original paper or signature of the electrician in question. The prevalent spelling, so far, is certainly Ruhmkorff and it may be as well to adopt it; but I shall be much obliged to any reader who will furnish me with the first-hand reference required.—Yours, &c.,

THE REVIEWER.

THE PARALLEL RUNNING OF OVERCOMPOUNDED MACHINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It was pointed out in your issue of Oct. 26th (page 741) that overcompounded machines run in parallel will only compound correctly for a certain line loss when all the machines are in circuit, and only two ways out of the difficulty were mentioned. Now, each machine has the ordinary series winding to compound for the internal loss (which we will call m_1, m_2, m_3 . . . m_n), and an extra number of turns to compound for a certain loss in the line.

Let us divide these extra turns into as many sections as there are machines, and call those sections on the first machine a_1, b_1, c_1 . . . n_1; and those on the second, a_2, b_2, c_2 . . . n_2; and so on.

Let a_1, a_2, a_3 . . . a_n be connected in series with m_1, and b_1, b_2, b_3 . . . b_n be connected in series with m_2; and so on. Then, if all the machines are in circuit, and there be t turns in each of the sections a_1, a_2 . . . b_1, b_2, &c., the number of series turns on each machine will be $(m + n\,t)$, and they will compound correctly.

But if only $(n - r)$ machines are in circuit, the number of series turns in each machine will be $(m + (n - r)t)$, and they will still compound correctly, whatever r may be.

This would necessitate between the machines as many pair of leads as there are machines, but it would be simpler than either of the other methods, and is, besides, perfectly automatic.
—Yours, &c.,

HUGH B. PHILLIMORE.

Stoneleigh, Lansdown, Bath.

The Metric System in Turkey.—It is said that Turkey will finally adopt the metric system, abolishing her ancient weights and measures, after March 1/13, 1896.

LEGAL INTELLIGENCE.

Muirhead and Others v. The Commercial Cable Company (Limited).

This was an appeal, which came on Friday last before the Master of the Rolls and Lords Justices Lopes and Rigby, from the Queen's Bench Division against a judgment delivered by Mr. Justice Kennedy on April 26th last in favour of the plaintiffs (Messrs. John and Alexander Muirhead and Mr. Herbert Arnand Taylor), the patentees and proprietors of certain patents for the "Muirhead Duplex System." The case commenced on February 18th, and the trial lasted until March 7th, when the learned judge reserved his judgment. The proceedings were fully reported by us in our issues of March 9th, 16th, and May 4th. From these reports it will be remembered that the form in which the action was brought was that the plaintiffs sued the defendants—a foreign company, incorporated under the United States laws—to recover certain royalties under a written agreement of January 2, 1884, which gave the defendants licence to use certain patents of the plaintiffs in consideration of an annual payment of £1,250—to be increased in certain eventualities. The total amount of the royalties claimed was about £3,560. The defendants admitted the alleged contract to pay royalties and also a *primâ facie* liability under it. But they alleged, further, that the patents in question had all come to an end at a certain date: and they paid money into Court sufficient to cover the royalties, due under their contract, up to that date. They relied upon the American patent law which enacts that where an American patent, which, for instance, would terminate, say, twelve years hence, is shown to be identical with any foreign one which terminates from any cause at an earlier date, then the American patent is held to be co-terminous with the foreign one. Under these circumstances the *onus* of proving that the plaintiffs' American patent was identical with their English one of 1876 was upon the defendants. For the plaintiffs it was argued that such a defence was, in effect, an attack upon the validity of the plaintiffs' American patent of 1880, and that, by a well-known doctrine of law, a licensee cannot dispute the validity of the patent for which his licence is granted. It may be remembered that the learned judge, when delivering his judgment on April 27th last, pointed out that the most important part of the agreement sued upon was its first article, viz., "The investors grant to the Company the right to apply the said patented duplex apparatus to the above-mentioned cables. This grant is made for the whole period during which the patents shall last . . . ." The agreement, he said, appeared to have been substantially carried out by all the parties up to July 1, 1891. The issue that was raised was, "Was Mr. Alexander Muirhead's patent, No. 234,490, and dated November 16, 1880, a patent which was 'lasting' after July 1, 1891?" That question, he said, involved some important issues of law and some complicated questions of fact. The plaintiffs' patent of 1880 was an American one, and expressed to be for seventeen years—from November 16, 1880—so that *primâ facie* it would not expire until November 16, 1897; but being an American patent it was governed by American law, which, he said, enacted that "every patent granted for an invention which has been patented before in a foreign country shall be so limited as to expire at the same time with the foreign patent, or, if there be more than one, at the same time with the one having the shortest term, and in no case shall it be in force more than seventeen years." Referring to the American law in point, the learned judge said it was his opinion that although an American patent had not on its face been limited, but contained an express grant for the full term of seventeen years, nevertheless, by the operation of law, if the invention had, in fact, been primarily patented abroad and the foreign patent had expired before the seventeen years had run out, the American patent would expire at the same date. That being so, he pointed out that the defence set up alleged that the plaintiffs' American patent of 1880 was for "an invention primarily patented abroad," viz., the English patent granted to Muirhead in 1876 (No. 2,564), and which expired on July 1, 1891, that the American patent of 1880 was in substance identical to that of 1876, and that, therefore, by the American law the former patent—though expressed to be for seventeen years—really expired on July 1, 1891. In reply to that the plaintiffs had set up the doctrine of the licensee's estopple, but he held that in such a case as this the defendants were not estopped from setting up the defence that the American patent had expired when the English one of 1876 lapsed in July, 1891, if those patents were the same in substance and effect. He also said he held on the evidence that it was the fair inference that the patent of 1876 had been granted with Alexander Muirhead's knowledge and consent, and that the American law was applicable; if it was found, in fact, that the English patent of 1876 did anticipate the American one of 1880. He also held that he had jurisdiction to decide all the issues raised, by virtue of an express clause in the contract between the parties. Finally, he asked, were the defendants right in their contention that the patent of 1880 was identical with that of 1876? If they failed there, the defence to the action entirely failed. In conclusion the learned judge said that the defendants to succeed must establish beyond all doubt that this particular combination of old instrumentalities, the working of which undoubtedly produced commercially better results than had ever been obtained before—was to be found in the earlier patent of 1876. But shortly, he said, the distinction seemed to him to be in the methods adopted for securing a proper balance throughout the entire system. He was satisfied upon the expert evidence that the introduction of the "three terminal" rheostat of low resistance placed at the apex of the bridge arms was a very important part of the 1880 patent. Upon all the evidence, he said, he was clearly of opinion that the 1876 patent did not contain the same combination as was found in that of 1880, and that the latter was a good and novel patent, and there would therefore be judgment for the plaintiffs for £3,566. 1s. 6d., and costs.

Sir RICHARD WEBSTER, Q.C., on behalf of the appellants, the Commercial Cable Company, asked the Court to reverse the judgment of Mr. Justice Kennedy in the Court below. Mr. Justice Kennedy had decided the law in favour of the appellants, and the fact as to the similarity, or otherwise, of the American patent to the English one of 1876 in favour of the respondents. Sir Richard Webster having briefly stated the cause of action and the decision of Mr. Justice Kennedy, proceeded to argue that that learned judge's view that the Muirhead American patent was a good and novel one was not supported by the evidence. He submitted that the real invention was the placing of the condensers in the bridge arms, and so effecting a reduction of resistance in those arms. That invention was described and claimed in the Muirhead specification of 1876, and the same invention was again described and claimed in the American patent of 1880. If that view was not the right one then the real and great invention of Mr. Muirhead was never protected at all in America. He pointed out that as regards the Canadian patents, which were included in the licence, they were admitted to be identical with that of 1876. The learned counsel then proceeded to describe, by means of diagrams and a very beautiful little model, made by Mr. A. J. Walter (one of the appellant's counsel), the general working of a duplex cable. Referring to the Muirhead specification of the 1876 patent, he pointed out that in it Fig. 1 (see *The Electrician*, Vol. XXXII., p. 529) showed what was old, and Fig. 2 showed the condensers placed in the bridge arms, and that was really the invention therein claimed. Fig. 2 in the 1876 specification showed exactly the same arrangement as did Fig. 3 (see *The Electrician*, Vol. XXXII., p. 528) in that of 1880, except, it is said, that in the latter the rheostat was placed at the apex of the bridge arms. This latter fact was held by Mr. Justice Kennedy to constitute an improved combination and a good invention within the claim of the 1880 specification. His argument was that the patentee himself, in both his specifications of 1876 and 1880, treated the fact of a rheostat or adjustable resistance as a well-known essential to any system of duplex telegraphy. It was admitted on all sides that some means of adjustable resistance was necessary in order to work any duplex system, and it would also appear from the evidence that the common place for a rheostat was the apex of the arms. His argument was that the real pith of Muirhead's invention in 1876 was the placing the condensers in the bridge arms, whereby a great reduction—and consequent advantage—of the resistances in the bridge arms was obtained; and that the American patent of 1880 really claimed and included that combination, and that the mere fact that by the rules of the American patent office a patentee had to enumerate in his claim each and every mechanical equivalent which was comprised or used in his invention, could not alter his real invention. Mr. Muirhead, in his 1880 specification, evidently assumed that the best position for the rheostat was common knowledge, because he therein mentioned no particular place for it, beyond the direction that it is to be placed between the earth and the bridge coils r^1 and r^2.

Lord Justice RIGBY observed that even assuming that the American patent of 1880, though an improvement upon that of 1876, included the invention claimed in the earlier patent, it would terminate when the 1876 patent expired.

Sir RICHARD WEBSTER said that that was so, and, continuing, said that the real object which the patentee desired to obtain was a reduction in the resistances, and a consequent acceleration in transmission, and that he arrived at, not by the use of the rheostat, but by placing his condensers in the two bridge arms, and his contention was that the same object was suggested and attained in the same way in the 1880 patent. Supposing, he said, that anyone had been proceeded against for an infringement of the 1876 patent, would he have had an answer to such an action by saying he placed the rheostat at the apex of the arms, instead of in the circuit between the earth and the resistance coils of the bridge arms?

Lord Justice LOPES remarked that he gathered from counsel's argument that the appellants' case was that the real essence of the invention was the placing of the condensers $s^2 s^2$ in the bridge arms, and thereby reducing the resistances and the retardation of the signals; and that the placing of the rheostat at the apex of the bridge arms was quite old—and had nothing to do with bringing about such a result.

Sir RICHARD WEBSTER said that that was their contention, and referred to the evidence of the Messrs. Muirhead, Taylor, Thompson, Jamieson, Kempe, Swinburne, Gott, and Mance; and also dealt with that of Lord Kelvin, and finally submitted that he had made out a case requiring an answer; and, having regard to the difficulties and complications involved, he asked them seriously to consider whether Mr. Justice Kennedy's view of the facts was the correct one or not.

Mr. MOULTON, Q.C., then followed on the same side, arguing that the 1880 patent was in substance a claim for the combination as that described in the specification of 1880. He referred to the specification of 1880, and pointed out that in Fig. 2 the resistance coils r^1 r^2 in the bridge arms were described as adjustable resistances, exactly as in the specification of 1876. It did not matter at all how you got your resistances, or in what position you placed the bridge arms. All you had to get was a certain ratio of resistance, and that you could do in various ways. He referred the Court to Cully's handbook on telegraphy, 1874, to show that even at that date the position and use of the rheostat was known and appreciated.

Lord Justice LOPES: You say that in 1876 the rheostat was a well-known means for correcting the resistance in the bridge arms, and that the apex was the common position for it, and that its addition in the 1880 invention does not make that patent different from the English patent of 1876?

Mr. MOULTON: Quite so, my lord; that is our contention.

The MASTER of the ROLLS referred to Lord Kelvin's evidence where he said that the rheostat, being placed at the apex of the bridge arms, was of the greatest importance, as it enabled the clerk who was operating to do so with much greater facility. He also pointed out that Lord Kelvin had stated that it was important that the sum of the resistance r^1 r^2 in the bridge arms should be constant; and that the use of the rheostat enabled this effect to be obtained.

Mr. MOULTON, in reply, said that on that point Lord Kelvin—with all respect for the greatest living electrician had hopelessly blundered.

The MASTER of the ROLLS observed that that was a strong expression, and he would like to be referred to the evidence.

Mr. MOULTON said that no other witness, that he could remember, supported that view but Mr. Bottomley, Lord Kelvin's assistant. He was willing to try that point by the decision of any expert.

The MASTER of the ROLLS: Then you would have ten experts saying one thing and ten others the opposite.

Lord Justice LOPES: I understand that Mr. Justice Kennedy held that the two patents were identical, except that the 1880 one showed the rheostat placed in the apex of the bridge arms?

Mr. MOULTON: That is so.

Mr. FINLAY indicated dissent.

The MASTER of the ROLLS: Whether the effect is the same in both patents or not, I maintain that as far as the drawings and the press in both are concerned they are quite different.

Mr. MOULTON continuing, said that the only point upon which Lord Kelvin's evidence differed with their view was his statement that it was of importance to have the resistances in the bridge arms constant. He would refer the Court to the evidence on that point to show that in that Lord Kelvin was mistaken. He referred to the evidence of Mr. Mockridge, Prof. Silvanus Thompson, Prof. Jamieson, Dr. Hopkinson, and Mr. Jacob. The learned counsel also pointed out that in a duplex system the adjustment of the balance was in practice never meddled with during the transmission of messages; but at other times of the day some four or five times a day (see evidence of Gott and others). He argued that it was wholly immaterial whether the sum of the resistances in the bridge arms was constant or not, as suggested by the respondents; and, even assuming that Lord Kelvin was right upon that point, though they said he was at fault, it did not affect Fig. 2 in the specification of 1876.

The MASTER of the ROLLS: Do you use this 1880 patent of Muirhead's now?

Sir R. WEBSTER: No, my lord, I am told my clients do not.

Mr. FINLAY: You have only ceased to since this action.

Sir R. WEBSTER: It is quite true, my lord, but the payments under our licence do not depend upon user, and the only reason, I am told, for not using it now is that there is no advantage in doing so.

Mr. MOULTON proceeded with his arguments, at the conclusion of which the Court rose.

Mr. FINLAY, on resuming on Tuesday morning, proceeded to address the Court on behalf of the respondents, Messrs. Muirhead and others. He referred to the specification of 1880, and pointed out that though the elements that were therein brought into use were all old, yet they were combined, or arranged with regard to one another in an entirely novel way, which gave better results than had hitherto been attained. The invention was for that combination, and that fact the whole arguments of his learned friends had ignored. In the United States they were very particular before granting patents, and there was a regular tribunal whose duty it was to look into all the claims for patents, and see if the inventions claimed had been previously patented at home or abroad. If they had been patented abroad then it was the custom to limit, on its face, the American patent so that it should expire whenever the similar foreign patent having the shortest term should determine. The learned counsel referred the Court to a case where this course was followed by way of illustration: and argued that as in the case of the 1880 patent this American tribunal had before it the patent of 1876, and yet made no limitation on the face of it, but granted it for the full term of 17 years, that therefore it had regarded the invention claimed as different from that claimed in 1876 in England.

Sir RICHARD WEBSTER said he could not assent to that argument.

Mr. FINLAY referred the Court to the American statute of July 4, 1886, section 7.

The MASTER of the ROLLS: What you say say is no doubt some evidence of a *prima facie* case, but this action has now gone far beyond that stage.

Mr. FINLAY agreed, and proceeded to point how in 1880 difficulties having been found in working the duplex system under the 1876 patent, Mr. Muirhead had in his American patent of 1880 succeeded in so arranging the old elements in use as to overcome those difficulties, and effect a great commercial success where before there had been failure. He contended that a great deal of his friend's arguments had been a skilfully veiled attack on the validity of the American patent, a course which he submitted was not open to them in law.

Lord Justice LOPES: What they said was that the 1876 patent was a good patent, and the 1880 one the same as it; but not, I understand, invalid.

Mr. FINLAY: But in effect they do, for they say that the whole invention in 1880 was the condenser , s^2 s', in the bridge arms; but I say that that is not the invention claimed in 1880, but a combination is therein claimed.

Lord Justice LOPES: I quite see all that, but still I say they do not attack the validity of your 1880 patent.

Mr. FINLAY: But they do, my Lord; for they say it is not for a combination at all, while that is our whole contention.

Lord Justice LOPES: Muirhead agreed that the essence of his invention in 1876 was to prevent the retardation of signals after a balance had been obtained?

Mr. FINLAY: That is a fallacy, my Lord: if you diminish your resistance you get greater speed but different balance. You cannot separate the two: they must go side by side. If you look at the specification of 1876 you would find the methods described for obtaining the necessary balance.

The MASTER of the ROLLS: In 1880 duplex telegraphy was known, and this patent was for machinery to work it to the greatest possible advantage.

Mr. FINLAY: Quite so. Passing again to the specification of 1876, the learned counsel proceeded to point out that quite three-fourths of it was given to describing in detail the numerous methods for obtaining a balance, and yet amongst them all there was nothing to be found in any way like the means by which that object was obtained in the 1880 patent.

Lord Justice LOPES: Is not the most important part of the specification (1876) at line 20 as it relates to Fig. 2?

Mr. FINLAY said he would come to that presently, and then deal with it.

The MASTER of the ROLLS: If that passage constitutes a combination, and that a similar combination to the one claimed in 1880, then your case is gone. I only say "if"!

Mr. FINLAY: We say it does not. The evidence, he said, was that the methods described in the 1876 patent for obtaining a balance really led the reader away from those described in that of 1880. He referred thereon to the evidence of Sir F. Bramwell, and read, *inter alia*, questions 581 to 595, when he said the means described in the 1880 patent for balancing were new, and cross-examination question 635 to 652.

The MASTER of the ROLLS: Where can one actually see these bridge arm arrangements?

Mr. BOUSEFIELD: The nearest station is at Valentia; but you could see the whole system at the Imperial Institute.

The MASTER of the ROLLS: Oh! I don't want to see a model.

Mr. BOUSEFIELD: The thing is of the actual size at the Institute. The apparatus could also be seen at Siemen's works, Woolwich.

Mr. FINLAY proceeded with Sir F. Bramwell's re-examination, question 665, where he stated that in the 1880 patent "there is the combination of rheostat plus double block—a condenser in each arm, and another on the receiving circuit, and that it appeared to him that every element of that combination was of great value in the working of the telegraph; and that the patentee had framed his 1880 patent upon that combination."

Lord Justice LOPES: You say the 1876 patent is not for a combination at all?

Mr. FINLAY: We do; and, continuing, he referred to Dr. Hopkinson's evidence (page 137, question 1,378, shorthand notes), which he said confirmed that of Sir F. Bramwell, he said elements old but never before used in any such combination as in 1880.

Lord Justice LOPES: That is an important answer.

Mr. FINLAY: The American specification admits the elements to be old; "old instrumentalities," it says, and "novel organisations." In dealing with the 1880 combination he pointed out that the means there used for adjusting the balance was a three terminal rheostat, and in answer to the Court as to what the difference—in effect—would be if one were to move the rheostat from the apex of the bridge arms, and place it anywhere along either bridge arm. He pointed out that one effect would be that you would at once lose one of the termini of the rheostat, which would then be no longer three, but two terminal. You would also get the sum of the resistances of your bridge arms unequal, and consequently a wild or uncertain signal on your receiver.

The MASTER of the ROLLS: Whether it makes any difference or not, if you have the sum of your resistance constant or not, I don't know; but I do know that both Lord Kelvin and Mr. Justice Kennedy thought it important that they should be constant, and the appellants will have to establish to us that both these gentlemen were wrong. Were the patents prior to 1880 actually in use up to that time?

Mr. FINLAY: Yes, but it was found that there was something wanting to make them successful.

The MASTER of the ROLLS: And you say that this something was discovered by and embodied in Muirhead's American patent of 1880? It is curious that this question was never asked to any of the witnesses by either side.

Mr. FINLAY was proceeding to read some more evidence when

The MASTER of the ROLLS said: We are really all saturated with electricity. Will no one refer us to his Lordship's judgment below, and point out to us what it is he is said to have done wrong? If there is any doubt as to the similarity of these two patents the patentee is entitled to it; the burden of satisfying us that they are identical beyond all doubt lies upon the appellants.

After some further evidence, the MASTER of the ROLLS refers to Mr. Justice Kennedy's judgment, viz., "The claim of the 1880 patent was one of the narrowest kind, and was for a particular combination only. The elements forming it were admittedly old. 'My invention,' says the patentee, 'relates to duplex telegraphs of the class worked in the bridge or differential system! The object is more especially to reduce the retardation of the signals and increase the speed of transmission on submarine lines, which ends I attain by certain novel combinations of old instrumentalities set out in the claims at the end of the specification.' The defendants, in order to succeed, must establish beyond all doubt that this particular combination of old instrumentalities, the working of which undoubtedly produced commercially better results than were ever obtained before, was also found in the earlier patent of 1876. Put shortly, the distinction seemed to consist in the method and means of adjustment that was the maintaining the balance. He was satisfied upon the evidence of the expert witnesses that the introduction of the three-terminal rheostat of low resistance placed at the apex of the bridge arms, and therefore in such a position as not merely to afford an easy and sufficient means of varying the resistances so as to get the ratio which gave a balance, but also to maintain the sum of the resistances of the two bridge arms constant was a very important part of the 1880 combination."

The MASTER of the ROLLS, having read this passage, said that the learned judge had clearly adopted the view expressed by Sir F. Bramwell and Dr. Hopkinson, that it was most important that the sum of the resistances should be constant, and the appellants would have to convince him that in doing so Mr. Justice Kennedy was wrong.

Mr. FINLAY proceeded to point out that Fig. 2 of the 1876 patent was not the same, and did not comprise the combination contained in that of 1880.

The MASTER of the ROLLS: Is there any evidence that anyone ever used Fig. 2 of 1876 between then and 1880 ?

Mr. FINLAY: It was never used except experimentally.

Lord Justice LOPES: If you are right in saying that the patent of 1876 was not a patent for a combination it carries you a long way, but I am far from agreeing with that contention at present.

This practically concluded Mr. Finlay's argument.

Mr. BOUSFIELD, Q.C., M.P., followed The invention, he said, that was claimed in the American patent of 1880 was for a combination—a particular arrangement of old elements. The resistance in the bridge arms in the English patent of 1876 used to be as much as 5,000 ohms, while now, by the arrangement described in the patent of 1880, it was enormously reduced. Again, one of the chief elements of the success of the 1880 patent was the capacity of readily varying the ratio of resistances to any degree required. By the use of the rheostat at the apex of the bridge arms you could vary the ratio at will in a moment.

Lord Justice LOPES: But is it not the introduction of the condensers into the bridge arms that really gives you the reduction of resistances ?

Mr. BOUSFIELD: No, my lord—but that is a different point from that with which I am now dealing. In Fig 2 of the 1876 patent, you have the resistance coils between the condensers and the terminals of the cable, and the artificial cable respectively—and it is the placing of the rheostat at the apex of the arms that enables you to dispense with those resistance coils, and so maintain the sum of the resistances in the bridge arms constant.

Lord Justice LOPES: In Fig. 2 (1876) there are the condensers in the arms, if you then add the rheostat at the apex as in Fig. 2 (1880), would you not get the same results ?

Mr. BOUSFIELD: True, if you alter the entire arrangement of the apparatus in Fig. 2 (1876) so as to be the same as that shown in the 1880 figure the results would be the same; but that new arrangement is the very combination that we say we describe and claim in our 1880 patent.

Lord Justice RIGBY: Is it a part of your combination to use a condenser in connection with the receiver ?

Mr. BOUSFIELD: Most certainly it is. But assuming that that was included in a combination in the 1876 patent, by the arrangement therein described they never could work without resistance, in the bridge arms. They were met in those days with two conflicting consequences, viz., high resistance good for balance but bad for signalling. Now, how was that difficulty overcome ? Why, by taking out the resistance coils from the bridge arms, as shown in Fig. 2 (1876), and what enabled that to be done ? The placing of the rheostat at the apex of the bridge arms.

Lord ESHER: It is suggested to you that Fig. 2 (1880) is the same as Fig. 2 (1876), as it, too, shows condensers, and also resistance coils in the bridge arms ?

Mr. BOUSFIELD: That is so; the reason for that is the prudence of the patentee; for had he not there shown them so arranged (as well as the arrangement without them, in his Fig. 3), an infringer could have got over Fig. 3 by using mere nominal resistances, say five ohms, in his bridge arms, such resistances being so low that with the rest of the patentee's arrangements he would have obtained practically equal results, while he would have been able to say his arrangement was different. He therefore described and drew Fig. 2 merely for purposes of protection—he says in the text that he prefers the other means (Fig. 3). The evidence of Muirhead and Taylor was that until 1880 no one ever thought of eliminating the old resistance coils from the bridge arms. The learned counsel went on to point out the importance of keeping the sum of the resistances in the bridge arms constant. The learned counsel went on to argue that seeing that the patentee in his specification of 1876 had taken up some three-fourths of the letter-press with graphic descriptions of different means for adjusting balance, it was not open to the Court to infer—as asked—that because he had not mentioned the rheostat or its position, the patentee had assumed it to be then common knowledge. Throughout the specification (1876), both in the letter-press and in the diagrams, whenever the patentee described an "adjustable" resistance he wrote the words "adjustable balance;" therefore, when he used the word "resistance" only he meant something else.

Lord Justice LOPES: If you look at Fig. 1 (1880) you will see that there the rheostat is shown at the apex, and that Fig. 1 is what the patentee says was known.

Mr. BOUSFIELD: Yes, but that is not what was known in 1876, but what Muirhead discovered just about 1880, and what led him to take out that patent. That assumption of prior knowledge on this point has been the fallacy of the whole of my friend's arguments.

In conclusion, the learned counsel pointed out that because in the 1876 specification the patentee had said he claimed all the combinations of the apparatus he therein described, it could not possibly be held that he included the one claimed in 1880. He had worked out what were the possible combinations, taken three at a time, of the different elements comprised in both these inventions, and the result was 2,300 ! Could it be seriously argued that the patentee's claim in 1876 covered each and all of these ?

Lord ESHER: Of course not.

Sir. R. WEBSTER then replied for the appellants, contending that on the evidence the Court ought to hold that these two patents were sufficiently identical to bring into operation the American law, which in effect enacted that in such a case the American patent would expire at the same time as the English one of 1880. Referring the Court to the specification of 1880, he said there was only one way of reading it; viz., that it was for putting the condensers into the bridge arms, and then by so reducing the resistances as to get a reduction in the retardation of the signals.

Lord ESHER: Why not an invention for the combination of all these specified elements arranged in the particular manner as described ?

Sir R. WEBSTER: There is nothing in the specification at all to say, for instance, that you are to place your rheostat at the apex of the bridge arms. It says in substance all those things (described), plus the condensers show the invention; all without them are not my invention. The American law enacted that if the essence of the later invention was included in the earlier foreign patent the American one could only last as long as that foreign one; mere additional improvements would not save the American patent. What, then, was the case here ? Was there in the 1876 patent a claim to substantially the same essential invention as was claimed in that of 1880 ? He submitted that on the evidence there was clearly such a resemblance between the two patents, and that, therefore, by operation of American law the appellants ought to succeed, and the judgment in the Court below should be reversed.

The Court said that they would take time to consider their judgment.

Edison-Bell Phonograph Corporation (Limited).

At Glasgow, on Friday last, the record was closed by Lord Stormonth-Darling, in an action in which the Edison-Bell Phonograph Corporation (Limited), London, seek to interdict David M'Kinnon, of Kilmarnock, from infringing letters patent No. 6,027, 1886, granted to James Yate Johnson, 47, Lincoln's Inn-fields, London, for "improvements in and apparatus for recording and reproducing speech and other sound," which was assigned in 1892 to the Edison United Phonograph Company, who assigned it to the pursuers in 1893. The defender replies that the alleged invention is invalid, because it was not new at the date of the letters patent, especially in regard to the use of wax and the method of engraving or cutting the records in a waxy or amorphous and slightly cohesive substance.

Newington, Priddle and Co. (Limited) v. Anders Telephone Company (Limited).

In this case, heard on Thursday in the Lord Mayor's Court, Guildhall, London, the plaintiffs claimed the amount of an account for telephone instruments, &c., supplied, and there was a counter-claim by the defendants for £410. 11s. 11d. for loss of sale on alleged defective instruments, establishment expenses during period of non-arrival of the receivers, &c. Mr. Holloway appeared for the plaintiffs, whose claim was admitted subject to the counter-claim. By consent of the parties a formal verdict was returned for the plaintiffs on the claim and for the defendants on the counter-claim, subject to a reference of the counter-claim to Mr. David Harrison (the Assistant Registrar), who was given full power to deal with all questions.

Cassel Gold Extracting Company (Limited) v. Cyanide Gold Recovery Syndicate (Limited) and Others.

In the Chancery Division yesterday, before Mr. Justice Romer, judgment was given in the above action.

The learned JUDGE said the patent could not be sustained. The invention claimed was a simple one—for the application of a solution containing cyanogen so as to dissolve the gold and silver in powdered ores. Leaving aside the silver, the patent was really for an alleged discovery that a solution containing cyanogen could be used to dissolve out the fine gold in powdered ore. His Lordship stated shortly the public knowledge at the date of the patent, and said that for some time afterwards the patent was not commercially worked, until the patentees discovered and patented a new method. Moreover, an American patent, taken out by one Rae in 1867, was published here before the date of the plaintiffs' patent. An American patent of one Simpson, taken out in 1884, had also been previously published in this country. There was, therefore, no real invention in plaintiffs' so-called discovery. The scientific evidence also satisfied his Lordship that at the date of the plaintiffs' patent no invention was required to discover that a solution of cyanide of potassium could be practically applied to dissolve gold and silver in crushed ore. The action must be dismissed with costs, except that the plaintiffs must have the costs as to the denial of infringement, as to which the defendants had put the plaintiffs to unnecessary expense.

Judgment accordingly.

Western and Brazilian Telegraph Company (Limited).—The Directors of this Company received yesterday from their representative in Rio de Janiero, the following communication marked "Urgent":—"Bill presented yesterday in Congress and published to day (November 8th) in *Diario Official*, authorising the Government to purchase at once the Western and Brazilian Telegraph Company under conditions of Clause 14, Decree 5,270 of April 26, 1873, of the Western Company's Concession, and to emit special telegraph Bonds value £100 sterling, bearing interest at 5 per cent. per annum for this purpose."

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices :—*

Laboratory Notes and Forms.—With the above title, we have in preparation a set of Elementary and Advanced Notes and Forms for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. They are prepared with the object of saving the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

The 1894 Edition of "The Electrician" Electrical Trades' Directory and Handbook contains 1,000 closely-printed pages, and several new and useful features have been added. The price of this edition of the Directory and Handbook is now 5s. post free; abroad 5s. 6d. *The 1895 edition is in active preparation*, and subscription and advertisement orders should now be sent in.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, will be ready on Nov. 19th. It will contain the latest information respecting the application of electric energy to mining purposes, in which the author has had much experience. The book is well printed, on good paper, and will contain some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d., post free 11s. (abroad 11s. 6d.). Orders can now be received.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is being printed, and will shortly be ready. Price 10s. 6d. post free.

Tenders Invited.—Our advertisement columns contain an announcement that tenders are invited for the supply of various fittings and materials used in installation work. All inquiries are to be made in the first instance to "Electrical Contractor," office of this paper.

——— The St. Pancras Vestry are prepared to receive tenders for the supply and laying of armoured cable mains, and for the extension of underground sub-station building. All particulars can be obtained at the offices of Prof. H. Robinson, 13, Victoria-street, Westminster, S.W., and tenders must reach Mr. Albert E. Pycraft, Chief Clerk to the Vestry, Vestry Hall, Pancras-road, N.W., on or before Thursday, the 22nd instant. Some further particulars appear in our advertisement columns.

——— The Cheshire Lines Committee require tenders for the supply of telegraph material, instruments, wire, &c. Tenders are to be in by December 1st.

Tenders Received.—The Special Electric Lighting Committee of the Islington Vestry reported at the last meeting of the Vestry that they had accepted the tender of Messrs. Moreland for the supply of the ironwork required for the erection of the central electric station for £1,936, and recommending that the seal of the Vestry be affixed to the formal contract. An amendment was, however, moved referring the matter back to the Committee, as it was believed that the work could be done at a much lower price. It was stated that Messrs. Moreland's tender was the lowest of four received, and that everything had been done properly, but the amendment was carried, and the Committee were given power to advertise for fresh tenders if necessary.

Sales by Auction.—Messrs. Wheatley Kirk, Price and Goulty will shortly sell by auction at the Deptford Central Lighting Station, Stowage Wharf, Deptford, S.E., a quantity of surplus plant and stock for the London Electric Supply Corporation (Limited). Particulars appear in another column.

——— Messrs. Fuller, Horsey, Sons and Cassell will sell by auction on Wednesday, the 28th inst., at 1 o'clock, at their offices, 11, Billiter-square, E.C., some nearly new modern electric lighting plant, to be disposed of owing to the space being required for other purposes. Particulars are given in our advertisement columns, and all further information can be obtained of the auctioneers, 11, Billiter-square, E.C.; or of Mr. H. Cuthbert Hall, 46, Queen Victoria-street, E.C.

Liquidations.—The petition of the Bedford Engineering Company for the compulsory winding-up of J. G. Statter and Co. (Limited) came before Mr. Justice Vaughan Williams on Wednesday. The petition was opposed on the grounds that the creditors would suffer by a winding-up, and that negotiations were pending to enable the Company to dispose of its business and thus acquire assets to satisfy the whole of its creditors; and his lordship ordered it to stand over for a fortnight.

Bankruptcy.—Monday, the 19th inst., is the last day for sending in claims against the estate of John Henry Brown, electrical cabinet case maker, of 16, South street, and 16, Archer-street, Halifax, to Mr. Thomas England, Official Receiver, Townhall-chambers, Halifax.

Bankruptcy.—The following are the principal creditors of William David Gooch, lately carrying on business as an electrical engineer at 3, Victoria-mansions, Westminster, S.W. :—

Anglo-American Brush Company, London	£550	0	0
Beale, W., London	130	0	0
Edison-Swan Electric Light Company (Limited), London	130	0	0
Goolden and Edmonds	50	0	0
Gülcher Electric Light and Power Company (Limited), London.	108	0	0
Hunter, E., London	100	0	0
Kent, J. V. M., London	70	0	0
Michael and Gerrell, London	417	0	0
Martin, W., London	50	0	0
Paterson and Cooper, London	110	0	0
Sharp, P., London	220	0	0
Sewell and Co., Manchester	80	0	0
Siemens Bros. and Co. (Limited), London	774	0	10
Westminster Trust (Limited), London	300	0	0
Woodhouse and Rawson, London	160	0	0
W. T. Glover and Co., Manchester	58	13	0

The total liabilities are returned at £4,365. 19s. 8d., and the assets at nil.

——— On Monday the first meeting of creditors in the estate of Woilliard, Scarborough and Co., electrical engineers, Wade-street, Halifax, was held at the offices of the Halifax Official Receiver. The statement presented showed liabilities £530. 17s. 11d., and assets £203. 16s. 10d., leaving a deficiency of £327. 1s. 1d. It was stated that the bankrupts began business in January last without capital, except a few tools, which they valued at £20. They borrowed £100 on commencing, and this amount was still owing. There were seventy unsecured creditors. For loans and interest the sum of £204. 14s. was due, and on account of trade items £326. 3s. 11d. The bankrupts alleged as the cause of insolvency "want of capital"; but they state that they only became aware of their insolvency on the day they filed their petition. Each debtor had drawn a salary of 35s. per week from the concern. The books of accounts appeared to cover the whole period of trading. No resolutions were passed by the meeting, and the estate was left in the hands of the Official Receiver for realisation.

——— A first dividend of 1s. in the £ in the bankruptcy of Dan Rylands, of Barnsley, will be payable on the 14th inst. at the Official Receiver's Offices, Figtree-lane, Sheffield.

Appointments Vacant.—The Corporation of Cardiff require a practical man to take full charge of the machinery at their electricity works, and applications must be sent in by the 14th inst.

Correction.—The reference made in a Trade Note lest week to the order received by Messrs. Connolly Brothers for electric light cable should have referred to the Oldham-street extension of the Manchester Corporation's electric lighting scheme, and not to the Oldham Corporation's electric lighting scheme.

Recent Installations.—Messrs. S. Dixon and Son, of Leeds, are lighting Dewsbury workhouse, and have fitted between 800 and 900 incandescents and a large steam generating plant and battery of E.P.S. accumulators. The same firm have recently fitted 500 incandescents in the premises of the Yorkshire Penny Bank, recently opened by the Duke and Duchess of Devonshire, and about 150 incandescents and 36 arcs on the three-wire system at the large Bank Mills of Messrs. Roberts, Mart and Co., Leeds. The steam engines in each case are of Marshall's make, with Greenwood and Batley dynamos and E.P.S. accumulators.

Ventilators.—Messrs. Baird, Thompson and Co. have recently secured several important contracts for their improved designs of ventilators, including the steamship "Islam," for the Japanese Government; St. Bartholomew's Hospital, London; the Municipal Buildings, Burton-on-Trent, &c. A new catalogue is now in the press, and will shortly be ready.

A New Switch.—The "Elieson" Electrical Switch (Limited) are now placing on the market the "Elieson" switch, for which several advantages are claimed.

Vulcanised Fibre.—Messrs. Mosses and Mitchell have just issued a neat pamphlet giving particulars and prices of their patent vulcanised fibre. The information given includes weights of sheets, particulars of uses to which the material can be applied, range of sizes, special shapes, with accompanying illustrations. This list cancels all previous ones, and can be obtained on application at the offices, 68-71, Chiswell-street, E.C.

Calculating Machines.—We have received from Mr. Charles Bradbury, of 249, High Holborn, London, W.C., a circular relating to the "Brunsviga" calculating machine, for which Mr. Bradbury is the sole agent in this country. It is claimed for the machine that by a very simple mechanical process it performs, with ease, rapidity, and absolute accuracy, the laborious and fatiguing work of calculating, either in plain figures or decimals, up to 13 figures for the smaller machine and to 18 figures in the larger. The machine is handy in size, and can be worked on a table or desk, It certainly appears very simple in construction, and is well built. Amongst the testimonials received by Mr. Bradbury are included the names of Profs. C. V. Boys, A. S. Herschel, and F. J. Smith, and also from C. S. Loch, Vice-President of the Royal Statistical Society. The machine has been supplied to many of the principal Government departments and municipal authorities throughout the country, as well as to a number of leading firms.

Price Lists.—Messrs. Pyke, Harris and Co. (Limited) have now ready their new list of alternating and continuous-current dynamos, alternating-current and low-tension transformers, small "combination" transformers, flame spark coils, condensers, &c., copies of which can be obtained on application to the offices, 33, New Tothill-street, Westminster, S.W.

Aberdeen.—The Town Council have decided to extend the electric light plant as recommended by Prof. Kennedy, and alluded to in our last issue.

Belfast.—Some time ago the Great Northern Railway Company put down an installation of the electric light for the inspection of cattle before shipment at night. At the meeting of the Harbour Board on Tuesday inquiry was made as to the result of the correspondence with the Northern Counties Railway Company on the same subject. The secretary to the Board read the reply from the manager of the Northern Counties Company, which was to the effect that while there was no doubt the Directors would be willing to do anything to meet the requirements of the traffic, he found upon inquiry that practically no cattle arrived at their station after sunset; and it, therefore, seemed that there was no necessity for installing the electric light for inspection purposes. It was pointed out by some of the speakers that the fact that there was no cattle arriving after dark at the Northern Counties Company's terminus was probably largely because there were no facilities for inspection at night, and after some discussion it was decided to refer the reply of Mr. Cotton (the manager of the Northern Counties Railway Company) and the question generally to Committee. ——At the last meeting of the City Council the Electric Committee reported that satisfactory progress was being made with the electric light works, and that they had already received applications from private consumers for about a fourth of the current which could be generated by the plant.

Blackburn.—A petition from tradesmen in Darwen-street that the electric light be extended to that thoroughfare has been referred by the Town Council to the Parks' Committee for consideration.

Carlisle.—The Town Council have decided that either Brockbank's-yard or Boustead's-grassing would be the best site for the central electric lighting station, and will make their final choice from these places.

China.—It will doubtless come as a surprise to Manchester (says the *Westminster Gazette*) to learn that at this moment, in the midst of an anxious military crisis, the erection of new spinning plant is serenely in progress in different parts of China. Some of the mills are being provided with the electric light, and there is every probability that an attempt will be made to run the spindles themselves by means of electromotive power. In these matters the Chinese are content with nothing but the best, and some of the appointments in their newest factories would put to shame the obsolete characteristics of many mills that still exist in Blackburn and Oldham.

Country House Lighting.—Houghton Hall, Norfolk, the seat of the Walpole family, has recently been fitted out complete for the electric light by the Planet Electrical Engineering Company. The installation consists of over 500 16-c.p. incandescents, and several arcs. The generating plant is supplied in duplicate, and includes two 16-h.p. oil engines, and two sets of accumulators of sufficient capacity to keep the whole of the lamps going for a considerable period. The work has been carried out under the supervision of the Company's engineer, Mr. A. L. Shepherd.——Messrs. S. Dixon and Son, of Leeds, are lighting Mr. W. Bartram's new mansion at Harrogate, with 100 incandescents from 8 to 50 c.p., and the residence of Mr. R. Kelly, at Harrogate, for both of which installations complete generating plant is supplied, the first of steam, the second of gas, and each includes a battery of E.P.S. accumulators.

Croydon.—At the last meeting of the County Council the General Purposes Committee recommended the adoption of the following suggestions with regard to an electric light installation:—"(a) That the Corporation should arrange with some Company of undoubted stability to establish an installation for the compulsory area, at such contract price as the consulting engineer of the Corporation might approve. (b) That the Corporation should find the necessary capital for the above purpose. (c) That the Company should undertake to work the undertaking for a term of years to be agreed, and to maintain the plant in thorough working order, taking the revenue to be derived from the undertaking, and satisfactorily guaranteeing to pay to the Corporation interest and sinking fund upon the capital expended. (d) That power should be reserved to the Corporation to take over the undertaking from the Company, upon terms to be agreed at an earlier date than the expiry of the period stipulated in the first instance." If the foregoing recommendations were adopted the Committee recommended that the sub-committee be authorised to retain and advise with a consulting engineer, to make all needful inquiries, and to report further. The Chairman of the Committee made a lengthy explanation on the report, and pointed out that in every case where the municipal authority had acquired the electric light there had been a profit in a short time. Several members seemed uncertain whether the Corporation were to pay for the carrying on of the work, and asked for more information. The Chairman of the Committee and the Town Clerk explained that the Corporation were to find the money for the installation only, and were, therefore, not risking the ratepayers' money. Eventually, after a considerable discussion, the recommendations of the Committee were carried by a large majority.

Derby.—At a meeting, last week, Councillor E. Haslam said that there were already 7,000 incandescent lamps installed in the town, and application had been made for 3,000 more. A new engine was being put down, but he was afraid that in three months' time the demand would exceed the supply,

Ealing.—At the last meeting of the Local Board it was moved that the proposed extension eastwards of the electric light cable be postponed, and that the proceedings in connection with the proposed further loan be dropped, but after some discussion the motion was lost, and the work will be gone on with.

The Electric Light in Gas Works.—The electric light has been installed in the purifying department of the Heckmondwike Gas Works, the object being, says the *Leeds Mercury*, "to illuminate the shed without the dangers which the use of the ordinary gas light exposed the place to."

Exhibition Awards.—The Maschinenfabrik Oerlikon have received gold medals for their exhibits at the Lyons and Antwerp International Exhibitions.

Fermoy.—At the last meeting of the Commissioners complaint was again made of the quality and price of the gas supplied by the local company; and the Clerk was instructed to fix a day for their consulting electrical engineer to attend and lay before them his views on the subject of the electric lighting of the town.

Gloucester.—At the last meeting of the City Council the Town Clerk reported that the two companies which had given notice of their intention to apply for a Provisional Order in respect of the city had withdrawn their notices.

Hampstead.—At the last meeting of the Vestry, the Electric Lighting Committee reported that they had agreed to the request of the Committee of the Metropolitan Asylums Board to be supplied with the electric current at their north-western hospital at a reduction of 33⅓ per cent. off the present price of 6d. per unit, provided the Board enter into an agreement to take the supply for three years certain. The Vestry approved the Committee's action. A reply had been received from the Comptroller of the London County Council on the subject of the loan of £24,400 required by the Vestry for electric lighting purposes, stating that negotiations were now going forward with the Treasury with a view to settling the period when the Treasury would allow for loans of this description, and that until the question is settled the Council would not be in a position to advance the loan. This was referred to the Electric Lighting Committee to negotiate and report to the Vestry.

Kendal.—The Town Council, at their last meeting, had under consideration an application by the Windermere and District Electricity Supply Company (Limited) for the Corporation's sanction to their proposed application for a Provisional Order. Some discussion ensued, and in the result it was decided to invite a representative of the Company to lay before the Corporation particulars of the Company's project.

Lancaster.—The Electricity Supply Committee reported at the meeting last week of the Town Council that on October 16th the borough surveyor stated that he had served notice upon the Brush Electrical Engineering Company requiring them forthwith to proceed with the due execution of the works, but that the Company had up to the present time delayed to proceed in an efficient manner with the works. The Committee resolved that in case the Company shall delay for the space of seven days after the service of such notice to proceed in an efficient manner with the works, the Corporation be recommended to take possession of all plant, implements, and material upon the works belonging to the Company, and to employ other persons to proceed with the works and to complete the same. They also resolved further that, in the event of its becoming necessary to employ other persons to proceed with the works and to complete the same, the surveyor should obtain from Messrs. Crompton three lamp pillars 18ft. high, and four lamp pillars 20ft. high, and 14 arc lamps and lamp carriers, and also obtain the necessary cables for the purpose of lighting such lamps.

Montrose.—At a special meeting of the Town Council on Friday the agreement with the Scottish House-to-House Electricity Company (Limited) to supply the town with the electric light was agreed to.

Ormskirk.—The question of the introduction of the electric light into Ormskirk came before the Local Board at their meeting last week, and after some discussion the matter was adjourned in order that particulars might be furnished as to the plans adopted in other towns.

Paddington (London, W.).—It was stated at the meeting of the Guardians last week that no reply had yet been received from the Local Government Board respecting the proposal to light the remainder of the infirmary by the electric current, and consequently they could not open the tender that had been received for doing the work. It was suggested that the tender might be opened, and accepted if suitable, subject to the approval of the Local Government Board, but the Chairman ruled that the matter must stand over. He would, however, call a special meeting of the Guardians as soon as the Local Government Board had sent a reply.

The Purchase of Tramways.—A deputation of the members of the Tramways Institute of Great Britain and Ireland, consisting of the chairman, directors, and general managers of the various tramways throughout London and the provinces, waited upon the President of the Board of Trade yesterday (Thursday) to ask him to consider the effects of the recent decision of the House of Lords as to the purchase clause of the Tramways Act, 1870. The deputation was introduced by Sir Albert Rollitt, M.P., and amongst the speakers were Mr. Carruthers-Wain, Mr. Richardson, and Mr. Lloyd, M.P. Mr. Bryce, in reply, said that he recognised in the fullest manner the interest which the deputation represented, and the point would have his best consideration.

Rhondda Valley.—In connection with the proposal to light the Rhondda Valley by electricity mentioned on p. 24 of our last issue, Mr. Williams, the electrician of the Ocean Collieries, has been interviewed by a representative of the *South Wales Daily News*. In Mr. Williams's opinion the extensive area to be covered would be best served by separate installations at the various collieries, but linked together so as to afford mutual assistance in case of need, and to equalise the pressure in the mains. He thought that an installation should be laid down for each of the following districts:—Treorky, Treherbert, Llwynypia, Clydach Vale, Penygraig and Dinas, Cymmer and Porth, Hafod, Great Western, and Hopkinsville. Mr. Williams thinks the scheme is quite practicable, and an economical one.

Rochdale.—At the last meeting of the Town Council inquiry was made as to when the electric lighting of the Town Hall, the Technical School, &c., would be carried out. It was stated, in reply, that the matter was still under consideration by the subcommittee appointed for the purpose, who had practically decided in favour of the electric light, the question now being the best and cheapest way of installing the light.

Southport.—The Mayor (Alderman Dr. Wood, J.P.) will today switch on the electric light for the Corporation's central station.

St. Martin's-in-the-Fields (London, W.C.).—At the instance of the Vestry, a communication was yesterday (Thursday) forwarded to Her Majesty's Office of Works protesting against the desecration of public monuments and buildings in Trafalgar-square by means of search-light advertisements. The whole question is to be discussed at the next meeting, and it is understood that a resolution will be proposed requesting the solicitors of the Vestry to confer with the Office of Works with a view to the prevention of such proceedings.

St. Pancras (London).—The St. Pancras Vestry, at its meeting on Wednesday, approved of a scheme of the Electricity Committee for supplying the remainder of the parish with the electric light, the commercial success of which has been proved in the south-west district. The estimated ultimate cost of the entire new works is £18,565. The Committee were authorised to proceed forthwith with the laying of mains in a large area to be served by the King's-road station, which is rapidly approaching completion. When these works were originally planned in July last it was calculated that the expense would be £28,000; but, having regard to the present reduced price of copper, it is anticipated that a saving of £6,000 will be effected in the estimate with respect to this material alone.

Whitechapel.—The District Board of Works inquired of the Guardians, at their meeting on Tuesday, whether, in the event of their being in a position to supply the electric light at a cost of not more than 6d. per unit, the Guardians would consider favourably the proposal to adopt it in the Baker's row Infirmary. Mr. Johnson thought if the Guardians took electric light it should be supplied at a lower rate than to the private consumer. It was decided to inform the District Board that the Guardians would consider the suggestion.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

October 27, 1894.

20,595. W. Grimes. London. Improvements in electrical signalling devices for railways.

20,596. S. Hammacher. Liverpool. Improvements in or connected with electric accumulators.*

20,613. C. Langdon-Davies. London. Improvements in electric relays.

20,614. F. W. Schindler. London. Improvements in or connected with electric heating wires or coils.

October 29, 1894.

20,693. A. Maseland. London. An improved acoustic device for telephones.

20,703. G. L. Anders. London. Improved telephonic switch and indicator.

20,716. P. T. Letchford. London. Improvements in and connected with portable electric lighting circuits and illuminating devices.

October 30, 1894.

20,746. F. Villiers-Stead. London. An electrical prepayment gas-meter.

20,783. J. W. Ray. North Shields. An improved telephone transformer.

20,781. H. J. B. Thiroux. London. Improvements in electric incandescent or arc lamps.

20,807. H. A. Taylor. London. Improvements in telegraphic transmitters.

October 31, 1894.

20,827. J. Taylor. Warrington. An improved telephone switchboard jack.

20,842. J. Machin. Birmingham. Improvements in propelling road and railway vehicles by electricity.

20,843. J. Machin. Birmingham. Improvements relating to road or railway vehicles propelled by electricity.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1893.

19,283. De Segundo and Derham. Electric heater.

20,793. Muirhead. Recording instruments for electric telegraphs.

22,817. Aron. Electric meters.

23,083. Aron. Recording electric currents.

23,221. Lake (Hussey and another). Incandescent electric lamps.

24,285. Edmunds. Electroliers, brackets for electric lamps, &c.

24,790. Crompton. Dynamo-electric machines.

COMPANIES' MEETINGS AND REPORTS.

West India and Panama Telegraph Company (Limited).

The following is the report of the Directors for the half-year ended June 30, 1894, to be submitted to the thirty-fifth ordinary general meeting, to be held at Winchester House, Old Broad-street, E.C., on Wednesday next, the 14th inst., at 12 noon:

The amount to the credit of revenue for the six months ended June 30th is £40,598. 1s. 2d. against £46,687. 4s. 3d. for the corresponding half-year of 1893, and the expenses have been £24,488. 17s. 5d., against £24,794. 6s. 11d. for the same period in 1893, leaving a balance of £16,109. 3s. 9d., which, with £718. 12s. 8d. brought from last account, makes a total of £16,827. 16s. 5d., with which it is proposed to deal as follows:—

	£	s.	d.
First Preference Shares—			
Dividend, six months, to June 30th, 6s. per share	10,368	18	0
Second Preference Shares—			
Dividend, six months to June 30th, 6s. per share	1,400	14	0
Ordinary Shares—			
6d. per share (free of income-tax)	2,208	0	6
Balance to current half-year's account	2,850	3	11
	£16,827	16	5

The traffic receipts for the six months show a decrease of £6,504. 10s. 9d., as compared with the corresponding period, this decrease being due to the continued depression of West India trade, and to the fact that, in the corresponding half year of 1893, this Company's receipts were augmented by an interruption of the French Company's cable between Cuba and Hayti, which diverted traffic to this Company's lines for a period of seven weeks.

Since the close of the half year, the Directors regret to have to report a further falling off in the estimated traffic receipts up to date, and a somewhat heavy expenditure in repairs. They therefore deem it prudent to carry forward the sum of £2,850. 3s. 11d. to the current half-year's account.

The cost of repairs to cables during the half year amounted to £11,373 19s. 11d. A large part of this expenditure is attributable to the difficulty experienced in repairing the duplicated cable between Jamaica and Cuba, which failed in about 2,000 fathoms. The great depth of water, combined with bad weather, prolonged repairing operations and caused the loss of a large quantity of grappling gear. The cable was at last hooked at a depth of 1,750 fathoms, and its repair effected with an expenditure of 25 knots of deep sea type.

The Directors are pleased to report that the Danish Colonies of St. Thomas and St. Croix have renewed their subsidies for five years.

Western Union Telegraph Company.

The annual meeting of the stockholders of this Company was held at the offices in New York on the 10th ult., Mr. Thomas T. Eckert, President and General Manager, in the chair, when the President's annual report, of which the following is an abstract, was adopted :—

The revenues for the year ended June 30, 1894, amounted to $21,852,653.09, and the working expenses to $16,060,170.21, leaving a profit of $5,792,484.88, which, added to $6,886,819.66 brought forward, gave a balance of $12,679,304.54. Of this amount there was applied—for dividends (5 per cent.), $4,740,063.75 ; interest on bonds, $891,616.25 ; sinking funds appropriations, $39,991—absorbing $5,671,671, and leaving $7,007,633.54 to be carried forward. The Company possessed at the end of the fiscal year 190,303 miles of posts and cables, 790,792 miles of wire, and 21,166 offices ; 58,632,237 messages were carried, the average receipt for each being 30·5 cents, and the average cost of each 23·3 cents. Over 1,300 miles of new pole line and nearly 22,000 miles of new wire were constructed during the year, more than half of the new wire being copper. The judicious expenditures that have been made upon the lines for many years past, and the continual substitution of copper for iron wires on trunk routes, have, says the report, kept the entire system up to the highest standard of efficiency. The establishment of dynamo plants at offices where there is a great demand for current in the place of chemical batteries is working a considerable economy in that branch of the service. The report states that the stockholders might, in view of the commercial distress through which the country had passed, congratulate themselves on the maintenance of the usual dividend. Since the expiration of the fiscal year the Company has purchased, for $550,000 Western Union Stock at par, the system of the American Rapid Telegraph Company, comprising 2,684 miles of posts and 20,370 miles of wire, extending eastward to Boston, southward to Washington, and westward to Chicago, which has been operated by the Western Union Company since 1885.

Some statistics issued by the Company include a complete list of the securities held by the treasurer, and a table setting out the mileage of lines operated, number of offices, number of messages sent, receipts, expenses, profits, average tolls, and cost per message for each year since 1866, from which we extract the following :—

Yr.	Miles of poles & cables.	Miles of wire.	Offices	Messages.	Receipts.	Expenses.	Profits.	Av. tolls per message.	Av. cost to Co. pr. message.
					$	$	$		
1868	50,183	97,594	3,219	6,404,595	7,004,560	4,362,849	2,641,710	104.7	63.4
1873	65,757	154,472	5,740	14,456,832	9,333,018	6,575,055	2,757,962	62.5	43.4
1878	81,002	206,202	8,014	23,918,894	9,861,355	6,309,812	3,551,542	38.9	25.0
1883	144,294	432,726	12,917	41,181,177	19,454,902	11,794,553	7,660,349	38.0	26.0
1888	171,375	616,248	17,241	51,463,955	19,711,164	14,640,592	5,070,571	31.2	23.2
1889	178,754	647,697	18,470	54,108,326	20,783,194	14,565,152	6,218,041	31.2	22.4
1890	183,917	678,997	19,382	55,878,762	22,387,028	15,074,303	7,312,725	32.4	22.7
1891	187,981	715,591	20,098	59,148,343	23,034,326	16,428,741	6,605,584	32.5	23.2
1892	189,576	739,105	20,700	62,387,298	23,706,404	16,307,857	7,398,547	31.6	22.3
1893	189,936	769,201	21,078	66,591,858	24,978,442	17,482,405	7,496,037	31.2	22.7
1894	190,303	790,792	21,166	58,632,237	21,852,655	16,060,170	5,792,484	30.5	23.3

NEW COMPANIES, STATUTORY RETURNS, &c.

CALA MINES SYNDICATE (LIMITED).—This Company was registered on November 3rd, with a capital of £1,000, in £10 shares, to purchase or otherwise acquire the "Cala" Copper Mines, in Spain.

GAVIN, THOMSON, AND CO. (LIMITED). This Company was registered on November 1st, with a capital of £10,000, in £1 shares, to acquire the businesses carried on by Gavin, Thomson and Co. and by the London Rubber and Packing Company, and to carry on the business of india-rubber and gutta-percha manufacturers in all or any of its branches.

LITTLE AND GRAHAM (LIMITED).—This Company was registered on October 31st, with a capital of £10,000, in £1 shares, to carry on the business of gas and mechanical engineers, boiler makers, tool manufacturers, metal workers, metallurgists, &c.

COLUMN PRINTING TELEGRAM SYNDICATE (LIMITED).—The annual return of this Company, made up to August 13th, has only just been filed. The Company has a nominal capital of £25,000 in £50 shares, and of these 249 have been taken up ; 100 have been issued as fully paid, and a call of £50 per share on the remainder has resulted in the payment of £6,800, leaving £650 as yet in arrears.

MINER'S LAMP ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return of this Company, made up to August 15th, was recently filed ; 301 shares out of the capital of £3,000 in £5 shares, have been taken up, and 190 have been issued as fully-paid. In consequence of the full amount being called on the remainder, £550 has been received, an additional £5 still being due.

OMNIBUS AND TRAMCAR ELECTRIC LIGHTING COMPANY (LIMITED). The statutory return of this Company, made up to February 10, 1884, has only recently been filed. Out of a nominal capital of £60,000, in £5 shares, the seven signatories' shares have been taken up and a call of £1 per share made and paid.

CITY NOTES.

ACCUMULATORENFABRIK AKTIENGESELLSCHAFT HAGEN.—At the recent meeting of the Hagen Accumulator Company, in Berlin, a dividend of 10 per cent. was declared for the year 1893-94, net profits amounting to £31,456 against £19,554 for the previous period. The Company has acquired the sole right to manufacture in Germany the Waddell-Entz accumulator, for which it anticipates a great demand for street railway purposes.

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ended November 4th were £939, as against £874 in the corresponding period of 1893, being an increase of £65. The total receipts for the half-year amount to £15,750, as against £14,680 for the corresponding period of 1893, an increase of £1,070.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of October are £3,300, as compared with £3,058 in the corresponding month of last year.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of October, 1894, amounted to £2,101, as against £2,121 in the corresponding period of last year.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the month of October, 1894, amounted to £67,754, as against £61,409 in the corresponding period last year, or an increase of £6,345.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the month of October, 1894, amounted to £42,584, and to £41,443 in the corresponding period of 1893. Increase £1,141.

ELECTRICAL COMPANIES' SECURITIES.—At the Auction Mart, Tokenhouse-yard, E.C., on Wednesday, some £10 "A" shares (£9 paid) in the Exchange Telegraph Company (Limited) were withdrawn at 5¾, and some £100 Five per Cent. Debenture Bonds of the Venezuela Telephone and Electrical Appliances Company (Limited) were withdrawn at 76.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company for the month of October, 1894, amount to £27,200, and from January 1st to October 31, 1894, £234,600. In the corresponding months of 1892 and 1893 the amounts were £223,600 and £226,800 respectively.

HALIFAX AND BERMUDAS CABLE COMPANY (LIMITED).—A circular has been issued on behalf of the trustees of the £120,000 Four and a-Half per Cent. Debentures of this Company, asking for the assent of the debenture-holders to an application to Parliament during the coming session for a modification of the trust deed. This deed, by an oversight, did not provide for the application of the sinking fund to the redemption of the bonds by drawings or purchases, while unless it is so applied there will be a deficiency of about £30,000 on the maturity of the bonds. Parliament is to be asked to sanction this method of redemption.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended the 4th inst. amounted to £884. The amount for the corresponding week last year was £608.

THE PARIS-NEW YORK CABLE COMPANY.—It would appear from the French papers that some of the shareholders of the Compagnie Française du Télégraphe de Paris à New York are not disposed to accept the Government approbation of the amalgamation of their concern with the Société des Télégraphes Sous-marins as final, since they are petitioning the Courts in the matter. A petition has been laid before the Courts, in which it is alleged that the extraordinary general meeting which approved of the amalgamation of the two companies was not legal. By Article 36 of the Articles of Association it is necessary that at such a meeting at least half of the capital of the company should be directly represented. By Article 34 it is further stipulated that proxies are inadmissible unless the holder of them is himself a shareholder, and that every holder of shares shall have one vote per 20 shares : no one to have more than 20 votes. The petition alleges that at the meeting in question, a majority of the voters were merely nominal and temporary holders of shares, and that a meeting in accordance with Article 36 has never been held. It also states that for many years one of the cable companies has held more than 17,000 shares, and that, although in reality it has never ceased to hold them, it has distributed them from time to time for temporary voting purposes to employes. The document concludes as follows : "It would be profoundly iniquitous and immoral that the shareholders should be at the mercy of speculators and temporary holders of shares, and in this way despoiled," and it calls upon the Court to declare the extraordinary general meeting of the shareholders of the Compagnie Française du Télégraphes de Paris a New York, held in Paris on September 29th last, null and void.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended November 2nd (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited) were £2,861.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the two weeks ending October 31st were £2,152, as compared with £2,162 for the corresponding period of last year. The July receipts, estimated £3,761, realised £3,784.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Oct. 31.		Price Wednesday, Nov. 7.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 7.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£1,012,880	Stock	9/0	Anglo-American	33	37	31	33	5 5 3	Jan., Apr., July, Oct.	37	..
£2,993,560	Stock	18/0	Do. Preferred	71	72	71½	72½	5 17 3	,, ,,	72	69
£2,993,560	Stock	5/0	Do. Deferred	6¼	6¾	6¼	6⅝	..	,, ,,	6 3/16	6⅜
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 17 1	January and July	.	..
130,000	£10	4/0	Brazilian Submarine	12½	13	12½	13	5 0 0	Mar., June, Oct., Dec.	13	12¾
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	110	114	110	114	4 8 11	June and December	113½	—
10,000,000	$100	$1¾	Commercial Cable Capital Stock	135	145	135	145	4 17 9	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12½	13½	12½	13½	5 18 6	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	,, ,,	..	..
12,931	5	1/8	Direct Spanish (£4 paid)	4¼	4¾	4¼	4¾	4 4 3	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¼	9¾	9¼	9¾	5 2 7	,, ,,	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	4 3 4	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8	8½	8	8½	5 17 7	Jan., Apr., July, Oct.	8¼	8⅛
400,000	10	2/6	Eastern	15¾	16	15⅝	15⅞	4 1 11	,, ,,	15¾	16½
70,000	10	6%	Do. 6 per Cent. Preference	16½	17	16½	17	3 10 7	,, ,,	17	16⅝
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	118	121	119	122	3 6 7	May and November	120¾	119
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	110	106	110	4 11 11	February & August	..	..
250,000	10	2/6	Eastern Extension	15⅞	16⅛	16¾	16	4 7 6	Jan., Apr., July, Oct.	16	15¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	116	120	116	120	3 6 8	February & August	118	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	106	103	106	4 15 6	January and July	..	—
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	106	103	106	4 5 6	,, ,,	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	104	107	104	107	3 15 6	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.) .... xd	109%	112%	107%	110%	3 12 9	May and November	..	..
180,227	10	1/3	Globe Telegraph and Trust	8⅝	8⅞	8⅝	8⅞	4 15 9	Jan., Apr., July, Oct.	8 13/16	8¾
180,042	10	6%	Do. 6 per Cent. Preference	15½	16	15½	16	3 15 0	,, ,,	16	15½
150,000	10	5/0	Great Northern	20½	21½	20½	21½	3 13 1	Jan., April, and July	21½	20¾
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	107¾	..
17,000	25	12/6	Indo-European .... xd	46	48	46	48	6 4 2	May and November	46¾	46½
37,518	10	5/0	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	107	110	107	110	5 10 1	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	104	107	104	107	3 15 8	.	..	..
11,830	8	4/0	Reuter's	3	5	3	5		April and October	..	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	104	109	103	108	6 7 11	,, ,,	103½	..
15,609	10	5/0	West African Telegraph	3	6	3	5	..	January and July	.	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	100	103	100	103	4 17 10	March & September	101½	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	101	106	101	106	7 10 11	June and December	..	..
88,321	10	9d.	West India and Panama	1¼	1½	1½	1¾	..	.	1 3/16	1⅛
34,563	10	6%	Do. 6 per Cent. 1st Preference	11	11½	11	11½	5 4 1	May and November	11⅛	.
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	..	..
£80,000	100	5%	* Do. 6 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 11 6	June and December		..
64,242	15	7/6	Western and Brazilian	9	9½	9¼	9¾	..	May and November	9½	9⅜
33,129	7½	7/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	..	.	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	3	3½	3¼	3¾	.	..	3 11/16	3 3/16
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	106	109	107	110	5 10 4	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	106	109	107	110	5 10 4	,, ,,	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds xd	115	120	112	118	5 18 8	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 16 6	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	..	..	..
224,850	10/0	2⅝d.	Consolidated Telephone Const. & Maintenance	¼	½	¼	½	..	May and November	..	..
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	7/16	9/16	7/16	9/16	..	Yearly	..	..
484,597	5	3/4	National	4⅞	6⅛	4⅞	5⅛	4 17 7	June and December	5⅜	4 13/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	16	15	16	3 15 0	,, ,,	16	15 7/16
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14	15	14½	15½	3 17 5	,, ,,	15½	—
119,234	5	3/4	Do. 5% Non-Cumulative 3rd Pref.	6¼	6¾	6¼	6¾	4 6 11	..	6 11/16	..
1,000,000	Stock	4½%	* Do. Debenture Stock, 4½% (red.)	110	113	110	113	4 0 9	January and July	..	..
58,000	6	1/0	United River Plate	2	3	2	3	.	,, ,,	..	..
£116,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	88	94	88	91	5 6 5	,, ,,	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	13	14	12½	13½	..	..	13¼	12 11/16
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	14½	15½	14¾	16¼	3 18 8	..	15	14⅝
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	131	133	131	133	3 15 2	June and December	132½	—
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	..	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	4½	5½	4½	5½	3 12 9	..	..	..
£57,400	£100	6%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	..
8,322	£5	..	House-to-House Electric	..		..		—	..	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		—	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		—	January and July	..	—
15,000	£5	2/6	Liverpool Electric Supply (fully paid)	6⅝	6¾	6¾	6⅞	—	..	..	—
111,000	5	..	London Electric Supply	¼	¾	¼	¾		..	..	—
19,900	£10	5/0	Metropolitan Electric Supply (fully paid)	9¼	9¾	9¼	9¾	2 11 3	..	9¾	9½
£150,000	Stock	4½%	* Do. 4½% Debs. (Bonds of £10, £20, and £10)	113½	114½	113½	114½	3 19 0	June and December	111	..
6,152	£10	..	Notting Hill Electric	5½	6½	6	7	—	..	..	..
19,980	£5	2/0	St. James and Pall Mall	7¼	8¼	7¼	8¼		..	..	..
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 15 8	—	..	..
69,900	5	2/0	Westminster Electric Supply (fully paid)	6¾	7¼	7	7¼	3 0 0	—	7¼	7 1/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
00,000	3	1/6	Brush Electrical Engineering	2¼	2⅝	2⅜	2½	5 14 3	..	2½	2 1/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2¾	2⅜	2⅝	4 11 6		2½	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	111	114	111	114	3 9 10	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref	2	2½	2¼	2¾	—	January and July —	..	..
12,139	5	..	Edison and Swan United	—		—		..	..	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	..	—	..
120,000	2	.	Electric Construction	¼	¾	⅜	⅝	..	—	.	..
12,845	2	2/0	Do. 7 per Cent Cumulative Pref.	1½	2	1½	2	..	—	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1¼	1¾	1⅝	1¾	..	—	..	..
20,000	5		Fowler-Waring Cables (fully paid)	¾	1¼	¾	1¼		—	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	24½	25½	25	26	4 16 1	February & August	25 11/16	25¼
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 5 0	March & September	..	—
15,995	£10	6/4	International Okonite Ordinary	..		..		..		..	—
16,000	£10	..	Do. 8 per Cent. Preference	..		..		—	December and June	..	—
20,000	9	.	Manchester Edison-Swan "A" (£1 5s. paid)	—	½	—	½		..	..	—
37,350	12	12/0	Telegraph Construction and Maintenance	41	43	41	43	4 3 9	March and July	41¾	41½
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July	..	..
37,514	£5	..	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		—		..	..	..	—
41,008	£5	..	Do. Preference (fully paid)	—		..		..	—	..	—
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	8	9	8	9	5 11 1	..	..	..
£30,000	10	.	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1%	City and South London Railway	36	38	37	39	2 11 8	May and November	38	..
7,000	10	5%	Do. 5% Perpetual Preference	13	14	13½	14	3 11 5	..	..	
£67,130	Stock	4%	Do. 4% Perpetual Debenture .... xd	119	121	120	122	3 5 7	May and November	121	
37,500	£10	1%	Liverpool Overhead Railway	8	8½	8	8½	1 4 7	..	..	..
6,295	10	5%	Do. 5% Preference	13	13½	13	13½	3 15 6	..	—	..
£125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July ..	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

THE ELECTRICIAN:

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NOTES.

The deputation representing the tramway interest which last week urged the President of the Board to promote a Bill practically cancelling the recent judgment of the House of Lords regarding municipal purchase must be likened to a forlorn hope; it could not, one would think, have expected any other reply than the one received. If the Legislature were to undertake to revise judicial decisions, acting as a sort of informal Court of Appeal, many strange developments might be looked for.

The tramway purchase clause was as unambiguous as anything of the kind could well be. In spite of it, the public were invited to subscribe, and actually did subscribe, a large sum of money towards tramway schemes in various parts of the kingdom. If the existence and purport of this supremely important clause were properly made known in the prospectuses, it was clearly a case of *caveat investor*. If, on the contrary, not even so much as a hint was given to the prospectus-reader that what he was asked to put his savings into was of the nature of short concession, certain to be bought up though on uncertain terms, what are we to think of those responsible for the drawing up of such misleading documents, and how thankful the investor should be that even at this late hour the inevitable Board of Trade should be taking steps to protect him by promoting a Bill intended to bring prospectus-mongers within easy reach of the law. We are no believers in the exceeding great virtue of municipalisation; but whatever evil or injustice may be wrought by the operation of this particular instance of it, not municipalisation, but either the sanguine investor or the imaginative company promoter is to blame.

Since writing the above we have had an opportunity of looking through a number of tramway company prospectuses, and in no single one of them was a word said about the liability to summary municipal purchase at the end of twenty-one years, although in many the investment was baited with the adjectives "safe and *progressive*." Astronomers employ the word "acceleration" to denote alike a hurrying-up and a slowing-down. Can it be that prospectus-mongers mean by a progressive investment one which may be expected to retrogress in value to absolute zero?

Commenting upon the disastrous trolley-car accidents which seem to be a common feature of American city life, the *Philadelphia Record* compares electric traction to gunpowder, and remarks: "We cannot do without it; but we must train ourselves to the means of safely using it." We have always maintained that we have much to learn from America, and this is a by no means unimportant lesson. In taking it to heart, we would divide the application of it between the general public and the electrical industry. The general public have up to the present done without trolley cars, but are beginning to think about them; electrical engineers, on the other hand, are busily investigating, by the study of the Papers of Messrs. Wilkinson, Blackwell, and Dawson, the general systems of operation and the details of the fantastic ironmongery with which it is proposed to decorate our sombre skies; and it is probable that they will have trained themselves to the means of safely and decently constructing the trolley system with the aid of these contrivances, or with others invented to suit English requirements, before they invite the public to use it.

The suggestion that the unit of light which was described in our last issue is superior in any way to the amyl-acetate lamp, either in practical accuracy or in the theoretical quality of being a "physical unit," is stoutly combatted by the inventor of this well-known standard, Herr von Hefner-Alteneck. In the abstract—which will be found in another column—of his reply to the Paper of Lummer and Kurlbaum, he indignantly objects to the relegation of his lamp to the category of standard candles, carcel lamps, and so on, and claims that it stands in need of calibration by nobody, not even the Reichsanstalt. We think his contentions are perfectly justified, but none the less admire the new standard; and von Hefner-Alteneck, the inventor, having defended his own valuable standard, von Hefner-Alteneck, the physicist, admits that the new unit may be of great importance in physical problems in which the highest degree of accuracy in light measurements may be demanded.

One of the most extraordinary and almost incredible schemes which has ever been put forward for the transmission of energy to a distance, is the idea of "pumping coal through pipes," which is said to be occupying the attention of Chicago capitalists, and which has without a doubt attracted the attention of a Chicago electrical contemporary. According to this paper, it is calmly proposed to grind coal to a fine powder at the collieries, then to mix it with an equal volume of water, then to transmit and distribute this gritty mud to various industrial centres, and finally to separate out the damaged fuel and burn it—as best they can! No doubt muddy water can be pumped through a pipe; there is nothing original in that; no doubt a 4in. pipe will transmit 320 tons of this ruined coal per diem; nor can there be any denying that the grit can be ultimately separated from the water without appreciable loss in the tailings; but where the doubt does come in—if there is not absolute certainty to the contrary—is that the fuel will be worth anything more than the poorest and dampest smudge after it has been strained or allowed to settle in tanks. Of course, it would be possible to make block fuel, first of all evaporating out the abundant moisture—but no! the whole thing must be someone's huge joke, for they can do better than this in Chicago.

◆

African Trans-Continental Telegraphs.—The line between Mazoe and Salisbury is now open.

Personal.—Sir David Salomons, Bart., has been elected Mayor of Tunbridge Wells for the ensuing year.

Institution of Electrical Engineers.—The students' annual meeting will take place this evening at 8 p.m., at 28, Victoria-street, for the election of committee and secretary.

Indian Telegraphs.—The Indian Government has been asked to sanction a special bonus to Mr. Melhuish, of the Telegraph Department, on account of his transformer apparatus invention.

Cable Interruption:	Date of Interruption.
Zanzibar-Mombasa	September 4, 1894.
Maranham-Para	November 10, 1894.
Sierra Leone-Accra	November 13, 1894.

The Pollak Accumulator in Switzerland.—The Société Suisse pour la Construction d'Accumulateurs Electriques at Marly-le-Grand, near Freiburg, has acquired the sole right to manufacture the Pollak accumulator in Switzerland.

The Condition of the Spanish Telegraph System.—It is reported that a Royal Commission has just been appointed in Spain to inquire into the condition of the telegraph system of the country and the means to be adopted to improve the same.

"Wiedemann's Annalen."—The editors of *Wiedemann's Annalen* announce that, owing to the great press of matter, and the impossibility of indefinitely postponing its publication, they have found it necessary to issue an "extraordinary" number. The scientific *cacoethes scribendi* has thus spread even to Leipzig.

Electric Traction in Germany.—The tramway at Bromberg is to be converted into an electric line. The work will be carried out by the Allgemeine Electricitäts-Gesellschaft of Berlin. The Union Electrical Company of Berlin has acquired the Frankfort-Eschersheim tramway with the object of converting it into an electric line.

Telephony in India.—The use of the telephone in India does not appear to be very considerable. There are now only 1,360 subscribers to the Telephone Exchange at Calcutta, Madras, Bombay, Karachi, Rangoon, and Moulmein, besides 26 Exchanges and 205 Exchange connections under the control of the Telegraph Department.

Obituary.—We regret to announce the death, on last Tuesday week, of Mr. H. J. Allison, the principal librarian at the Patent Office. Mr. Allison has been connected with the Patent Office for about 42 years, during the last 12 of which he was chief librarian; he also was editor of the *Patent Office Journal*. Frequenters of the useful library at the Patent Office will miss his kindly and courteous services. He died at the age of 65.

Secondary Cells as Instruments of Education.—The Armour Institute of Chicago recently purchased some foreign storage batteries for the laboratory, and held that they should not be dutiable, being for educational purposes. After some controversy, the Board of General Appraisers has decided that they are subject to duty, and, therefore, by implication, devoid of any educational value.

Electric Traction in Chicago.—Conspicuous in the notable electric railway development of Chicago at the present time, says the *Western Electrician*, is the work under way for the Chicago City Railway Company. This Company, with its 7,000 H.P., will have a power station as large as any in the country, and is taking a place as one of the great electric railway companies of the world. An interesting feature of the equipment is the employment of a great electric motor to supplant two engines in the cable-driving plant adjacent to the electric power house.

Electrical Journalism in France.—Our neighbours across the channel are extremely "well" off just at present in the matter of electrical journals. *La Lumière Electrique* and *Electricité*, indeed, are dead, dying of dignity like all old-established institutions; but France still enjoys the advantage of possessing *L'Industrie Electrique*, *L'Electricien*, *L'Eclairage Electrique*, *L'Energie Electrique*, *L'Etincelle Electrique* and the *Revue de l'Electricité*, not to mention *La Semaine Electrique* and the *Bulletin International de l'Electricité*.

Royal Society Medals.—The President and Council of the Royal Society have this year awarded the following, among other medals:—The Copley Medal to Dr. Edward Frankland, for his eminent services to theoretical and applied chemistry; the Rumford Medal to Prof. James Dewar, for his researches on the properties of matter at extremely low temperatures. A Royal Medal has been awarded to Prof. J. J. Thomson in recognition of his contributions to mathematical and experimental physics, especially to electrical theory.

The Austrian Telegraph Budget for 1895.—The telegraph estimates for 1895 just laid before the Austrian Parliament show that both telegraphy and telephony continue to make great progress in Austria. The telephonic receipts for 1894 were half a million gulden in excess of the revenue of 1893. For 1895 it is estimated that the telephone revenue will be higher than that of 1894 by over 100,000 gulden. During the next twelve months something like one-quarter of a million gulden will be devoted to telegraphic and telephonic extensions.

Uniformity in Stopping Cars in Philadelphia.—Ever since the introduction of electric cars in Philadelphia, the matter of stopping at street intersections has, says the *Street Railway Gazette*, been under active discussion. The outcome of this discussion is the decision that all trolley cars shall stop on the near side of street crossings. The Philadelphia Traction Company, to make the system uniform throughout the city, decided that its cable cars should conform to the new rule, so that all cars in Philadelphia now stop in accordance with the new practice, except the horse cars, which are fortunately rapidly disappearing.

Way-Leaves in America.—The *Electrical Review* of New York says that a strong protest is being made against the running of electric cars on the highways of Deal Beach and South Elberon, N.J. The property owners along the proposed route take the position that electric roads, being very profitable, should be willing to purchase the right of way through property at fair and equitable valuation, and not obstruct the narrow roads laid out in the olden times, which are used both for pleasure driving by seashore visitors and also by truckers who supply Asbury Park and Ocean Grove with farm produce. On some portions of the proposed route the old-fashioned roads are so narrow that an electric railway would completely obstruct the use of it for ordinary travel.

Compulsory Sale of Tramways in South London.—On Tuesday week the London County Council resolved, by 103 votes to 4, to serve a notice on the London Tramways Company, requiring it to sell to the Council the portion of its undertaking authorised by the Extension Order of 1873, consisting of about 2$\frac{1}{4}$ miles from Kennington Park-road to Old Kent-road. It is only a small section of the system belonging to the Company, the whole measuring about 23[illegible] miles, but it is a very important section, as two branches spread out from it, one going to Brixton and Streatham, and the other to Balham and Tooting. The remainder will fall in about four years hence.

Lightning Extraordinary.—A Rotterdam correspondent vouches for the truth of the following story, which we shall tell in his own words:—"During a short but heavy thunderstorm the lightning paid a visit to a clock station in this town. The station is situated on the border of one of the numerous canals, and the door leading thereto was open. Suddenly the engineer saw a ball of fire approach over the canal, enter through the doorway, envelop the fireman standing by in a mass of fire, and then travel along a bit of copper wire the man held in his hand to a steel tool hanging on the wall; this tool was blackened, the man received heavy shocks in arms and chest, but no damage ensued."

Telephonic Communication in South America.—On p. 740 of our issue of October 26th we stated that telephonic communication had "just been established between Monte Video and Buenos Ayres." A correspondent writes to point out that such communication was first established in 1889, and that there are now two aërial wires of 4mm. silicious bronze, each about 80 miles, and two submarine cables across the River Plate, each about 20 miles in length. The Van Rysselberghe system is used, and works splendidly, whilst the two wires are being simultaneously worked for ordinary telegraph traffic (Morse duplex). Several banks and firms, both in Monte Video and Buenos Ayres, are in direct communication from their offices

Canal Boat Propulsion.—A recent number of *L'Industrie Electrique* contains a description of an apparatus which has recently been tried for canal boat propulsion. It consists of a propeller attached to the far end of the rudder, and driven by an electric motor placed on the top of the vertical shaft of the rudder, and driving the propeller by means of bevelled gears running in a reservoir of oil. One of the advantages of this system is that it requires no change in the boat except the change of the rudder. The vertical pressure due to the weight of the armature is balanced by a magnetic system; the weight of the whole rudder is balanced by making it hollow, so as to cause an upper pressure by displacement. It was tried on a boat 125ft. long, of 180 tons, which attained a speed 40 per cent. higher than that attained by two horses. The power consumed was 3·4 kilowatts. The current was furnished by a battery of accumulators.

Trials of "Fenders" in Philadelphia.—The traction companies of Philadelphia, says the *Street Railway Gazette*, have been engaged in testing fenders during the last few weeks with a view to the selection of a certain style as a standard. The tests were made with dummies formed of canvas and stuffed with bran. Although invited to do so, the inventors did not care to stand in front of the fenders to illustrate their efficacy. It was concluded from these tests that several of the simple fenders would operate to save persons who had been knocked down, once in three times and perhaps every other time. The fenders were tried in two different places: part of the tests took place on a street where the paving was brick, almost as smooth as asphalt, and again on a street where granite blocks were used. The People's Traction Company has also been experimenting with fenders, and recently two of its cars have been equipped with a device of a scoop form, made in accordance with a design of one of the officers. This will be tested by putting it into actual service, as "the Company thinks that experiments with dummies prove nothing."

Technical Education.—The Science and Art Department have lately issued a report showing the way in which the money raised under the Customs and Excise Act, 1890, has been disposed of in promoting technical education by the County Councils and other bodies to whom the money was made over. The return states that the total amount expended on technical education during the year 1892-3 in Great Britain was nearly £530,000, and that the amount allocated for the same purpose for the year 1893-4 was close upon £700,000. It should be understood that this amount does not include the sums devoted by private liberality to this purpose, such, for instance, as the money subscribed by the companies of the City of London. The money dealt with in this report includes only the sums obtained from the Customs and Excise Act, and also the amounts raised by local rates levied under the Technical Instruction Acts. It appears, from the report, that a great majority of the local authorities are applying the whole of the funds provided by the Customs and Excise Act for technical education alone, though, in some cases, only a part of the funds are thus applied, and, in a very few, they are used for the relief of the rates. The return gives very full details as to the way in which the money is expended in each case.

The Use of the T-Rail on Paved Streets.—At the Atlanta meeting of the American Street Railway Association Mr. Strathearn Hendrie stated that the tendency in America during the past ten years or more has been toward smoother and better paved streets, which has resulted in a demand for improved forms of rails. Many city officials have forced the street railway companies either to use the English grooved rail or its American modification, neither of which, however, has proved satisfactory to the railway companies. For the street railway man questions of price, joints, quick delivery, competition, coal and construction combine to recommend the T-rail. The suggestion of a T-rail is generally startling to the average citizen, but his idea of such a rail is that used by steam roads and projecting four or five inches above the street. There is more than one way of putting a rail in the street. The paving is perhaps the most important point. Modern street railway construction and street paving imply broken stone, concrete or other solid foundation, a high girder or T-rail, and a brick, asphalte or granite surface to the street in larger cities, or cedar blocks, cobble or macadam in the smaller ones. Asphalte or macadam can be paved as easily to a T-rail as to any other. They should be laid flush, and room should be made for the flange by running a railroad freight car or other car having a larger flange than the street car over the track before it is open for traffic.

Railroad Travel in England and America.—Our New York contemporary, the *Electrical Engineer*, in a recent issue, comments on an article on "Railroad Travel in England and America," in the current number of *Scribner's Magazine*. Our contemporary prefaces its remarks by the statement that "the period of steam travel in England will never have a better presentation" than at the present time, for "that very soon a large proportion of the English railroads will be operated electrically." This is good news. Our New York contemporary further thinks that agricultural light railways have an especially good chance in England. It says: "It may be pointed out that the adoption of the trolley system on the English roads is free from all the objections raised against its use on streets, especially as nearly every English crossing is made above or below grade. Another feature is that costly and heavy construction would no longer be necessary. Cars running singly at frequent intervals do not require the massive tracks, bridges, &c., that trains weighing hundreds of tons do. Even if the trolley were restricted to slower travel, there is an incalculable amount of traffic to be done cheaply at those lower speeds." Finally, as our contemporary remarks, "in a country like England, trolley roads may be made to feed the old steam roads, also; and we believe that in this country the shrewder steam railway managers will soon be trying the effects of such a plan, calling in the transverse lines to offset the evils of the parallel.

Proposed Chicago-Milwaukee Electric Railway.—The Chicago–St. Louis Electric Railway having died a natural death, another scheme of the kind is promptly proposed. A number of Chicago capitalists, says the *Western Electrician*, are said to be interested in the project of establishing an electric railway connecting a number of towns between Chicago and Milwaukee, and making a continuous system of electric service between these cities. The project, our esteemed contemporary states, has assumed definite form in the establishment of the Lake Shore Electric Railroad Company, which was incorporated at Springfield, Ill, with a capital stock of $10,000,000. The plans of the Company were outlined by Mr. Lauderback in an interview, in which he said: "We expect to connect all the towns mentioned with a trolley electric system. The plans were formed about two weeks ago, when a number of gentlemen, several of them representing large real estate syndicates, called on me, and agreed to furnish the right of way if we would build the road. It all rests with them now whether the lines are constructed. If they make their promises good, we will go ahead with work. I think this would be the largest single electric system ever put in—about 88 miles. There may be several longer lines in eastern states—New Jersey, perhaps, and probably in the New England states—but they are made up of a number of short lines, originally independent of each other, but now consolidated. Such lines have been very successfully operated in the East."

Electrical Communication with Lighthouses.—The following notice to mariners has been published by the Irish Lights Office:—The following lighthouses under the jurisdiction of the Commissioners of Irish Lights being now, or about to be, electrically connected with the Postal Telegraph system, mariners are informed that arrangements have been made with Her Majesty's Postmaster-General, whereby they can have casualties at sea reported by telegraph to owners or others through any of the stations named. Payment at the rate for ordinary inland telegrams (*plus* tenpence per message) will be demanded on delivery of the telegram. Telegrams in reply will be accepted from the owners or others, for transmission, if possible, to the vessel in distress, and will be subject to the same charges. It is, however, necessary to state that the present staff at a lighthouse does not permit of a constant look-out being kept, so that signals may not always be observed. It must be distinctly understood that no messages will be transmitted other than those which relate to shipping casualties. The arrangement here described is supplementary to that under which messages from light-keepers themselves, to summon lifeboats, are transmitted free of charge. List of lighthouse stations: North Coast—Tory Island. North-West Coast Galley Head. South-West Coast—Valentia. East Coast——Killybegs (St. John's Point). South Coast—Fastnet Rock, Howth Bailey, Tuskar Rock, Hook Tower, Minehead. West Coast—Loophead, Kilcredaune (River Shannon). According to the recommendations of the Royal Commission, the Fastnet Rock, it will be remembered, was to be connected to the shore by a "non-continuous cable"; *i.e.*, by an induction-coil arrangement.

Electrical Accident in the City.—The following accident occurred shortly after 1 o'clock on Saturday afternoon last. A horse attached to a brougham was being driven along Cannon-street, and on turning into Budge-row the animal began to tremble violently, and immediately afterwards fell down. When the coachman got off his seat he at once received an electric shock, but sustained no injury. The horse, however, died in a few moments. Directly afterwards two explosions occurred simultaneously in the junction boxes opposite No. 22, Budge-row, and in Cannon-street facing No. 22, Walbrook. The latter premises are occupied by a hosier, whose shop window-blind was damaged, the basement window being also broken. The explosion forced off the covers of both boxes; and part of the brickwork and iron frame of the box in front of the hosier's shop was considerably damaged. A portion of the footway and kerbstones was blown into the carriage-way, striking and injuring two or three people. Three persons passing also received shocks. A few seconds after the explosion smoke was seen issuing from the junction box opposite No. 22, Budge-row. The officials of the City of London Electric Lighting Company have reported the whole circumstances to the Board of Trade, and an inquiry will be held on Monday next at Winchester House. We are asked by the British Insulated Wire Company to state that their cables were in no way responsible for the trouble. They consider this disclaimer necessary, as their name has been so closely connected with that of the City Company of late. Another account states that there are one or two singular points about the accident in Budge-row. It appears that the first explosion did not occur until a quarter of an hour after the horse fell down, and that five minutes after this another explosion occurred some 30 or 40 yards away from the spot where the horse fell. Previous to the horse that subsequently died being struck, another horse had been somewhat similarly affected, and made a deliberate leap, almost overturning a cab in Cannon-street.

Carborundum Electric Light Carbons.—Many efforts have been made to improve the quality of illuminating carbons, for the purpose of lengthening the life of the filaments, rods or points, and also to produce a combination of carbon with other substances that would give more light for the electrical energy consumed. The main object of inventors has always been to produce a carbon containing a material having an excessively high fusing point and equally difficult of oxidation, and, at the same time, having a high luminescent value. Mr. E. G. Acheson, the inventor of carborundum, has, says the *Electrical Engineer* of New York, recently produced a carbon in which he claims to have covered these points. He takes pure carbon and carbide of silicon (carborundum), reduces both to fine powder and mixes them in the proportion of nine parts of the former to one of the latter, together with tar or any other good binding material. The mixture is then baked and moulded into the proper form for use. In order to get the full and complete effect of the illuminating qualities of the carbide of silicon more distinctly separated from that of the carbon, the ordinary cored carbon rod is used, and the core is filled with the carbide of silicon, either alone or with a binding agent. For the filaments of incandescent lamps the carbide of silicon in a very fine powder is mixed with and suspended in the oil used in the oil bath for the treatment and building up of the carbons, and in the process of depositing the carbon from the oil bath into the filament the fine particles of carbide of silicon become fixed to the filament simultaneously with the deposit of carbon. As carborundum is formed at a temperature approximately that of the electric arc, it is necessarily free from all volatile matters, and eminently fitted (as the result of having already existed at these high temperatures) for the light-giving body. It has also been demonstrated that it resists oxidation to a greater extent than any other known material, having resisted such chemical action when highly heated and exposed to a stream of oxygen gas. Associated with these two essential qualities of infusibility and non-oxidisability, is a third equally valuable one, that of luminescence, as it is claimed to produce a greater amount of light for the electrical energy consumed than any illuminating body heretofore used.

Hertzian Waves, Carbon Microphones and "Coherers."—Under this comprehensive heading Dr. W. J. Morton, of New York, relates in the *Electrical Engineer* of that city the following interesting experience:—About eighteen months ago I put into use the Vetter method of controlling the current derived from the Edison 110-volt system. The controlling devices were a 16-c.p. lamp and a pulverised carbon rheostat. On several occasions when the electrodes were attached to some part of a patient's person and a spark was being administered to another patient seated upon a platform charged by an influence machine, some 15ft. distant in the same room, the first patient would exclaim and protest against receiving a considerable shock. That a spark occurring 15ft. away should cause a shock to a person in an independent circuit excited my wonder; it was inexplicable, and yet so certain to occur, that I was obliged to abandon the use of the two pieces of apparatus at the same time. At last, when time permitted, I set out to investigate. I suspected the microphonic rheostat of pulverised carbon, and having cut it out of circuit, I substituted for it a water rheostat. The phenomena now failed to occur. Replacing the carbon rheostat, and putting a telephone in circuit, I adjusted the milliammeter to read two milliamperes, causing an assistant to evoke the distant spark. All was now clear. At each spark the needle jumped forward, and a distinct telephone click was heard from the telephone receiver. I observed that the first jump of the needle was the longest, as well as the first click in the receiver the loudest, both needle jump and click dying away gradually at each successive spark until they ceased at from the twentieth to thirtieth. Unable to furnish any reason why the electric radiation of a distant spark should reduce the resistance of pulverised carbon I refrained from publishing the bare observation in the hopes of finding an explanation by further experimentation, merely noting to friends the delicacy of the pulverised carbon rheostat as a detector of Hertzian waves, and making some further experiments with it and a telephone receiver in circuit in this direction. The recent publication of the brilliant researches of Dr. Oliver J. Lodge now makes the entire matter clear. My experiments would seem to fully demonstrate that carbon as well as metals may act as coherers.

MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 34.)

The excessive friction in unbalanced valves is caused by the large amount of surface which is exposed to the steam chest pressure, the force upon which is directly exerted between the rubbing surfaces. This friction is not only a source of loss of power, but it also hinders the prompt action of the governor and leads to the phenomenon known as "hunting." If the governor meets with great frictional resistance in its effort to readjust the valve motion, it is evident that its action must be delayed until there is a sufficient want of equilibrium to exert the necessary force. Thus arise the tardiness and irregularity which give rise to hunting, *i.e.*, to the alternate rise and fall in speed of the engine due to the inability of the governor to get into step with the requirements of the engine. Slide valves are usually balanced by means of a relief frame, which screens the greater part of the valve from the steam chest pressure; or, in other cases, by having a cylindrical valve, known as a *piston valve*, which effects the steam and exhaust distribution by means of ports completely surrounding it. Some balanced valves are described later. It will be seen from the foregoing table of tests, what a great reduction of friction arises when the valves are balanced.

Friction of the crank shaft bearings depends on the manner in which the power is taken from the engine, as well as upon the balancing of the reciprocating and rotating parts. If the power is taken off by means of a simple torque on the shaft the shaft bearing friction will chiefly arise from internal (engine) causes; but if it is taken off by belt, rope or other usual form of gear, the side thrust applied at the pulley will be communicated to the bearings and will increase their friction.

The difference between piston friction in vertical and horizontal engines is not brought out in the table, as the author has not found any reliable data on the subject. This form of friction is undoubtedly greater in the latter type of engine. It may be minimised in any particular engine by the use of suitable piston rings and by proper cylinder lubrication. Light fixed oils, often chiefly composed of the less volatile mineral oils, are most commonly used for the latter purpose. The vertical engines made by the Brush Electrical Engineering Company are frequently unprovided with cylinder lubrication, and are found to give good results under this condition. One advantage of using no such lubrication, where the steam is condensed and returned to the boilers, is the absence of oil from the feed water. Oil separators are sometimes necessary, to remove cylinder lubrication from the condensed steam. Friction in other parts of the engine is minimised by allowing a sufficient amount of bearing surface to prevent the lubrication from being squeezed out from between the sliding parts, and by the use of suitably viscous lubricants. Slow moving parts under great pressure require heavy oils; quick moving parts under smaller pressure should be provided with light, thin oils. Continuous and copious lubrication must always be adopted if a high mechanical efficiency is desired.

Relation of Load to Friction.—The only logical mode of determining the variation of engine friction with the load is, to deduct the B.HP. from the I.HP. throughout a series of values of either the latter or the former. Argument based upon measurement of steam consumption is fallacious, as it is illogical and wrong to assume a constant steam consumption per I.HP. at all loads. Commencing with no B.HP., *i.e.*, with the engine running light at its normal speed, we may ascertain the corresponding I.HP. by means of an indicator diagram. The whole of this power is, of course, absorbed by engine friction. Such an indicator diagram is usually called a "friction card." Gradually increasing the B.HP. a series of cards may be taken, from which the values of the I.HP. may be obtained. In the majority of types of engines it will be found that the difference between the I.HP. and the B.HP. is constant throughout, and is always equal to the value obtained from the friction card. In this connection, Prof. Thurston says:* "The so-called friction card of the machine represents practically the friction of the engine when fully loaded, the indicated power without load being sensibly the measure of the wasted work of the engine when in operation under load of whatever amount. Even the compound engine, contrary to the expectation of the Author, exhibited substantially the same internal friction at all loads up to its rated power, and with no load at all." The truth of this, in the case of a steam engine worked at variable load with constant cut-off—the steam being throttled to suit the load—has been abundantly proved in a series of experiments with his engine, by Mr. P. Willans. Some doubt has been cast upon the truth of the generalisation, in so far as it relates to double-acting engines with variable cut-off. These engines are, however, subjected to almost constant force between all their working parts; the pressure in the steam chest and on the valve is constant, the pressure on the crank pin falls only slightly as the cut-off is hastened, and the piston friction cannot be affected by the cut-off. Consequently, there can be but little reduction of the engine friction as the load falls. Experiment, too, seems to confirm the generalisation in its application to these engines. Double action, nevertheless, may give rise to variation of engine friction, if it leads to "knocking" or "lost motion" at the brasses of the crosshead and crank pin, and the loss of power on this account probably becomes excessive if the engine is overloaded. Mr. D. K. Clark observes "that the degree of nearness to uniformity of frictional resistance for various powers of the same engine, at the same speed, is probably dependent upon the degree of nearness by which the momentum of the reciprocating parts is balanced by the pressure of the steam."

Thus, engine friction, considered as a force, may be taken as fairly constant, provided the conditions of steam pressure are unaltered. The power expended, if the speed is constant, is also found to be unvarying. Under the stated conditions, therefore, the work done against friction in each revolution of the engine is a fixed quantity. In cases, then, where the speed varies directly as the power developed, the absorption of power by engine friction is not constant, but is a constant fraction of the total power. The mechanical efficiency of such a condition of working is constant.

Methods of Varying Engine Power.—There are three methods of varying the power of a steam engine in common use: (1) by varying the speed; (2) by varying the initial pressure of the steam, with unvarying cut-off; and (3) by varying the point of cut-off, with constant initial pressure. These are sometimes combined as follows, viz., by slightly varying the speed as the load varies, the greater part of the change of load being met either by the throttle valve or by a change in the cut-off. We may conveniently consider this last to be the fourth form of regulation.

Regulation of Power by Variation of Speed.—Regulation of power of a steam-engine, to meet the conditions of a varying load, by keeping the steam distribution constant and varying the speed of the engine, is the least common method adopted in practice. It is only rarely that the mechanical conditions can be adequately adapted to the electrical requirements. In the majority of cases the dynamo must be driven at a constant or nearly constant voltage; and this condition must be maintained at all loads on the dynamo. To run the dynamo in this way, while running the engine at a speed which varied directly with the load, would necessitate the interposition of a variable-reduction gear capable of transmitting the whole power between the engine and the dynamo. No such gear, capable of dealing with several hundreds of horse-power, is known; and those which have been designed for smaller amounts of power have proved inefficient, unreliable, and inconvenient. There is one system of electrical distribution of power, however, which lends itself to this method of engine regulation, viz., distribution at constant current, with variable volts. Examples of this are commonly met with in series arc lighting; and, though the method is by no means the only available one for regulating the power supply, it is largely used by some makers of arc light machinery. The usual plan is to couple the engine to the dynamo, either directly or by some form of gear, and to adjust the throttle governor so that it shall only come into action in the event of the engine racing. The field-magnets of the dynamo are under constant excitation, and the armature current is also constant; so that the dynamo opposes a constant torque. The engine is supplied with steam at a constant pressure, of such a value that it will develop a mean force capable of overcoming this torque *plus* the mechanical friction. Left to itself, such an arrangement will run at a speed which will be directly proportional to the load; and the governor will only interpose in the event of the dynamo accidentally losing its field, or when the belt slips. The high mechanical efficiency of this arrangement has led many electrical engineers to cast covetous eyes on it, wishing that it might be adapted to other systems of electrical distribution. It is probable, however, though exact information is not forthcoming, that the high mechanical efficiency at low load would be largely if not wholly lost in the increased condensation of steam, due to the reduced speed.

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* Thurston: "Engine and Boiler Trials."

Regulation of Power by Variation of Initial Pressure.—The method of regulating the power of an engine by throttling the steam down to a suitable initial pressure, and keeping the point of cut-off fixed, was first introduced by James Watt, and is the most common means adopted for varying the power of high-speed steam engines in electric power station in this country. This method is often erroneously said to give "variable power with fixed ratio of expansion," whatever that may mean. As a matter of fact a throttle valve varies the expansion ratio quite as widely as does an automatic slide valve. The difference between them lies in the fact that, whereas in the latter case the expansion takes place wholly in the cylinder, in the case of regulating by a throttle valve a variable portion of the expansion occurs at the valve and a fixed remainder occurs in the cylinder. Though from a theoretical point of view thermodynamically inefficient, the practice of regulating by a throttle valve has many practical advantages and even merits; and it is doubtful if any other mode of regulating will give superior results in economy and prompt regulation. Firstly, it is to be noticed that, since the range of expansion in the cylinder is kept constant, there will not be a very much greater range of cylinder temperature at low loads than full load. Indeed, where only moderately high pressure is used, the range of temperature may be considerably less at low loads. The practical advantage of this is, that initial condensation is not liable to become excessive at low loads. Secondly, it is to be noticed that the first stage in the expansion, viz., that taking place at the throttle valve, has a drying action on the steam; which will also tend to prevent initial condensation. And it must further be observed that this drying effect increases as the load is reduced; so that at very light loads the steam may possibly enter the cylinder in a very dry or even superheated state, the direct effect of which is to tend to prevent initial condensation in proportion as other tendencies would lead to its production. A throttled engine, supplied with fairly dry steam from the mains, and running on a light load at normal speed, is under much more favourable condition in regard to economy of steam than a similar engine regulated by a slide valve. Thirdly, from the fewness and simplicity of parts, and the ease with which they may be perfectly balanced in regard to steam pressure and friction, throttle valve gear is more effectively and promptly controlled by a governor than is the case with automatic slide valve governing. A steam gauge placed on the steam chest or dome of an engine which is regulated by this method, will serve to indicate the exact fraction of full power at which the engine is running, the gauge having been calibrated for the purpose. It is, however, necessary to damp the oscilations of the pointer, arising from the fluctuations of steam pressure.

Regulation of Power by Variation of Cut-off.—Large, slow speed electric power engines are most commonly regulated by means of a governor acting on the cut off, the point of cut-off being automatically hastened as the load falls. Steam at full pressure is admitted to the cylinder up to the point of cut-off; so that the range of temperature of the cylinder walls is greater at low loads than at full load. At very low loads the whole of the period of highest pressure takes place in an early part of the stroke; and the effect of this, in some types of engines, may be to increase the fluctuation of speed on account of the distortion of the crank effort. Slide valves are commonly controlled by varying either the lap, or the travel and angle of advance; though in some cases all three are automatically varied. Corliss valves and other forms of trip or trigger valves, are controlled by automatically varying the instant in the stroke at which they are allowed to snap and close the steam passages.

Regulation of Power by Variation of Speed and Expansion.—In many systems of electric power supply a network of conductors is fed with power at a fixed voltage at a number of points in the network, called feeding points. These feeding points are electrically connected to the dynamos by means of unloaded cables, called feeders, *i.e.*, cables which have no load on their entire length, but which take the power at the station end and deliver it, less a certain amount internally wasted, at the network end. Were it not for the internal waste, the voltage at the station end would be the same as that at the feeding points; but, as it is, the voltage must be higher than that at the feeding point by an amount which is directly proportional to the load at the feeding points. For this reason, the generator must develop electric power, not at quite constant voltage, but at a voltage which rises in direct proportion to the loss of volts in the feeders. The dynamo voltage must, in fact, equal the constant volts at the feeding points *plus* the variable volts lost in transmission. One method of arriving at the necessary regulation of dynamo voltage is, to vary the field-magnet excitation; but another method which is sometimes adopted, and an extensive example of which occurs at the Manchester Corporation electric supply station, consists in speeding up the engine in proportion to the volts required for transmission. When supplying practically no power, but when connected to the feeders, the dynamo would be run at a certain speed, and would develop the feeding point voltage. The supply of steam to the engine would be just sufficient to overcome the engine and dynamo mechanical resistances. As the load came on the dynamo, more steam would be supplied to the engine, in proportion to the current given by the dynamo, either by automatically varying the cut-off or the throttle-valve, and at the same time the engine would be speeded up until the required voltage was obtained at the feeding points. The speeding up is sometimes controlled by hand, the engine driver being guided by a voltmeter; but a more prompt method is to use some form of mechanical or electrical control.

Crank Effort.—As a preface to the study of the governing of engines, it will now be necessary to say a few words about the fluctuations of the effort exerted by the reciprocating connecting rod upon the crank pin. Owing to the harmonic variation of the length of the arm at which the force of the steam is exerted on the crank—that arm vanishing at two points, called the dead points—and owing, too, to the fact that the steam pressure is not constant, but varies considerably during the stroke, and will sometimes be of negative value, the polar diagram of crank effort of a single cylinder is far from being a circle; *i.e.*, the torque exerted is far from being constant. Fig. 32 is constructed to show the polar diagram of crank effort for a single cylinder, the curves, however, being plotted radially from the circumference of a circle, instead of a polar point, in order to show the negative as well as the positive values. The continuous line shows the curve of crank effort when the steam is cut off at 75 per cent. of the stroke, and the dotted line shows the same for a cut-off at 33 per cent. The magnitude of the effort is the length of the radius beyond the circle. It will be understood that these curves are only to be taken as examples, and that the actual curve depends, not only on the cut-off, but on all the points in the steam distribution.

Now, it will be noticed that not only does the effort fluctuate enormously, but that twice in every revolution it becomes negative. It will be seen that the direct result will be a tendency to vary in speed during the time of each revolution. The engine will tend to run quicker where the curve is farthest from the centre and slower where it is near to that point. There are two methods of obviating the great fluctuation of speed which would result from this fluctuation of turning moment: (1) to absorb the surplus or make up the deficit turning moment, above or below the average, by means of a mechanical store of energy such as is afforded by a flywheel affixed to the crank; (2) to connect two or more separate pistons and connecting rods to the same crank shaft by means of cranks set at such an inclination to one another that the maxima or minima of the several efforts do not coincide, being so arranged, in fact, as to produce by their combined efforts an equable, or less variable, turning moment.

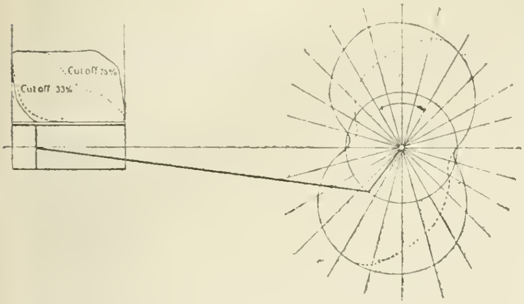

Fig. 32.

(To be continued.)

PRINCIPLES OF TRANSFORMER DESIGN.

BY ALFRED STILL.

(Continued from page 36.)

"Wattless" and "Hysteresis" Components of the Magnetising Current.—The dotted centre line $h\,o\,b$, in Fig. 5, may be taken as representing the relation between exciting current and magnetism on the assumption that hysteresis is absent. Hence it follows that at any point in the real cycle the portion of the current which may be considered as doing the work against hysteresis is indicated by the length of the current line comprised between this dotted line and the outside curve. This current will be *positive* when measured to the right of this new centre line, and *negative* when to the left. The short horizontal lines in the figure represent the successive *positive* values of this hysteresis current, during the change of the magnetism from its negative to its positive maximum. In Fig. 6 the curve of magnetisation is marked m, as before. C_E is the imaginary exciting current for the assumed condition of no hysteresis in the iron, and is plotted from measurements taken on $h\,o\,b$ in Fig, 5, while C_H is what we may call the hysteresis component of the current, and is also drawn from measurements made on Fig. 5. The resultant, or true magnetising current, is at every point equal to the algebraic sum of these two.

It has been shown that the hysteresis losses, although they occur in the iron only, are equivalent in the exciting coil to a current flowing against the induced E.M.F., it being understood that the E.M.F. applied to the terminals of the coil is such as to force the requisite amount of current against this induced E.M.F. Now, the phase of the induced E.M.F. being always, as previously explained, exactly one-quarter of a period behind that of the magnetism, it follows that the current component C_E is wattless; but if we take the ordinates of C_H and multiply them by the ordinates of the induced E.M.F. curve (not shown), we obtain the rate (in watts) at which work is being absorbed through hysteresis. Note also, that if the frequency remains constant, the induction B (Fig. 5) is a measure of the induced E.M.F., and that the lost watts are, therefore, directly proportional to the product of C_H and B, or to the area of the curve Fig. 5, as already shown.

Although hysteresis has the effect of distorting the magnetising current curve and increasing its area, it does not alter either the position or magnitude of its *maximum* value, which agree always (except when eddy currents are present) with the maximum value of the magnetism. The actual hysteresis and eddy current losses occurring in transformer iron will be found further on, among the notes on practical design.

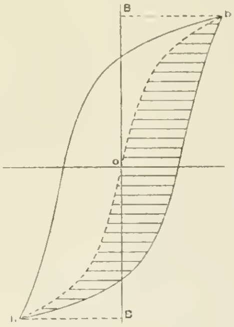

Fig. 5.

Before leaving this part of the subject it may be well to emphasise the main principle governing the flow of an alternating current in a circuit containing self-induction. The varying current produces changes of magnetism, which, again, produce a varying E.M.F. called the E.M.F. of self-induction. This, together with the E.M.F. already existing (and without which no current would flow), produces the *effective* or *resultant* E.M.F. By dividing the value of this resultant E.M.F. at any instant by the total ohmic resistance of the circuit, the corresponding current intensity is obtained. This condition *must* always be fulfilled, otherwise Ohm's law will not be satisfied. With regard to the exact shape of the E.M.F. curves, this will depend, of course, upon the design of the generator. For instance, if the armature has projecting iron poles, the magnetism will enter and leave the coils abruptly, thus producing a *peaked* form of E.M.F. curve, the maximum ordinate of which is considerably in excess of the mean; but with most modern alternators the E.M.F. wave approximates very nearly to the sine curve, which, as is well known, represents the simple harmonic law of variation. This is, therefore, the curve which should be adopted in designing transformers, for, although some alternators may yield an E.M.F. varying in a somewhat different manner, the manufacturer of transformers is not usually supplied with the curve of actual

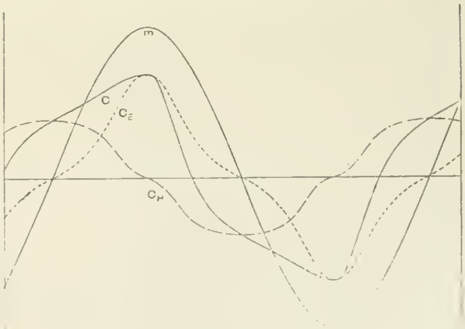

Fig. 6.

variation; and, indeed, he does not require it, as it is more important that his designs should suit the average of English alternators, than that they should apply more especially to some particular law of variation.

However, the advantage of a graphic method of treatment is that any shape of curve can be easily dealt with; the relation between the induced E.M.F. and the magnetism being obtained by drawing a tangent to the magnetism curve at any particular point. The "slope" or "steepness" of this line gives the *rate of change* in the magnetism, and consequently the induced E.M.F. at that moment. If the magnetism is read off in C.G.S. lines, and the time in seconds, the ratio, multiplied by the number of turns of wire in the coil, and divided by 10^8 gives the induced E.M.F. in volts.

Maximum and Mean Values of Current and E.M.F.—The maximum value of the magnetising current in a transformer, or choking coil, is what determines the induction in the core, and for this reason it has frequently to be determined; but, for calculations of *power*, as, for instance, the watts spent by an alternating current in heating the conductor, or in lighting glow lamps, we require to know that value of the current which, when squared, and multiplied by the resistance of the circuit in ohms, will give us the actual power absorbed in watts. This *square-root-of-the-mean-square* value is not necessarily the same thing as the *mean* value. It is obtained by squaring all the ordinates of the current curve, calculating the mean value of these ordinates, and then extracting the square root of this mean. In the case of a sine curve, the *mean* value of the ordinate is $\frac{2}{\pi}$ times the maximum value, whereas the *root-of-the-mean-square* is $\frac{1}{\sqrt{2}}$ times the maximum value, or 1·111 times greater than the mean.

The above remarks apply equally well to the case of an alternating E.M.F. For instance, the deflection of a Cardew voltmeter depends upon the watts spent in heating the wire. These may be expressed as: $\frac{E^2}{r}$ where r is the ohmic resistance of the wire. If E is an alternating E.M.F. the heating effect will depend upon the value of the mean E^2, and the volts read off the instrument will, therefore, correspond with the *root-of-the-mean-square* value of the alternating E.M.F. applied to the terminals.

Hence it is this value, and not the maximum or the true *mean* value, which we generally require to know; and, when an alternating current is spoken of as being so many amperes, or an E.M.F. as so many volts, it must be understood that the $\sqrt{\text{mean square}}$ values are alluded to, unless otherwise stated.

Choking Coils.—A choking coil is simply a means of creating self induction in a circuit. It reduces the current by producing a back E.M.F., and thereby diminishing the effective or resultant E.M.F. in the circuit.

Let N stand for the maximum value of the magnetisation. It is the number of magnetic lines in C.G.S. units, generated in the core of the choking coil, when the current is at its maximum value.

During one complete period, the changes in the magnetism are as follows: first, from zero to its maximum value, and back again to zero; then to its maximum value in the opposite direction and again back to zero. Hence, the total number of lines threaded through the circuit during one complete period is represented by $4\,N$. Let n = the frequency in periods ($\sim$) per second, and T = the number of turns of wire in the coil. Then, since 10^8 lines cut per second generate one volt, it follows that the *mean* value in volts of the E.M.F. of self induction is:

$$\frac{4\,N\,n\,T}{10^8},$$

and, if we assume the sine law to hold good, and make E stand for the $\sqrt{\text{mean square}}$ value of the E.M.F., we obtain the expression—

$$E = \frac{4{\cdot}44\,N\,n\,T}{10^8}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

by the aid of which a choking coil can be designed to produce any required back E.M.F.

Of course this induced E.M.F. is not simply the difference between the volts supplied to one terminal of the coil and those available at the other; it is the square root of the difference of their squares, as will at once be evident by inspection of Fig. 2. There the applied E.M.F. is represented by the hypotenuse of a right-angled triangle, the sides of which represent the induced E.M.F. and the effective E.M.F. It is this last which, divided by the ohmic resistance of the circuit, determines the current which will flow.

For instance, consider a 10-ampere arc lamp on a 100-volt alternating-current circuit, containing a choking coil to reduce the volts to 45. This coil must be designed to produce a back E.M.F., not of $(100 - 45) = 55$ volts, but $\sqrt{100^2 - 45^2} = 89$ volts, which is considerably greater.

It will probably be found, on applying formula (1), that a closed magnetic circuit is not suitable in this case, as the number of turns, T, must be small in order to keep the induction in the iron within reasonable limits, and consequently N and the cross section of the core will be very great. But by introducing a small air gap in the magnetic circuit, the resistance of the latter may readily be increased so as to allow of a proper number of turns being wound on the core.

Calculations of N must be made in the usual way from measurements of the magnetic circuit, and with the aid of curves giving the relation between induction and exciting force, for the iron used; or the following empirical formula may be adopted: it gives the ampere turns required per inch length of the iron circuit, and applies to a very good quality of transformer iron:

$$\text{Amp. turns per inch} = \frac{B}{10{,}000} + 2, \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where $B_{''}$ = the induction in the iron, in C.G.S. lines per square inch of cross section.

For an average quality of transformer iron, the formula:

$$\text{Amp. turns per inch} = \frac{B}{9{,}000} + 3, \quad . \quad . \quad . \quad . \quad . \quad (3)$$

is, perhaps, more generally useful.

These rules apply only to cases where $B_{''}$ lies between about 12,000 and 40,000; they are based on the assumption that the curve connecting exciting force and induction is a straight line between these limits.

For air, the formula:

$$\text{Amp. turns per inch} = 0{\cdot}313\,B_{''}, \quad . \quad . \quad . \quad . \quad . \quad (4)$$

is true for all values of $B_{''}$.

For purposes of calculation of the number of turns T required to give the necessary magnetising force, it will generally be sufficiently accurate to assume the maximum current value to be 1·4 times the $\sqrt{\text{mean square}}$ value.

Transformers.—Consider a transformer, of which the primary winding is connected to constant pressure mains, and from which no secondary current is taken. Under these conditions the primary circuit acts simply as a choking coil, of which the self-induction is so great, and the ohmic resistance relatively so small, that no current passes, except the very small amount required to magnetise the core. The induced E.M.F. is therefore practically equal and opposite to the applied E.M.F., and the formula (1) still holds good, if we make E stand for the E.M.F. supplied to the terminals of the transformer.

The current in the primary will grow until it is sufficient to produce the magnetisation N indicated by formula (1). On account of the large number of turns of primary wire this current will be very small. It should be plotted, when required, from the hysteresis curve of the iron used; or it may be calculated as follows:—

The *wattless component* (see Fig. 6) is obtained by dividing its *maximum* value, as given by formula (2) or (3), by 2·6, which is a constant, found to be about right for the low inductions generally used in transformers, but which has no physical meaning whatever; for, if high inductions were used in the iron, the maximum value of the current might be many times greater than its $\sqrt{\text{mean square}}$ value, thus rendering the above rule worthless.

The *hysteresis component* of the magnetising current is obtained by dividing the total open-circuit loss in watts by the E.M.F. in volts supplied to the transformer.

The *true magnetising current* is the resultant of these two currents, differing in phase (as shown in Fig. 6) by one quarter of a period, which we may represent graphically as an angle of 90°. Hence—

$$C_M = \sqrt{C_E + C_H} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Where C_M = true magnetising current.
C_E = wattless exciting current, on the assumption that hysteresis is absent.
C_H = hysteresis component of total current, or that portion which, multiplied by the E.M.F., gives the open circuit loss in watts.

Dr. J. A. Fleming has given the name of *power factor* to the ratio of the *true watts* to the *apparent watts* supplied to a transformer on open secondary circuit. The *apparent watts* being the number obtained by multiplying the applied E.M.F. by the total magnetising current.

The ratio $\frac{C_H}{C_M}$ gives us the power-factor, which, in a good transformer with closed iron circuit, is generally about 0·7; hence, if we divide the watts lost in the iron by the primary E.M.F. and again by 0·7 we obtain a very fair approximation to the true magnetising current. Note also that the number 0·7 being very nearly $\frac{1}{\sqrt{2}}$ applies to the case in which the wattless component and the hysteresis component are equal.

A small power-factor is no indication of low efficiency in a transformer; it is the result of a large wattless component of the current, which may lead to a slight increase of loss in the mains, but is otherwise of little or no consequence.

Effect of Closing the Secondary Circuit.—Since the secondary and primary coils are both wound on the same core, it follows that any variations in the magnetism will produce an E.M.F. in *both* circuits; also, the actual volts induced will be directly proportional to the number of turns of wire in the coil.

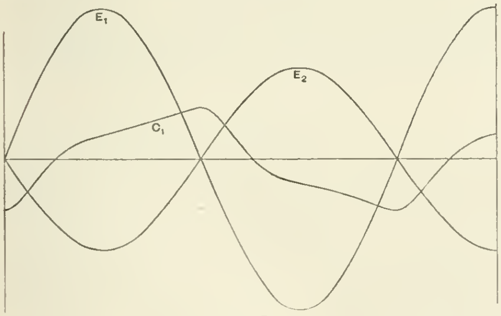

Fig. 7.

On closing the secondary circuit through a resistance the resulting current will produce a magnetising force in the core. This magnetising force will not produce a change in the magnetism, because it will be instantly counteracted by a change in the primary current, which will so adjust itself as to maintain the same (or nearly the same) cycle of magnetisation as before, this being the only possible way by which Ohm's law will continue to be fulfilled in the primary circuit.

The curves, Figs. 7 and 8, show the action of a transformer on open secondary circuit and on full load.

In Fig. 7, E_1 is the curve of primary impressed E.M.F., and C_1 is the magnetising current, distorted as in Figs. 4 and 6 by the hysteresis of the iron core. E_2 is the curve of secondary E.M.F., which coincides in phase with the primary induced E.M.F., and is, therefore, on account of the comparatively small ohmic resistance of the primary, almost exactly in opposition to the impressed E.M.F. The curve of magnetisation (not shown) would be exactly one quarter period in advance of the secondary E.M.F.

In Fig. 8 the secondary circuit is closed through its proper load of incandescent lamps. There is no appreciable self-induction in such a circuit, and the secondary current will therefore be in step with the secondary E.M.F. For simplicity it is represented in Fig. 8 by the same curve as E_2.

The tendency of this secondary current, being to weaken the magnetism in the core, and therefore diminish the primary induced E.M.F., it follows that the current in the primary will grow, until the magnetism is again of such an amount as to restore balance in the primary circuit. Hence, neglecting the small loss of volts due to the increased primary current, the induction through the primary must remain as before; and the new current curve, C_1 (Fig. 8) is obtained by adding the ordinates of the current curve in Fig. 7 to those of another curve, exactly opposite in phase to the secondary current, and of such a value as to produce an equal magnetic force.

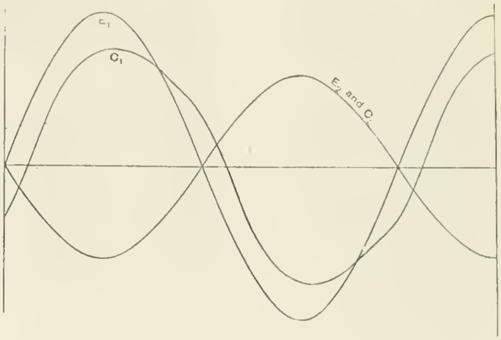

Fig. 8.

(To be concluded.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, November 16th.

Institution of Civil Engineers.

8 p.m. Students' Meeting. The following Paper will be read: "Economics of Direct-Current Central Stations," by John F. C. Snell.

Institution of Junior Engineers.

8 p.m. Meeting at the Westminster Palace Hotel. Presidential address by Mr. Alexander Siemens.

TUESDAY, November 20th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. The following Paper will be read with a view to discussion:—"The Machinery of War-Ships," by Albert J. Durston.

WEDNESDAY, November 21st.

Royal Meteorological Society.

7:30 p.m. Ordinary Meeting at 25, Great George-street.

Society of Arts.

8 p.m. Ordinary Meeting. Opening address by Maj.-Gen. Sir John Donnelly.

Royal Microscopical Society.

8 p.m. Meeting at 20, Hanover-square.

THURSDAY, November 22nd.

Institution of Electrical Engineers.

8 p.m. Ordinary Meeting. The following Paper will be read:—"Electrical Steep Grade Traction in Europe," by Charles S. du Riche Preller. After which, discussion will take place on (1) "Notes on Electric Tramways in the United States and Canada," Supplementary Paper), by H. D. Wilkinson. (2) "Electric Traction, with special Reference to the Installation of Elevated Conductors," by R. W. Blackwell and Phillip Dawson.

FRIDAY, November 23rd.

Physical Society.

5 p.m. Meeting at rooms of the Chemical Society, Burlington House. The following Papers will be read:—(1) "The Measurement of Electromagnetic Capacity," by Fred. Womack. (2) "Mirrors of Magnetism," by Prof. S. P. Thompson and Miles Walker. (3) "Students' Simple Apparatus," by Prof. W. E. Ayrton and Others.

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AN OUTSTANDING PROBLEM.

The progress of the engineering of electric lighting has left, and still leaves, a number of outstanding or residual problems which may be considered to form a sort of residuary legacy to be carried forward to the account of the future. Many of these problems are of comparatively trifling importance, others are momentous ; some of them have been partially solved and then shelved, others have been cast aside in all their initial nakedness and rawness. Of these outstanding problems there is one not even partially solved, but which is worthy of more than the trivial attention which is usually devoted to it. Hitherto, in fact, engineers have scarcely recognised it, save, perhaps, as an inheritance for the dim and distant future ; and it has been divided between the theoretical experimentalist and the unscientific enthusiast. Exactly stated, this is the problem of exciting definite single waves of radiation, simple waves of one given wave-length. Popularly, but erroneously, stated, it is the problem of producing light "without heat" ; but, inasmuch as a given quantity of luminous radiant energy will produce just as much heat as, and no more than, an equal quantity of non luminous radiation, the problem is seen to be one rather of producing light without *unnecessary* heat. What is really desired is to be able to transform any amount of non-radiant energy into an equal amount of radiant energy, of an absolutely controlled character as regards wave-length.

The difficulty of exciting an harmonic variation in any energy medium does not, however, restrict itself to the particular medium which transmits light, nor to those particular wave-lengths which are emitted from heated or luminous bodies. On the contrary, it presents itself at almost every place where it is sought to propagate energy by harmonic variations of any medium. It is admittedly difficult, if not impossible, to produce a pure and simple sound; and the strident notes of the abominable tin whistle are said to depart least of all from acoustic simplicity. Sonorous harmonics, overtones and under tones—audible, and doubtless supra-audible and infra-audible—inflict themselves on every apparatus wherein the attempt is made to produce a simple acoustic wave. In mechanism of the grosser kind, as, for example, the piston of a steam engine, a simple harmonic motion is often difficult or impossible to obtain, though, of course, the difficulties here are not, generally speaking, as great as in the physics of sound, light, or electromagnetic waves. Even in the exalted attainments of alternate-current electrical engineers, we are bound to confess the limitations which the difficulties attending the production of the "true sine curve" impose. And here, too, in the wasteful phenomena of eddy currents and line loss, the objectionable consequences of a lack of perfect control over the nature of the harmonic wave make themselves felt.

So much, then, for the difficulties of this problem where the apparatus is of the same order of magnitude as man himself, and where the design and working of it are more or less under his control. But, in the phenomena of luminous radiant energy, the apparatus is of atomic and the so-called sub-atomic magnitudes; and the design of it is completely, and the mode of working of it is well-nigh completely, beyond the power of man to control. Whether the source, or engine, of the radiation is a solid or liquid (a complex atomic structure) or a gas (a less complex structure) the engine has, speaking anthropomorphically, ideas of its own, eternally and ineradicably involved in its structure, as to how it should vibrate and propagate ether waves. Tickle and agitate the atoms as he may, man will find it uncommonly difficult to persuade them to vibrate precisely according to his wishes, unless those wishes happen to correspond with what is equivalent to their own. Of the barbarous and indiscriminating mode of producing light from solid bodies by heating them, and thus agitating their molecular and atomic structure in a haphazard and unguided fashion, it may only be remarked that atomic structures so unsystematically dealt with cannot be expected to produce efficient or satisfactory results. As well expect to produce a pure middle C by shaking peas in a tin canister.

The problem appears to have the greatest difficulty in relation to solids and liquids; least in relation to gases. The former are of a more complex structure, their atomic and molecular motions are more irregular than the latter; while in the latter the particular wave-lengths which arise when radiant energy is emitted are comparatively few in number. Yet it is from the heated solid that a far greater percentage of luminous radiation is obtained than from the scarcely glowing heated gas or vapour. But, then, heating, as an ideal excitant of luminous radiation, is out of the question; and it would appear, from the researches which have yielded any fruit up to the present time, that when more systematic and scientific excitants—such as are proposed by Hertz, Lodge, Tesla, and others—are used, gases are nearly, if not quite, as good for the purpose as other substances. It is in the fewness of molecules and the simplicity of molecular structure that the hope of solving the problem mainly appears to lie.

It may be objected that the terms of the problem, as stated by us, are too narrow: that what is wanted is, not so much a complete control over every wave-length of the radiated energy as a power to restrict the wave-lengths between certain limits; namely, the limits of visibility on the spectrum. The answer to such an objection is, that the latter implies and of necessity involves the former by inclusion. To be quite sure of having transformed all the available energy into light it would be necessary to have complete control over the character of the wave produced; and this would be impossible without complete control over each and all of its components. The engineer ought to be able to draw up a balance sheet, perfectly accounting for every foot-pound of the radiation, just as he can produce a balance-sheet to account for the heat developed in a boiler furnace.

Again, it may be objected that we have been stating an ideal which is quite beyond the power of man to attain. Granted: this is the fate of most, if not of all, ideals; but ideals are not on that account of no value. On the contrary, it is by the recognition of the conditions of the ideal that the best and most methodical improvements can be effected in the real. Two lines of research tending towards this ideal are being engaged in at the present time. The first, the chief line, and the one which seems most likely to yield the best results, is the attempt to excite definite radiation by directly electrical means; and the second consists in heating to incandescence solid bodies, which possess an abnormally high coefficient of emissivity. The latter has, of course, the demerit of producing light by the objectionable aid of heat; but, waiving this for the moment, it is seen to have several points of interest. In an article by Messrs. Nichols and Crehore, on "Studies of the Lime Light," in the current issue of the *Physical Review*, attention is drawn to the remarkable fact that lime and other earthy oxides possess the property of emitting, for a short time after the commencement of their exposure to an oxyhydrogen flame, a very abnormally high degree of incandescence. Thus, in ten minutes from the moment of ignition, the light fell from about ten per cent. to about three per cent. of the total radiation, and at the end of half an hour it had fallen to a steady value at about two per cent. Subsequent cooling and exposure to the air enabled the lime to recover this property of abnormal emissivity, the degree of recuperation varying in different samples of lime cylinders. Certain inventors have found that in some oxides the excessive emissivity is not only well marked but more permanent. Certain it is that in this selective physical property we have one step towards the ideal of the excitation of definite waves, for this property consists in the intensification of the luminous, and especially the violet, part of the spectrum. In one of our Notes this week mention is made of an attempt to use carborundum for a similar purpose in the carbons of an electric arc. The writer erroneously uses the term "luminescence" to convey the idea of emissivity; but the two ideas are by no means identical. An example of true luminescence is to be found in Herr Ebert's beautiful lamp, which was described in our columns a few weeks ago. In that lamp visible radiation from the so-called luminous paint is excited by non-luminous electromagnetic waves. Other examples occur in the phenomena of the electric discharge in high vacua. These phenomena, taken all together, seem to point to the fact that it is not impossible to reduce the molecular structure of a substance, whether of solid or gas, to such a condition as that, temporarily at any rate, it will emit an abnormally large proportion of luminous radiation. If so, one of the practical phases of the problem immediately before us is, to contrive to stimulate visible radiations and if possible to make that molecular condition permanent.

LIGHT RAILWAYS.

The Board of Trade "Light Railway" Conference will meet at 8, Richmond-terrace, on Thursday, December 6th, at 11 a.m.

The article below from *The Times* of Friday last, and the selected correspondence by which it is followed, will, we venture to think, be of some interest and value to our readers. Electric traction has now a unique opportunity of bringing itself to the notice of the public. In the same pertinacious way that the advantages of electric lighting have been dinned into the ears of town councillors must the unequalled advantages of electric traction be urged upon agricultural local authorities :—

It is only right that *The Times* should cordially welcome the proposal of the Board of Trade to convene a conference on the subject of light railways. It was by articles published in *The Times* at Easter of this year that the subject was first definitely brought before the public in a concrete form, and those articles have since then been quoted and commented on in newspapers and at meetings in all parts of the country. Last July the Royal Commission on Agriculture took, as was suggested in *The Times*, evidence on the subject, and it is understood that it intends to go further into the subject when it resumes its meetings after the recess. The House of Commons, too, has not remained a stranger to the discussion, for towards the end of last Session a voluntary committee formed itself, with Mr. Storey as hon. secretary, and approached the Foreign Office with the idea of obtaining information as to the present position of affairs in foreign countries. The Board of Trade, therefore, are undoubtedly correct in believing that the subject is one of considerable public interest at the present time. Still, it is impossible to suppress all doubts whether their method of going to work is the best that could be devised. Mr. Storey's committee, perhaps, were wiser when they decided that the first thing to do was to obtain information. Whether the information that they will obtain through our diplomatic and consular agents abroad will be of the slightest value, when obtained, is a separate question—a question to which those who know what previous Foreign Office reports on railway subjects have been worth can have only one answer, and that, unfortunately, not an affirmative one. But, for all that, preliminary information, collected on the spot, not by young attachés but by competent railway experts, is what we want. At present, on the practical side of the question, we have no experience available in this country as to railways without fences or stations, and a suggestion to run a train of seven or eight carriages down the High-street of a market town—a thing habitually done all over the Continent—would probably be regarded by an ordinary mayor and corporation simply as proof of sheer insanity on the part of its maker. Then there is the same absence of authoritative information on the political and legislative side of the question. There are probably not three men in this country who have read the text of the French Light Railway Bill of last session, or who know what is proposed in the Bill on the same subject just prepared for submission to the Austrian Parliament. It would seem, therefore, as though we were hardly far enough advanced at this moment for a conference to produce definite practical results.

There is another point. It may be doubted whether the proposed conference will not be of too miscellaneous a character for satisfactory discussion. Some of the delegates, one cannot but think, ought not to be there at all. If there be one public body on the face of this globe more unconcerned with the question of light railways than another, it is surely the London County Council; and because a few members of that body have been so supremely ignorant of the question as to imagine it possible that light (that is, cheap and simple) railways could be constructed inside the county of London, that was really no reason for inviting the London County Council to send delegates in its own name, while giving to the counties directly concerned nothing but indirect representation through the County Councils' Association. And, though the claims of all the other bodies to representation are undeniable, it is evident that most of them are entitled to express opinions only on one side of the question. For example, the views of the Associated Chambers of Commerce on the subject of facing point locks or the necessity for starting-signals are really of no particular value, while, on the other hand, the answer may be taken for granted which the Railway Association would give to a question whether interest on the capital they may spend on new railways in poor districts ought to be guaranteed by the public authorities. In fact, it would seem as though the subjects for discussion divided themselves into two separate heads, the one technical, the other what a German professor would describe as economico-politico-legal, and that each head should be dealt with separately by separate sets of people.

It is, however, too late to alter this now, and, after all, English men of business have a wonderful knack of working out practical results, even without employing the ideally best methods. Possibly the conference, when it meets, may see its way to appointing two or three committees to accumulate information on the separate branches of the subject, and report again to the conference at a later date. The task of a technical sub-committee such as is here suggested, though, of course, not an easy one, would at least be confined within precise and manageable limits. It would deal in the first instance with the construction of light lines. It would make positive recommendations on such questions as gauge, the necessity or non-necessity of fencing, of gates at road-crossings, of platforms and station buildings, and would propose a normal type and weight of permanent way. Then, secondly, it would deal with the working of these lines when made, and draft a new code of rules on the subject of signalling, interlocking, block-working, and so forth. It would discuss the best pattern of rolling stock both for goods and for passengers, and the modifications in our normal methods of ticket issuing, account keeping, staff organisation, and so on, made necessary by the cheap and simple character of the proposed new lines. Such a report, to be of real value, must be made by men who can combine a good general knowledge of what is being done at present abroad with a practical familiarity with English conditions as now existing at home, and who can add to both sufficient insight and imagination to appreciate how far Continental methods must necessarily be modified when brought into contact with our English habits and ideas, or, it may be, prejudices. Another sub-committee might be imagined dealing with a wholly separate set of questions. First and foremost, who is to find the money for these undertakings? In every other country—Holland is the nearest approach to an exception—it has been found necessary in some form or other to pledge the public credit. Is there any reason to hope that commercial enterprise will do the whole work here unaided? If public assistance is to be given, what form is it to take? A gift of money out and out, a subscription for ordinary shares of the undertaking, or a guarantee of minimum interest on shares issued in the ordinary manner on the Stock Exchange, after the fashion of the Irish Act of 1883? And, if public assistance is to be given, who is to give it—the State or the counties or the municipalities and districts, or some combination of all these, and, if so, what combination? An equally important point is the question—What control is to be reserved to the public authority in return for its assistance? Mr. Balfour's Act of 1889 gave money out and out to the Irish companies, reserving to the public no exceptional rights of control in return. It may be that the precedent is one to be followed; but at least the matter deserves more discussion than was possible at the fag end of the Session of 1889. Yet another point—Should the control, whatever it is, be in the hands of the central Government or of some local authority? The legislation of France and Prussia differs in most things, but agrees in this, that, while ordinary railways are a matter for a Minister of State to manage, light railways are of purely local interest, and may safely be left in charge of the local authorities.

It may be thought that a sufficient programme for sub-committee No. 2, if we may so call it, has already been sketched out; so, perhaps, it would be as well to appoint a third, this time composed of railway men and engineers and what may be called public representatives jointly, to discuss a third series of questions. One of the most important of them is the question how far it would be possible in England to lay railways along the public roads; whether there would be any real economy in doing this if practically possible; and, if so, under what conditions, and subject to what terms imposed by or on behalf of the road authority, such lines should be made? Another equally important question is that of rates and fares. Are these new railways to be integral parts of the existing system, subject to the ordinary requirements of the Traffic Act as to through booking and so forth, or, on the other hand, independent concerns feeding the railways in the same way that the carrier's cart does now, only on a somewhat larger scale? Are the rates and fares to be fixed on the high standard which alone is possible if the line is to yield a commercial return, or are they to be kept down to a non-paying point, in the hope that the indirect gain to the neighbourhood will more than counterbalance the direct obligation on the taxpayers or ratepayers to make up the difference? In other words, are these light railways so far analogous to roads that it is reasonable to put them in the same category with roads and to charge their maintenance—maintenance, of course, as distinguished from out-of-pocket cost of transport along them—on the general rates of the district? The question, also, by whom these lines should be worked is one of great importance and cannot be left for decision till the lines are made; for, if they are to be worked by the great companies with whose lines they connect, they will be built in one way; if by a separate light railway organisation they will be built in another. Probably the idea that they can be worked each as a separate and independent entity need not be seriously discussed; nor is the time ripe for a proposal that the local authorities should work them themselves.

There is another question that the Board of Trade has set down for discussion, which really seems—if indeed the question be not too plain for argument—not to belong to the province of any of all the authorities who are summoned to the conference. It is proposed to discuss "whether additional legal facilities for obtaining powers to construct tramroads and light railways are necessary or desirable." Probably the body best qualified to answer this question would be the Society of Parliamentary Agents. They would be able, doubtless, to tell the Board of Trade and the conference that the Railway Construction Facilities Acts and the light railway clauses of the Railway Regulation Act of 1868 have been a dead letter from the beginning, and that a line constructed under the Tramways Act, with the limitations of speed, &c., therein imposed, with no power to take land compulsorily, and no right to charge terminals, is, except under special circumstances, a practical impossibility. Whatever be the theoretical possibilities under these Acts, the fact that they have absolutely failed to promote the growth of light railways such as exist in every other country is written large over the face of the entire kingdom, plain for all folks to see; and, were it only as a matter of sentiment, it would be well to commence *de novo*, and not hamper the new enterprises by associating them with the abortive legislation of the past.

TO THE EDITOR OF "THE TIMES."

SIR: Having been a member of a committee desirous of securing a light railway in an agricultural district, I think it advisable that the public should know some of the difficulties met with now that this question is being so discussed.

The question of gauge was decided emphatically in favour of the standard 4ft. 8½in., a narrower gauge necessitating breaking of bulk and damage at main line junctions. Few places are more than 12 miles from a present station, and it would pay better to cart coal and agricultural produce the whole way than to incur this additional expense and damage.

The question of wider gauge was not considered prohibitive in making a cheap line. The principal objections were:—The high cost of application to Parliament: the drawing of plans and formula at present in vogue: non-agreement of some owners to allow land to be taken cheaply; and, chiefly, through engineers being obliged to avoid level crossings, steep and frequently-changing gradients and sharp curves, causing deep cuttings and high embankments.

Railways could be made at a cost of less than £5,000 a mile if the Board of Trade would be less exacting in their requirements, and county councils could grant the right of making lines and compulsory taking of land for such purpose on a simple arbitration basis at market value; not paying fictitious severance damages, but being allowed to set off against the damages the advantages accruing through having a railway.

If the present neighbouring companies were compelled to work these light lines to best advantage on easy terms at cost price, there is no reason why they should not pay a fair profit, more especially if county councils were allowed to advance or guarantee money at 3 per cent. to make them and charge part or whole on the rates of the district served, Government also granting subsidies, where necessary, from the land-tax of the districts, now excessively high through agricultural depression.—Yours truly,

Great Bardfield, Essex, November 8th. A. E. ADSHEAD, J.P.

ELECTRIC TRACTION, WITH SPECIAL REFERENCE TO THE INSTALLATION OF ELEVATED CONDUCTORS.*

BY ROBERT W. BLACKWELL AND PHILIP DAWSON.

(*Continued from page 46.*)

Of that important factor, the trolley wire itself, little need be said. The universal American practice is to employ No. 0 hard-drawn copper. Many Continental lines have employed lighter trolley wire—in some instances as small as 6mm.—and some use larger. It may be taken, however, that No. 0 is the size that gives the best all-round results. Phosphor-bronze is of doubtful utility as a substitute for hard-drawn copper, the increased tensile strength being more than over-balanced by the reduction in conductivity. The manufacturer of the trolley wire should guarantee 98 per cent. conductivity or better, and perfect joints, and should deliver wound on special reels in mile lengths. Good running and a low rate of depreciation depend largely upon the exactitude with which the trolley wire follows the line of the metals, and pains taken to ensure a smooth and even path for the trolley wheel are always well repaid.

In the selection of the line of appliances to be used, the nature and needs of the individual road must be borne in mind. For a suburban line and light traffic, where economy in first cost is a first requirement, this "Ætna, A type," insulator serves the purpose well. You will see that the series in this type includes a straight-line insulator, single and double pull-off for curves, and a bracket arm hanger. In this type, the homogeneous mass of insulating material, while still in a plastic state, is forced under heavy pressure into a casting provided with internal flanges to hold it securely in place, and external points to which the span or strain wires may be attached. The threaded thimble is moulded into the insulating material at the same time. The threads are made to take $\frac{5}{16}$ or $\frac{3}{8}$in. screw studs, according to the strain they are to sustain. The metallic parts, which partially protect the insulating substance, are of either bronze or malleable iron. In this type the strain and weight of the trolley wire is taken by the insulating material itself. This is the type of insulated suspension employed by the South Staffordshire, Douglas and Laxey, and Guernsey lines, and many Continental and colonial roads.

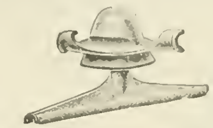

FIG. 2.—"Ætna A" Straight Line Insulator.

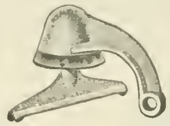

FIG. 3.—"Ætna A" Single Pull-off.

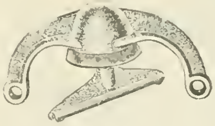

FIG. 4.—"Ætna A" Double Pull-off.

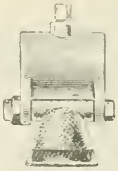

FIG. 5.—"Ætna A" Bracket Arm Hanger.

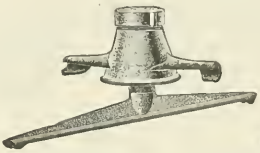

FIG. 6.—"West End" Straight Line Insulator.

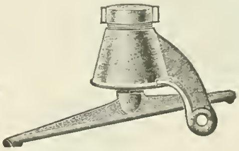

FIG. 7.—"West End" Single Pull-off.

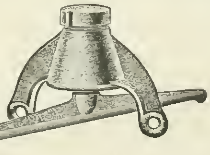

FIG. 8.—"West End" Double Pull-off.

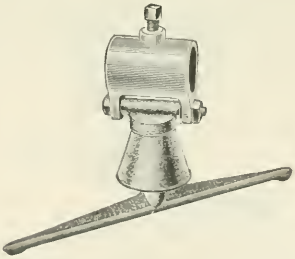

FIG. 9. "West End" Bracket Arm Insulator.

To supply the needs of tramways where constant and heavy traffic is to be expected, and where security to the service is of far more importance than small economies in first cost, the "West End" type of insulating material has been evolved. This series is more elaborate than the former, comprising a straight line insulator, single and double pull-off, bracket arm hanger, and bridge, spring bridge, and car house insulators. These are far more substantial than those first described. The essential difference in construction is that the insulation is wholly protected from injury from exposure or chance blows by a metallic skirt, and that no part of the strain comes upon the insulating material itself, the load and strain being wholly taken under all circumstances by the heavy metallic parts of bronze or malleable iron. The insulating part is a bronze or steel bolt, heavily coated under pressure with non-conducting material, the head of which fits closely into a recess at the top of the protecting casting, and is firmly held there by a screw cap. These bolts are interchangeable throughout, and can be slipped in or out at any time. When it is desired to bring a feeder into the line the insulating bolt is slipped out, and a metallic "feeder plug" of exactly the same size takes its place, this throwing the whole hanger into circuit, and allowing an insulated feeder wire to be attached to it in exactly the same way as an ordinary span wire would be.

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* Paper read before the Institution of Electrical Engineers, Thursday, November 8th.

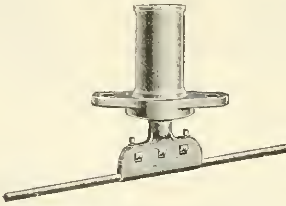


Fig. 10.—"West End" Spring Bridge Insulator, with "Anderson" Mechanical Ear.

A special tool is used in putting up "West End" straight line hangers, and much facilitates the labour of erection. The casting is held in the fork at the top of the tool. The span wire fits into the groove of the wheel, and a single movement of the lever snaps the wire into position. By the use of this "West End" type of apparatus, the span wires can be erected, and the castings inserted at the fixed points of suspension, before the insulating material is brought on the line. Ears can be soldered to the trolley wire and attached to the insulator afterwards, and there is a minimum of leakage through moisture. As an illustration of the care taken to supply each need, I would call your attention to the "spring bridge" insulator, used under bridges and elevated railway structures and in tunnels. As the fixture is, of necessity, rigidly attached to the structure above the line, a yielding support is provided in order that the trolley wheel, at high speed, may not strike a point without flexibility and have a tendency to jump the wire. The spring is protected by a galvanised iron case, and the insulating bolt within has a fluted metal covering, which preserves the insulation from injury by chafing, and prevents the bolt turning.

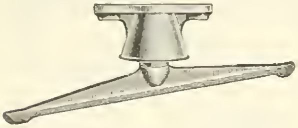


Fig. 11.—"West End" Bridge Insulator.

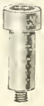


Fig. 12.—"West End" Insulated Bolt.

The use of high-class line material greatly facilitates both construction and operation, and in no part of the equipment can a little additional expense be incurred with such good reason.

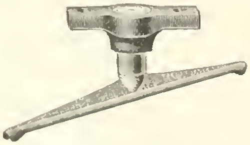


Fig. 13.—"West End" Car House Insulator.

Note how carefully the makers of both the above types of apparatus endeavour to bring span wire and trolley wire close together. Earlier styles did not possess this virtue, the span wire being led over the top of the insulator. Experience quickly showed that it was an error to separate span and trolley wire more than absolutely necessary. To connect the trolley wire with its insulated supports, ears, or clips, are used, of which a number of varieties are on the table.

For efficiency, durability, and smooth running, nothing quite equals an ear soldered to the trolley wire, and soldered ears are almost indispensable at curves or points of heavy strain. However, it takes skilled labour and quite one third longer in time to erect a line using soldered ears throughout. I would especially call to your attention the fact that the blow pipe must not be used in erecting a trolley wire with soldered ears; but, instead, heavy grooved soldering irons, like the one shown, must be employed. The use of the blow-pipe softens the wire and renders it liable to break.

A trolley wire must be "anchored" at least every mile of straight line, and always at either end of every curve. Special ears are provided to which the anchor wires can be readily attached.

Special ears are also used for joining together lengths of trolley wire. Joints should always be made at fixed points of support. A properly soldered combination anchor and splicing ear is on the table. Other ears are used for points where it is desired to make connection with feeders. Trolley wire soldered ears are made 7, 9, or 15 inches long. Samples are shown of the regular soldering and span wire work of the linemen of the Boston tramways.

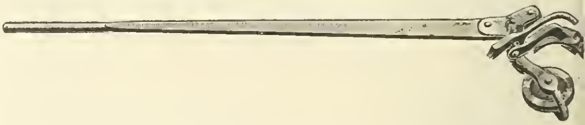


Fig. 14.—Special Tool for putting up "West End" Straight Line Hangers.

The perfect mechanical ear has not yet been evolved, although improvements are constantly being made. Several types are on the table. The difficulty is that all mechanical ears interfere more or less with the smooth under surface of the trolley wire; and any obstruction, however slight, to the passage of the wheel is a disadvantage. This "Badger" mechanical ear is simple and effective. It is composed of two interlocking plates of malleable iron or bronze, which, when placed together, leave a groove into which the trolley wire is clamped by the wedge-shaped stud of the insulator being forced into the jaws formed by the upper portion of the two plates. A pin through the stud holds the ear and stud together. Another exhibit shows the same clamping principle applied to a hinged ear, a screw stud set in the insulator being substituted for the wedge, and the pin being dispensed with. Another type shows the clamps held together by screws. The "Anderson" mechanical ear is composed of a bronze casting grooved along its lower surface to fit the trolley wire, and a plate of hard-rolled copper bent to fit over the trolley wire, and furnished with eyes which close over slotted projections on the casting. The whole is bound together by forcing the eyes into the slots by the small screw bolts at the top of the casting. A special clamp is used to force the copper plate into position and hold it until the screws have been set up. The number of mechanical clips is legion, but none are quite up to the soldered ear. Mechanical ears are good or bad in proportion to the extent to which they interfere with the smooth running of the trolley wheel and necessitate bending of the wire. The latter is always a mistake, because, if it happens that the position of an ear has to be changed, a kink is left in the wire. It is also an error, frequently made in early days, to allow any play or joint between the insulator and the ear.

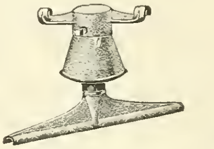


Fig. 15.

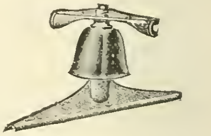


Fig. 16.

Old-Type Straight Line Insulators.

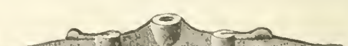


Fig. 17.—Anchor Ear.

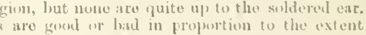


Fig. 18.—Splicing Ear.

By the courtesy of Mr. I. Everson Winslow we are enabled to exhibit to you a series of the Thomson-Houston insulated suspensions employed by him in the erection of the elevated conductors for the Roundhay tramway line at Leeds. In the straight line insulator, and single and double pull-offs, the strain is taken by malleable iron or bronze castings, which spread out sufficiently to protect the insulation from accidental blows from the trolley, and to form a water-shed. A cap of insulating material, from which projects a screw stud, fits closely over the top of the casting, and the recess beneath receives a cone of the same insulating substance, through the centre of which the stud passes. When the ear is screwed upon the stud the whole is bound tightly together. Some of the insulators shown have been in regular use at Leeds for three years, and show no sign of deterioration. A bracket arm insulator, anchor ear, splicing ear, and an aerial frog, as used at Leeds, are also before you. Earlier Thomson-Houston forms, showing porcelain insulation, instead of the material now used, are also exhibited.

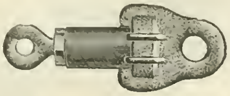


FIG. 19.—"Brooklyn" Strain Insulator.

Dr. Edward Hopkinson has been kind enough to send us this insulator and mechanical ear used by the Isle of Man Tramways. It is somewhat similar to the "Anderson" ear already described, but of stronger construction. It must be borne in mind that the Douglas and Laxey line employs a sliding contact, and not a wheel. We have been unable to obtain one of the Douglas collectors for exhibition to you, as no spare ones were at hand.

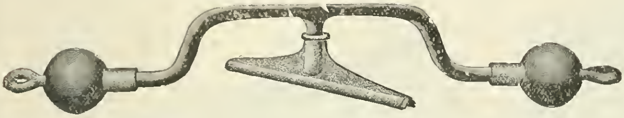


FIG. 20.—"Goose-Neck" Double Curve Pull-off.

Double insulation is an essential feature of first-class overhead line work. This is effected by supplementing the insulated trolley wire supports by an additional insulator at the pole-head. The "Brooklyn" strain insulator and turnbuckle combined is the best device for this purpose. Aside from its insulating qualities, a pair of the smaller size shown will take up 6in. of slack in the span wire. This is extremely useful in adjusting tension, when the span wires have become stretched by constant use. The larger size is adapted for terminals, and for corner poles to which a number of curve pull-off wires are carried. The "King" insulated turnbuckle is a device of similar nature, and strain insulators of the various types are also frequently used. All globe and strain insulators, by the way, are constructed so that, should their insulation be entirely destroyed, their interior metallic parts would interlock and prevent the line falling. Sections and parts of insulators by a number of makers are on the table.

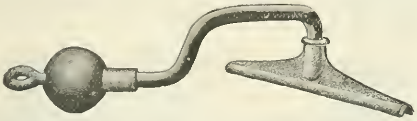


FIG. 21.—"Goose-Neck" Single Curve Pull-off.

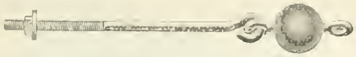


FIG. 22.—Globe Pole Insulator.

In cases where the trolley wire is supported by bracket arms double insulation is obtained by the use of a tube of insulating material within the sleeve of the bracket-arm hanger. In this connection we would warn you against the frequent mistake of fixing bracket-arm insulators to predetermined points of the bracket. A sleeve which will slide along the projecting arm easily should always be used, as nothing but observation of the trolley wheel as it passes under each bracket can determine the exact point at which the hanger can be most advisably fixed. This feature is also apparent in the Thomson-Houston type of bracket arm hanger from the Leeds line. In this appliance double insulation is obtained by washers and tubes of insulating material, which prevent metallic contact between the upper casting in which the sleeve is formed and the lower casting from which the ear depends.

A trolley wire of any considerable length should always be divided up into sections, so that an accident should not cause the whole line to be thrown out of service. Several types of section insulators are before you. Connection between the two sections of trolley wire is made or broken through a switch contained in a box on the nearest pole. The earlier type shown, made of brass sections insulated from each other by mica, is somewhat clumsy. You will note that the insulation of the two later forms is effected by bolts similar to those used in the "West End" hangers, and that the latest and most improved type has the greatest advantage of being "straight under-running," allowing the trolley wheel to pass under it without the slightest "dip."

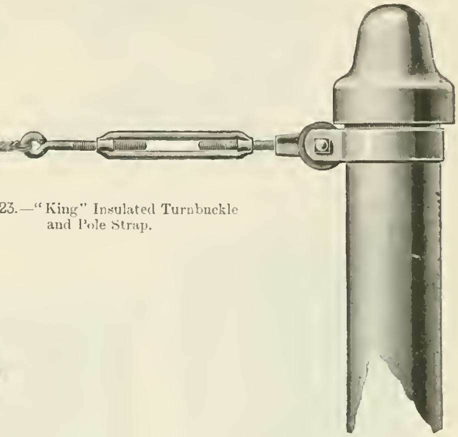


FIG. 23.—"King" Insulated Turnbuckle and Pole Strap.

This device is strong and durable. The wooden piece between the terminals is renewable, and can be changed while on the line. A convenient clamping device renders it possible to leave enough trolley wire coiled on top of the section insulator to allow of its being let out to repair the line in case of a break. Another part of this combination clamp holds the feed wire in such a way as to obviate the necessity of stripping the insulation from the wire, except at the part held by the clamp. By this arrangement the feed wire is left insulated from the poles to the section insulators, and between the lines (where there is a double track).

A number of frogs and crossings are on the table, and you can see how greatly the later types are improved over those used a year or two ago. All the newest styles have the "straight under-running" feature, and require no solder, the trolley wire being clamped into the casting. You see that in all cases the trolley wire is carried *over* the casting, so that the excessive wear at these points is taken by the heavy metallic flanges, and not by the conductor. Right and left-hand, "Y," and three-way frogs are used, and they are insulated and supported by frog pull-offs.

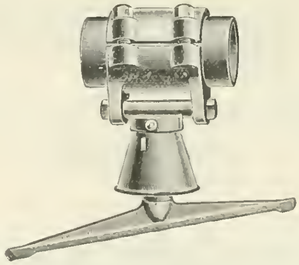


FIG. 24.—"West End" Bracket Arm Insulator. Double insulation.

The operation of right and acute angle crossings is easily understood, and an insulated crossing is employed whenever one trolley wire crosses another from which it must be insulated.

The wire-stretching machine shown is an extremely useful tool in all cases where it is necessary to take the tension off the trolley wire, as in splicing, or inserting switches, frogs, &c.

Several styles of feeder insulators are shown. The best has a metallic yoke into which the feeder cable is laid and firmly held by a screw cap. This greatly economises labour in the erection of an aërial feed wire. Where guard wires are used they are insulated by small porcelain insulators. The utility of guard wires is extremely doubtful, and many lines have discarded them. On the Continent, a strip of wood is often attached to the upper side of the trolley wire, whenever any danger from falling telegraph or telephone wires is apprehended.

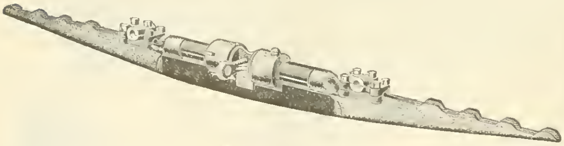


Fig. 25.—"Ætna" Section Insulator.

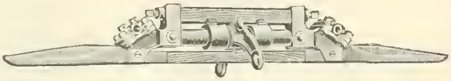
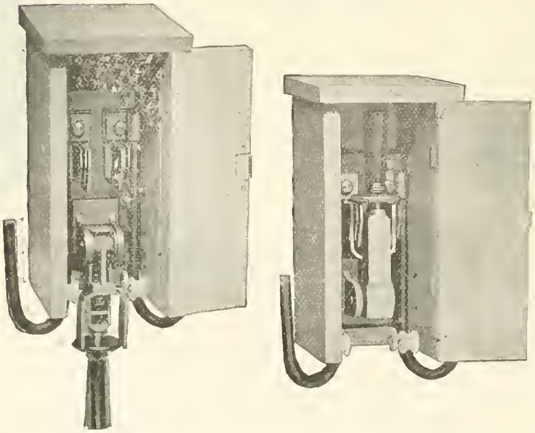


Fig. 26.—Section Insulator. (Straight under-running.)



Figs. 27 and 28. "Ajax" Line Section Switch—Open and Closed.

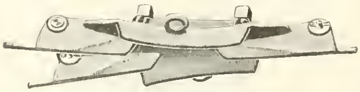


Fig. 29.—Two-Way Aerial Frog. (Straight under-running.)

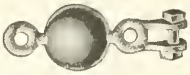


Fig. 30. "Globe" Frog Pull-off.

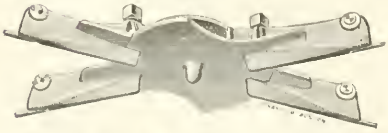


Fig. 31.—Diagonal Crossing. (Straight under-running.)

A number of special tools and appliances are on the table, to which we will not refer at length. They are self-explanatory, and we should be glad to have you examine them.

The trolley itself next claims our attention. As in the case of all electric tramway supplies, the earlier types were comparatively clumsy, and the old form of trolley base occupied a great deal too much room on the roof of the car. It is shown in an illustration. The latest "Boston pivotal" type is fixed to the table. You note how easily the trolley moves in every direction. This base is of simple construction—neat, compact, and designed to allow of passing under low bridges. Experience has proved it to be smooth-running, easy of adjustment, strong, and durable. It lies close to roof of car, and can be swung around to change direction. With pole laid down flat, the highest point on the base is but 6in. above the roof. To avoid overtaxing the springs so that they will set or break, a very large safety factor is allowed. A special construction ensures an even pressure of the wheel against the trolley wire in the different positions. This trolley received the highest award at the World's Columbian Exposition at Chicago. The steel trolley pole is of one piece of steel with a continuous taper, and without joints, shoulders, or other points of weakness. It is light, strong, and stiff. If bent by an accident, it can be straightened cold.

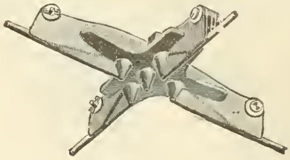


Fig. 32.—Right Angle Crossing. (Straight under-running.)

The steel trolley fork is of a new pattern, tapering in form, of sheet steel, light and strong, provided with phosphor-bronze contact springs and washers, which have proved far more durable than those of copper. The spindle is of hardened steel.

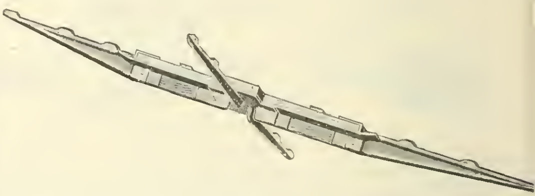


Fig. 33.—Insulated Trolley Wire Crossing.

We are again indebted to Mr. Winslow for the loan of the Thomson-Houston trolley base, which is also fixed to the table. Its operation is practically the same as the other pivotal trolley; but you will see that the construction, especially as regards the arrangement of springs, is somewhat different. Great attention has been paid to the development of a first-class trolley wheel, and several types are exhibited, showing the evolution of the present approved type now universally used.

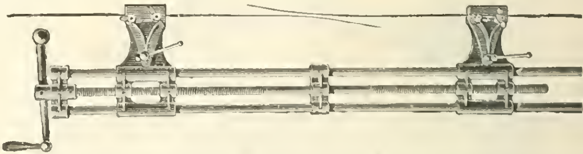


Fig. 34.—Wire-Stretching Machine.

This is the earlier form of wheel, made, as you will see, of a single bronze casting, and with the V-shaped groove then considered best. A substantial improvement was made upon the earlier form in the "Boston" wheel before you. In this a very substantial hub was provided to take the spindle. Iron guard plates were riveted on either side to prevent the trolley jumping the wire. The wear was taken by a contact ring which could be

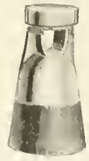


Fig. 35.—"Ætna" Brass Cap Feeder Insulator.

removed and replaced as needed, but at considerable expenditure of time and trouble. You will see how the shape of the groove has changed. Spoked wheels are now universally used, like this "West End" wheel. These are made of a single bronze casting, having a wide and highly polished groove, and being furnished with either graphite or self-oiling bushings to receive the spindle.

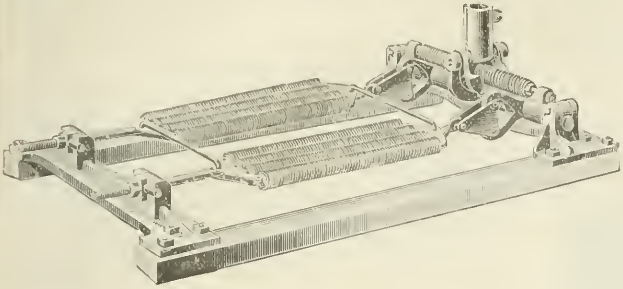
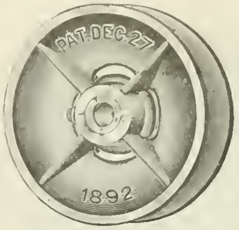


Fig. 36.—Old-Style Trolley Base.



Figs. 40.—Modern "West End" Trolley Wheel.

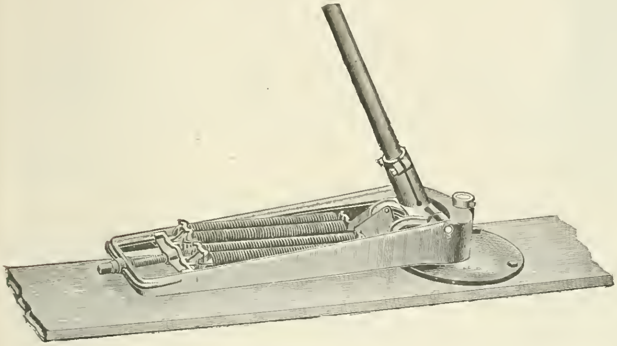


Fig. 37.—"Boston Pivotal" Trolley Base.

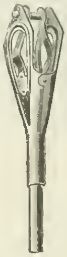


Fig. 41.—Modern "West End" Pole-Head.

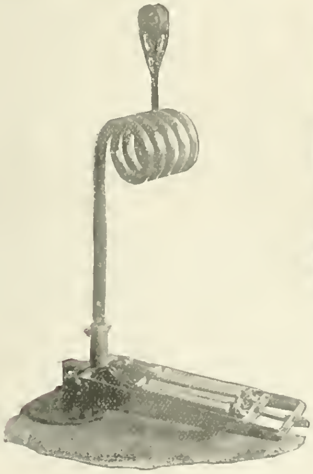


Fig. 38.—"Boston Pivotal" Trolley, with pole *bent cold* to show strength of material.

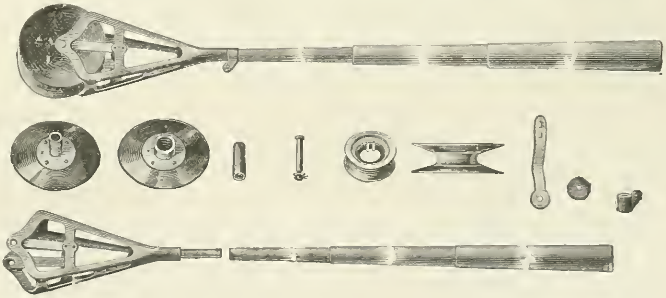


Fig. 39.—Old Style Trolley Wheels and Trolley Pole Head.

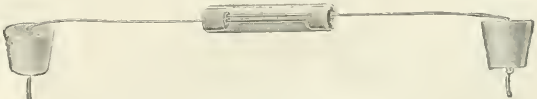


Fig. 42.—"Ajax" Lightning Arrester Fuse.

When the older form of brass trolley wheel is used, the flange drops off when the groove which receives the trolley wire wears through to the outside. By using the "spoked" trolley wheel this difficulty is entirely obviated by a simple and effective method of construction. The ribs serve to hold the flange in position after the sparking of the wheel indicates that it is worn through, and therefore should be discarded. This warning is timely, for the wheel may be used after the flange is cut through by the trolley wire long enough to get to the car house, where a new wheel can be put in. With the old form of brass wheel, when the flange wore through and dropped off, the car was disabled, and had to be pulled to the car house or removed from the track. If this break down occurs in a crowded thoroughfare, or in an out-of-the-way place where it is not easy to obtain assistance, as is often the case, the awkwardness of the situation and the annoyance resulting from it are obviously great. You can see how thoroughly these ribs fulfil their mission by inspecting this "West End" wheel, which has run about 4,000 miles upon an English line.

A great deal of care has lately been devoted to the elaboration of a trolley more suitable for use with the English top-seat car than any of the American types shown. We hope to be able to exhibit it, and one is on its way to us as this Paper is being written. We regret that we have been unable to secure for exhibition one of the trolleys of the South Staffordshire line.

One of the most interesting appliances to which your attention is directed to-night is this "Ajax" lighting arrester. The rest of the apparatus is merely a support for holding a succession of these fuses, so that one after another is brought into operative position automatically by the action of the current as it consumes each fuse in turn.

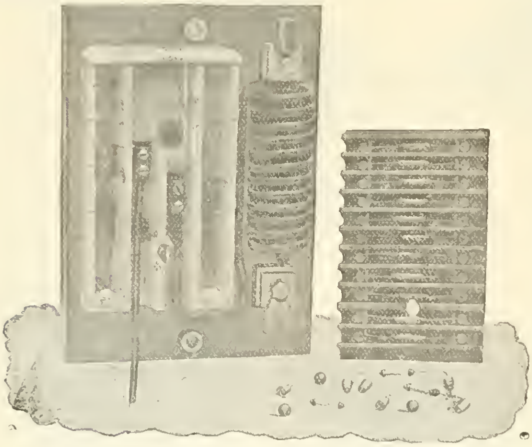


FIG. 43. "Ajax" Lightning Arrester for Isolated Plants or Motor Cars. (Casing removed.)

The fuse consists of two pieces of No. 26 brass wire, each 3in. long, having a single silk insulation, and laid side by side for about 1in., as do consecutive coils in an armature. This 1in. lap of the wires offers abundant surface for the discharge gap, which is formed by the two thicknesses of silk, and amounts to little more than 0·002 of an inch.

Small pellets of a highly insulating wax secure these wires in the above position, and a small glass tube is hermetically sealed over this part of the fuse to keep the dischargers clean and dry until used.

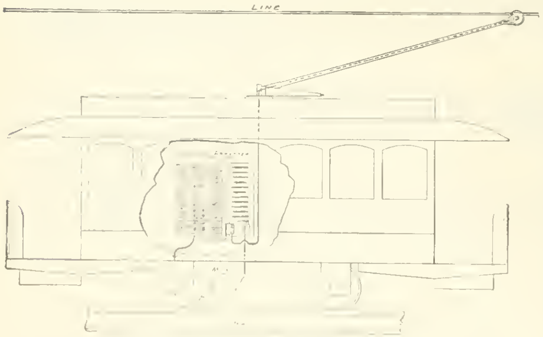


FIG. 44.—Diagram of Connections of "Ajax" Motor Car Lightning Arrester.

The extreme sensitiveness of this part of the apparatus is made possible by its being called upon to act but once.

The soft rubber plugs serve to hold the fuse in the corrugated cover of the arrester, and the bare ends of the wires project through the cover, ready to be brought into contact with the line and ground terminals.

This is the type of arrester used for protecting stationary motors or isolated plants. The regular size is made with a 100 ampere coil, having coil and arrester mounted on a marble slab 7¾in. × 11in. × 7in.

Pole boxes are cast iron, asbestos lined, and so constructed as to exclude rain.

This is the more general form of pole arrester. In this the choke coil is contained in the arrester box; but it may be made by turning the insulated span wire on itself a sufficient number of times to make the choke coil, thus making a cheaper construction and a smaller pole box.

The warming of tramway cars by means of electric heaters is now universal in America wherever the climate is at all cold. This is the simplest form, of which any number desired may be screwed under the seats of a car. More elaborate forms are also made.

A word may be said in support of what Mr. Wilkinson has said as regards the appearance of overhead conductors. Undoubtedly some aërial lines have been put up with an utter disregard of appearances, and inexperienced or careless constructors have erected webs of trolley strain and feeder wires which were most obnoxious. This is especially true of many hastily built American lines, pushed through at high pressure, and at the smallest possible expenditure. Now that the first rush is over, and the tramway operator, the manufacturer, and the contractor have had time to take breath, the weight of public and Press criticism has had its effect, and no pains is spared to perfect the entire plant and apparatus.

A carefully designed and erected line with sub-surface feeders, handsome poles, &c., has but few objectionable features; and in the great majority of cases public convenience is so greatly enhanced by the overwhelming advantages that closely follow upon the introduction of improved and more rapid transit facilities, that opposition to the extension of a trolley line is almost unknown.

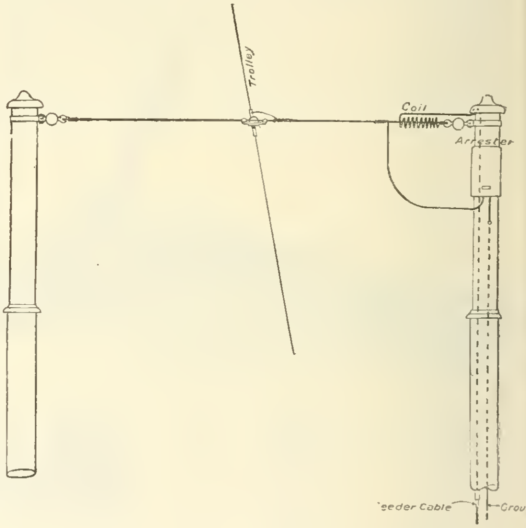


FIG. 45.—Diagram of Connections of "Ajax" Pole Lightuing Arrester.

The Siemens line at Guernsey—the line that crosses the great piazza on which Milan Cathedral stands—the Brussels, Hamburg, Bremen, and a dozen other Continental installations, are European examples of line construction to which no reasonable objection can be urged. The electric tramway has a future as great in Great Britain as elsewhere, and in no other country in the world has it failed to already secure universal acceptance.

The English tramway operators, and the able executive officers of the Tramways Institute of Great Britain and Ireland, are keenly alive to the possibilities that lie in electric traction, and, under most adverse conditions, are doing their best to smooth the path of progress. It remains with you, gentlemen, to supplement their endeavours, and to do your best to stimulate and encourage the growth of public opinion in its favour.

Royal Institution.—The Christmas course of lectures, adapted to juveniles, at the Royal Institution, will be delivered by Prof. J. A Fleming, F.R.S. The subject will be "The Work of Electric Current," and the first lecture will be delivered on December 27th at three o'clock.

MUNICIPAL PURCHASE OF TRAMWAYS.

As briefly mentioned in our last issue, a deputation from the Tramways Institute of Great Britain and Ireland waited upon Mr. Bryce (President of the Board of Trade) at Whitehall-gardens, on Thursday last week, with reference to the effects of the recent decision of the House of Lords as to the purchase clause of the Tramways Act, 1870.

Sir Albert Rollit, M.P., in introducing the deputation, said that of the 76 tramways affected by the decision of the House of Lords 50 were represented on that occasion, while the capital represented was upwards of seven millions sterling, out of a total of 12½ millions, or thereabouts, invested in the tramway industry. The deputation did not desire in any way to attack the decision of the House of Lords; but, owing to the interpretation of the Act of 1870 being different from what those who had invested their money in tramway companies had expected, they asked that the term of 21 years granted by the Act might be prolonged. They also asked that, in view of the municipalities being entitled, according to the judgment of the House of Lords, to take over the tramways, the companies should have some preferential consideration as to leasing or otherwise working the lines.

Mr. Carruthers-Wain pointed out that many poor people, to whom their investments represented a great deal, had put their money into tramway undertakings in the belief that the meaning of the Act of 1870 as interpreted by three of the judges in the House of Lords was the correct one. It was not the truth, as was popularly supposed, that tramway companies generally earned large dividends, although one or two were fairly successful. There were no less than 60 that paid less than 5 per cent., and 25 that paid no dividend at all. The deputation asked, in the first place, that any corporation that elected to buy a part of any tramway line should be compelled to purchase the whole of it, otherwise these bodies might select the paying sections and leave the companies with the extensions that in many cases had been constructed at the desire of the local authorities, but would not by themselves be remunerative to work.

Mr. Richardson, Mr. Morris, and Mr. Lloyd, M.P., having spoken,

Mr. Bryce, in reply, assured the deputation that he was fully alive to the importance of the tramway industry to the country. The public interest was the basis on which they must, after all, deal with the question. The public interest in tramways was very large, particularly that of the working classes, because these undertakings supplied them with the cheapest mode of locomotion which was available for travelling to and from their work. He fully agreed as to the desirability of further extending the facilities tramways offered. It was perfectly clear to him that the existing tramways did not supply anything like the need there was for them. The Board of Trade had shown its interest in the matter by the proposals they were going to invite upon the subject of light railways and tramways, because he considered the subjects were, as regards cities, intimately connected, and, of course, the developments of modern science in the direction of electricity promised some future developments in the tramway industry which might go beyond what had been able to be accomplished by horse cars. He was glad to perceive that they had all abstained from making any request to his department that it should undertake legislation with the view of what might be called attempting to reverse the decision given by the House of Lords. It was quite clear that no attempt to declare that the tramroads should be purchased upon any other basis of valuation than that the House of Lords had laid down to be the true basis of valuation contemplated by the Act would have any chance of success in Parliament. The requests made to him seemed to be practically two—namely, that it should be enacted that upon the occasion of future purchases the local authority purchasing should be required to buy the whole undertaking and not merely a part of it. (Hear, hear.) In the second place, they asked that where the local authority purchased an undertaking it should immediately offer so much as it had purchased to the company from whom it had been acquired, to be worked before going into the open market, and that if it were unable to agree with the company as to the terms these should be submitted to arbitrators appointed by the Board of Trade; that in case the company accepted the terms fixed by the Board of Trade a lease should be given to it, and if not then, and not till then, the local authority should be free to go into the open market. These two practical proposals appeared in effect to amount to the varying of the terms of the existing law. To carry them out would require legislation which would change the terms of purchase as settled by the Act of 1870. The question which confronted him in meeting such proposals was whether any proposals of the sort would not be deemed by Parliament to be in substance just as much an attempt to depart from the bargain made by Parliament on behalf of the local authorities with the tramway companies, as any proposed change in the basis of valuation, which was affirmed by the House of Lords in its recent decision to be the basis contemplated by the Act. He could only answer that question in the affirmative. He must ask them as practical men whether they thought there was the slightest chance of Parliament consenting to alter the terms of the bargain made by the Act of 1870? It had been said that they did not bring these matters forward as hostile to the municipalities. He would like to know what the municipalities thought of it. Would any municipality assent to such a variation of the Act of 1870? On the contrary, he thought they would all offer strenuous opposition to the proposals the deputation had outlined. It would be argued strongly that the municipalities existed for the sake of the public, and that if they worked the lines they would do so to give the greatest public benefit, and that the Board of Trade would be injuring the public if it endeavoured to alter the bargain already made against the municipalities in the interests of the shareholders. If they thought there was any chance for it, of course it was perfectly open for the tramway companies to introduce into Parliament a Bill for the purpose of amending the Act of 1870 in the way they desired. If it were carried the position of the Government would at once become quite different from what it was now. Then they had suggested that if some such change as that asked for was not made—if better terms were not offered to the tramway companies—the tramway extensions would stop, and that, as a consequence, the interests of the public would suffer. That, of course, was a serious consideration, and he was going to supply them with an argument that he was surprised none of them used, afforded by the parallel case of the Electric Lighting Acts The electric lighting scheme of 1882 was launched upon terms Parliament then settled; but the persons who at that time were thinking of introducing the electric light into cities considered that the terms were not sufficiently favourable, and so the Act of 1882 was followed by disappointment. The electric lighting enterprises expected were not carried out, although he had no doubt other causes contributed to that result. They knew what happened. A select committee of the House of Commons was appointed to consider the question, and the outcome of it was that in 1887 an Act was passed which gave new and better terms to the electric lighting companies, and upon the basis of that Act a very large number of companies had been formed for supplying electric light to our cities, and the industry had gone forward by rapid strides, to the benefit of investors, he hoped, and certainly to the benefit of the public. The same thing might happen in connection with tramways. If it turned out that the terms on which, according to the decision of the House of Lords, the tramway undertakings could be acquired were not sufficiently advantageous to encourage the continuance of tramway enterprise, he admitted there would be a strong case for them to go to the House of Commons with. It was quite clear that if it proved to be a losing business to make tramways the municipalities would not apply for power to make them, and private individuals would not, and as a result the public would suffer. They would then have a strong case to ask that, for the future at any rate, some new arrangements should be made. Sufficient time had not elapsed since the decision of the House of Lords to judge whether or not the disastrous effects the deputation anticipated would actually take place, and they could hardly go to the House of Commons and ask for more favourable terms until it became clear, as in the case of the electric lighting industry, that the existing terms were not sufficiently advantageous to encourage tramway enterprise. It would then be the duty of Parliament to give most careful attention to any facts or figures they might submit. He profoundly regretted that there had been any misapprehension in the minds of tramway shareholders as to what the state of the law was. Although that misapprehension was not universal, it had been abundantly shown by correspondence that had taken place, and, however much he might regret it, he was obliged to look at what was practicable and possible, and at the palpable interests of the public, which would be deemed by Parliament to be represented by municipalities, who could not have any interest in the matter except the public interest, and to whom Parliament had shown an increasing disposition to grant the conduct of such affairs.

The deputation, after thanking Mr. Bryce for receiving them, withdrew.

THE REICHSANSTALT UNIT OF LIGHT.

In the number of the *Elektrotechnische Zeitschrift* following that containing the Paper by Messrs. Lummer and Kurlbaum on this subject, of which we gave a full abstract in our issue for November 9th, Herr von Hefner-Alteneck, who, as the inventor of the standard hitherto most used in Germany, is entitled to attention as an authority on the subject, has some remarks on the question, of which we give the gist below.

In the introduction to the Paper in question ("The Search for a Unit of Light," O. Lummer and F. Kurlbaum: *The Electrician*, November 9, 1894, p. 37), in the first instance, every source of light which is constant and capable of being reproduced is regarded as a unit, and then a distinction is drawn between a working and a physical unit merely by regarding the latter as more accurate and the former as more easily and cheaply reproducible. In connection with the further researches described, the "physical unit" is described as the one proposed by the authors, while the Hefner lamp is simply relegated to the category of standard candles, carcel lamps, and so on: being treated, in fact, as if the lamp were in need of standardisation, and should be referred to as accurate as possible a physical light unit. Herr von Hefner-Alteneck remarks that the terms "working" and "physical unit" have not their usual significance, or are not applied with reference to the constitution of the unit itself, for in this respect the Hefner lamp is just as "physical" as the Lummer and Kurlbaum platinum unit itself.

Under which category the Violle and Siemens units come is not clear, but apparently they are "unphysical," as they are so very inaccurate, although the new unit rests on the same basis. Of course Messrs. Lummer and Kurlbaum may call their unit by what name they please, but Herr von Hefner-Alteneck must reserve to himself equal rights.

In the second place, and emphatically, the author remarks that the Hefner lamp requires no standarisation but only a few measurements, which can be made by any physicist or technical man with apparatus in constant use and only requiring a little care; the only other condition is the chemical purity of the fuel and determination of its boiling point. But the Hefner lamp differs from the carcel burners, standard candles, &c., with which it has been classed, not only by reason of its "satisfying the requirements of technical men" but by differences in its constitution. The other lamps or lights are not light units, nor even strictly light measures, because the indefiniteness of the fuel supplied does not enable any calibration to be of value for any length of time. The Hefner lamp, on the other hand, has a definite chemical compound as fuel, and is in general so defined that it can be regularly set up and used without its being necessary to call in the aid of the regulations of the Reichsanstalt.

To refer the Hefner lamp to a standard, and to use it only as a means of comparison or sub-standard, would only be of use if the lamp when prepared in accordance with the instructions showed constant variations in the light. This is not only primarily improbable, as constant variations must have constant causes; but it has also been frequently shown that such variations do not occur, and that small defects of construction, even such as are easily avoidable, have no observable effect on the light. The illuminating power of a Hefner lamp is a definite unit of light in itself, and the author proposed it as such ten years ago, and it was in wide use before the Reichsanstalt could occupy itself with it.

As far as the accuracy of the Hefner light as a unit is concerned, it is limited by a certain uncertainty in the height of the flame, and by the effects of certain atmospheric influences which have not yet been fully investigated, and which affect every flame burning in in free air. It may be expected that these difficulties may be removed, or the values of the disturbances determined, so that no practical objection shall remain on this score. But, in any case, it is no good comparing the lamps with a unit unaffected by such atmospheric conditions, as one cannot send out properly regulated air in which each lamp is to be burned.

Since 1884, when the Violle unit was adopted as an international unit, it has been seen of none, and its adoption was a complete failure, as it only stood in the way of an agreement among electrical men. However, as proposals are constantly being brought forward for comparing the actual standard of comparison with a unit of light, in spite of this failure, the author may be allowed to say that such a comparison, even with a perfect unit of light, is absolutely unnecessary, and of no use. It might be, for instance, that the Hefner lamp might be made without any care, and then each compared with the light unit, and either so used or perhaps adjusted to a definite value, say by altering the height of the flame. But this would lead to greater errors than the use of the present accurate Hefner lamp as standard, as it adds a new and great source of error in the photometric comparison which it necessitates, and the errors in the standard itself. It may be generally affirmed that every source of light which is capable of being used for measurements as a sub-standard can also be developed into a standard unit of itself, and that to ensure as great an agreement as possible in light measurements it should only be used in the latter form.

"The search for a unit" in photometry can only be of use if it is directed to the distribution to the greatest possible extent of a source of light, which is actually to be used in the measurements as a unit of light in itself. If the best source of light hitherto used for this purpose has drawbacks, the efforts of experimenters should be devoted to clearing up the doubtful points and generally improving the lamp itself. It is quite possible that the platinum unit proposed by Drs. Lummer and Kurlbaum, as used in connection with their most ingenious and novel method of determination of the temperature of the platinum in the regular air circulation, has a greater accuracy than can ever be attained by the Hefner lamp; but according to the authors' own showing "it necessitates the setting up of complex and delicate apparatus, and the application of considerable experimental skill."

If physical problems should crop up in which the highest degree of accuracy in light measurements should be demanded, so that a considerable increase in trouble and cost should be of little importance, then the new unit may be of great importance, being the only applicable standard, and it will mark a step in advance of indubitable importance. But such cases may be dealt with on their own account and without reference to the large outer field of physical and technical photometry; and Herr von Hefner-Alteneck only wishes to put in a word for the wide and clearly defined separation of these fields and the units assigned to them.

In connection with the above remarks we may call attention to a description of the Hefner lamp which appeared in our columns;* we also note that, in reference to the question of variations in the light given by a Hefner lamp, that Herr A. Krüss, who published in the *Zeitschrift für Instrumentenkunde* a description of a Hefner lamp, in which the thickness of the wick tube was 0·32mm. instead of 0·15mm., with the result that the lamp burnt 3 per cent. low. Other determinations of the absolute value of the variations alluded to are not before us.

CORRESPONDENCE.

THE ANTIQUITY OF ELECTRIC LAUNCHES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The following quotation from the "The Faërie Queene," Bk. II., Canto VI., v. 5, will show that as far back as Spenser's time the electric launch had been invented:—

"Eftsooues her shallow ship away did slide,
More swift than swallow sheres the liquid sky
Withouten oare or Pilot it to guide,
Or winged canvas with the wind to fly;
Onely she turned a pin, aud by-and-by
It cut away upou the yielding wave,"

while the remainder of the verse shows that a valuable automatic danger-indicating and steering apparatus had been invented, the idea of which has since been lost:—

"Ne cared she her course for to apply;
For it was taught the way which she would have,
And both from rocks aud flats itself could wisely save."

And all this was known 300 years (more or less) ago!—Yours, &c., P. L. Gray.

15, Francis-road, Edgbaston, Birmingham,
Nov. 13, 1894.

RUHMKORFF OR RHUMKORFF?

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The original exhibition of Ruhmkorff's coil is described in *Comptes Rendus*, XXXVI., p. 649, and XXXVIII., p. 801. See also *Cosmos*, I., p. 260. This settles the spelling of his name. I am not aware that he was ever addicted to *rhum*.—Yours, &c., Silvanus P. Thompson.

Technical College, Finsbury, November 9, 1894.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I was wrong in writing that a *little* research would reveal the correctness of the spelling "Ruhmkorff," for, strangely enough, the name does not occur in any form in the first series of the Royal Society's Catalogue. But in the *Comptes Rendus* for the years 1842-77 will be found papers *by* Ruhmkorff in Vols XIV., XXIII., L., LXXIII., and notices *of* him in at least Vols. XXXVIII., XLII., XLVI., XLVIII., XLIX., LXXXV., in all which places the name appears as above, except that it is spelled "Rumkorff" in XXXVIII., p. 314 (corrected in the index), "Ruhmkorf" in XLVI., p. 378 (corrected in the index), and "Rhumkorff" in L., p. 215 (here appearing in the second reprint of a report which contains the name ten times, so that once out of thirty times, so far as this document is concerned, the printer has been at fault).

I know of no German paper which contains the name otherwise than as "Ruhmkorff," and, as to the nationality of its owner, I cannot go behind the testimony of Prof. Poggendorff, who, in 1860 (*Pogg. Ann.*, CX., p. 527), wrote "Unser geschickter

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* *The Electrician*, Vol. XXXI., p. 623

Landsmann, der Mechanikus Ruhmkorff in Paris." This statement, however, may possibly be considered ambiguous, since its author's name too ends in *rff*.

With respect to the reviewer's suggestion, I have the authority of Mr. Morfill, the University Reader in Russian at Oxford, for saying that both the combination *rff* at the end, and the combination *rh* at the beginning, of a name are equally impossible in Slavonic. "Korff" is, however, a common name in the Baltic Provinces, which are of distinctly German nationality; and doubtless the doubling of the *f* is a mere ornamentation, as it obviously is in "Poggendorff." Of such variations our own country affords only too numerous examples.—Yours, &c.,

Christ Church, Oxford. ROBERT E. BAYNES.

LEGAL INTELLIGENCE.

Cassel Gold Extracting Company (Limited) v. the Cyanide Gold Recovery Syndicate (Limited) and Others.

It was briefly announced in our last issue that judgment had been given for the defendants in this action.

Mr. Justice ROMER, in the course of his judgment, said he was confirmed in the opinion that this patent could not be sustained. The invention claimed in the patent was a very simple one, and the claim very comprehensive. It was for the application of a solution containing cyanogen, so as to dissolve the gold and silver in powdered ores. The gold is then to be recovered from the solution by any of the well-known ways. The kind of solution to be used as the solvent was described by the specification very broadly. It was to be any solution containing cyanogen or any cyanide soluble in water (such as cyanide of potassium), or any other substance or compound containing or yielding cyanogen. No special apparatus or machinery, or device or scheme of any kind was required. The solution is simply to be poured on the ore. You may stir the ore about in the solution if expedition is required; or, if you choose, you may let the solution rest, so as gradually to solve the gold in the ore. In fact, the patent really is for an alleged discovery that a solution containing cyanogen can be used to dissolve out the fine gold in powdered ore. At the date of this patent it was perfectly well known that a solution of cyanide of potassium would solve gold in a fine state, and that the finer the gold the more speedy the process. The peculiar property of cyanogen, that it would solve fine gold if oxygen were present, was well known. The chemist in his laboratory knew that by pouring a solution of cyanide of potassium on fine gold he could solve the gold. It was proved before him that for some time after the date of the plaintiffs' patent the patentees' alleged invention was not commercially worked because no efficient and paying method was known of recovering the gold, and that it was not until the patentees subsequently made a discovery, which they patented, of a new method of recovering the gold from the solution that the use of a solution of cyanide of potassium to extract the fine gold in the ore was practically employed for commercial purposes. But the matter does not rest here. Not only was the abovementioned property of cyanide of potassium known, but in 1867 one Rae took out a patent in the United States, and the specification of his invention was published here before the date of the plaintiffs' patent. Rae's invention was for the extraction of the gold from the powdered ore. He took a solution suitable to solve the gold from the ore, and he expressly mentions a solution of cyanide of potassium as one that could be employed, and he poured this solution on the ore in a vessel which he agitated by machinery, and he used electricity for two purposes—first, to facilitate the action of the solution in solving the gold in the ore; and, secondly, to recover it from the solution by depositing it on a certain base in the machine. So that, undoubtedly, in his specification he recommends the use of cyanide of potassium in a solution as a means and for the purpose of solving the gold in the powdered ore; and he was, of course, right in so using it. And I do not see that his recommendation is rendered worthless because he also recommends electricity to facilitate the action of the solution and also to do some other work with the solution after the gold is extracted. Then, again, in 1884, one Simpson took out a patent in the United States, and his specification was published here before the date of the plaintiffs' patent. Simpson's process, as described in this specification, was substantially identical with the plaintiffs', except that the solution he mentions is one not of cyanide of potassium only; but of a comparatively small quantity of carbonate of ammonia added. Of this addition of carbonate of ammonia the plaintiffs have naturally made the most; but I am satisfied on the evidence that the addition does not substantially affect the operation of the cyanide of potassium on the ore, and that Simpson's solution is perfectly efficacious. Under these circumstances, I come to the conclusion that at the date of the plaintiffs' patent, having regard to what was then published and known, there was no real invention in the plaintiffs' so-called discovery. There being, in my opinion, no real invention or discovery in the application at the date of the patent of a solution of cyanide of potassium to extract the gold from powdered ore, it follows that on this ground alone the patent must fail. His Lordship's judgment agreed with the views of Mr. Riley, Mr. Mactear, and Prof. Attfield, who stated that, in their opinion, at the date of this patent no invention was required to discover that a solution of cyanide of potassium could be practically applied to dissolve gold and silver in crushed ore. But, in addition, he thought there was another ground on which this patent was bad. Even if the invention was one which could form the good subject of a patent I think it was anticipated by Rae's and Simpson's specifications. Test it in this way. If the patent were held valid, would not Rae's and Simpson's processes, if now used according to the specifications published, be liable to be stopped as infringements? I think they certainly would. What chance of escape would a person have who took Rae's, for instance, and used the cyanide of potassium specially mentioned by Rae? It would be said against that person with crushing effect that he was using the cyanide of potassium for the very purpose pointed out in the plaintiffs' patent: viz., to dissolve the gold in the crushed ore, and not the less because he tried to assist the process by the aid of electricity which might or might not be of any real assistance, and certainly not the less because he used the electricity also for another and different purpose. So, also, a person now using Simpson's process would be liable to be stopped. For it would be proved against him that he was using the cyanide of potassium for the very purpose and in the very way pointed out in the plaintiffs' specification, and that the addition of carbonate of ammonia made no material difference. To hold that Simpson's was not an anticipation would lead to a strange result. A person using cyanide of potassium alone would be an infringer, but if he chose to add a slight amount of carbonate of ammonia (which is cheap and practically innocuous) he could not be restrained. This would in itself render the plaintiffs' patent practically valueless. Now, as the specifications of Rae and Simpson were published here before the date of the plaintiffs' patent all persons in this country are at liberty to use the processes there set forth, and that right is incompatible with those persons being liable, if they do use such processes, to an injunction at the suit of the plaintiffs. For these reasons the action must be dismissed.

Wise v. The Metropolitan Electric Supply Company.

This case again came before Mr. Justice Stirling on Saturday last. The plaintiffs had in April last (see *The Electrician*, May 4, p. 20, Vol. XXXIII.) obtained an injunction against the Company restraining them from carrying on their works at Manchester-street, W., so as to cause a nuisance to the plaintiffs by vibration. The operation of that injunction was, however, suspended until September 5th. At the time of the granting of the injunction the Company were endeavouring to overcome the difficulty by works intended to increase the rigidity of the bed upon which the engines rested, and, although their operations in that direction were partially successful, they do not seem to have been entirely so, for the Company have, since the injunction, come to the determination to substitute steam turbines for the reciprocating engines hitherto in use. The Company have accordingly removed some of their engines to another of their stations; and have already erected one turbine and ordered two others, which, when in position, will, it is hoped, enable them to supply all the necessary electric energy. In the meanwhile, the plaintiffs alleged that, in spite of the injunction, the Company have allowed the nuisance to continue, and they now moved for leave to issue a writ of sequestration against the Company. A great mass of evidence was read on either side.

At the conclusion of the evidence, his Lordship asked if the Company were willing to undertake not to use more than one reciprocating engine besides the turbines for a period of three weeks, and, upon counsel for the Company consenting to that, his Lordship said that it appeared to him, upon the evidence now presented to the Court, that if the Company worked three engines of the reciprocating class a nuisance would be caused; but if they only used one there would be no such vibration as to amount to a breach of the injunction. He was anxious to be satisfied by a further experiment that that was so, and under these circumstances he should direct the motion to stand over for three weeks upon the above undertaking by the Company.

The counsel appearing in the case were Mr. Hastings, Q.C., and Mr. Beaumont for the plaintiffs; Mr. Vernon Smith and Mr. Waggett for the Company.

BOOKS RECEIVED.

"Provisional Orders of the Board of Trade." By Francis J. Crowther. Second Edition. Price 3s. 6d. (London: Jordan and Sons. 1894.)

"University College of North Wales." Calendar for the year 1894-95.

"Central Station Book-keeping," by H. A. Foster. Price 5s. 3d. (New York: The W. J. Johnston Company. 1894.)

"Electric Lighting Plants.' By W. J. Buckley. Price 8s. 4d. (Chicago: Wm. Johnston Printing Company. 1894.)

"The Royal Engineers Field-Service Pocket-Book," by Major G. R. Scott-Moncrieff, R.E. Price 8s. (Chatham: W. and J. Mackay and Co. 1894.)

"Annual Report of the Board of Regents of the Smithsonian Institution to July, 1892." (Washington: Government Printing Office. 1893.)

"Electricians and Their Marvels." By Walter Jerrold. Price 1s. 6d. (London: S.W. Partridge and Co.)

"Journal of the United States Artillery." Vol. III., No. 4. October, 1894.

"Kalender für Electrotechniker." 1895. By F. Uppenborn. (Münich and Leipzig: R. Oldenbourg).

"Electric Lighting and Power Distribution." By W. Perren Maycock. Second edition. (London: Whittaker and Co.)

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices :—*

Laboratory Notes and Forms.—With the above title, we have in preparation a set of Elementary and Advanced Notes and Forms for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. They are prepared with the object of saving the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

The 1894 Edition of "The Electrician" Electrical Trades' Directory and Handbook contains 1,000 closely-printed pages, and several new and useful features have been added. The price of this edition of the Directory and Handbook is now 5s. post free; abroad 5s. 6d. *The 1895 edition is in active preparation*, and subscription and advertisement orders should now be sent in.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, will be ready next week. It will contain the latest information respecting the application of electric energy to mining purposes, in which the author has had much experience. The book is well printed, on good paper, and will contain some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d., post free 11s. (abroad 11s. 6d.). Orders can now be received.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is being printed, and will shortly be ready. Price 10s. 6d. post free.

"The Work of Hertz."—The lecture delivered by Dr. O. J. Lodge at the Royal Institution on June 1st is reprinted with corrections and additions, and many original illustrations, price 2s. 6d. net.

"Electrical Engineering Formulæ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"Electromagnetic Theory" (Vol. I.), by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application. Vol. II. is in preparation.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application to the Publisher.

"Drum Armatures and Commutators."—This book, written by Mr. F. Marten Weymouth, is also ready; price 7s. 6d (abroad 8s.). Prospectus on application.

Tenders Invited.—The St. Pancras Vestry are prepared to receive tenders for the supply and laying of armoured cable mains, and for the extension of underground sub-station building. All particulars can be obtained at the offices of Prof. H. Robinson, 13, Victoria-street, Westminster, S.W., and tenders must reach Mr. Albert E. Pycraft, Chief Clerk to the Vestry, Vestry Hall, Pancras-road, N.W., on or before Thursday, the 22nd instant. Some further particulars appear in our advertisement columns.

——— The Vestry of St. John, Hampstead, invite tenders for wiring the buildings in the stone yard, Lithos-road, Finchley-road, London, N.W., for the electric light, including the supply and fixing of all cables, casings, and fittings, but not lamps. Form of tender and copy of specification can be obtained of Mr. A. P. Johnston, the vestry clerk, and tenders must be in by 4 p.m. on Thursday, the 29th inst. Further particulars are given in our advertisement columns.

——— The Cheshire Lines Committee require tenders for the supply of telegraph material, instruments, wire, &c. Tenders are to be in by December 1st.

——— The Midland Railway Company require tenders for the supply of stores, including telegraph instruments, stay rods, bolts, &c., and telegraph and signal wires. Tenders must be in by Tuesday next.

——— The Directors of the North-Eastern Railway Company require tenders for the supply, for the first six months of 1895, of telegraph apparatus and telegraph wire and line stores. Tenders are to be in by the 27th inst.

——— The Secretary of State for India invites tenders for steel spans and creosoted Baltic red pine sleepers. Particulars can be obtained at the India Office, Whitehall, London, S.W.; and tenders have to be in by two p.m. on November 20th.

Tenders Received.—The tender of the Walsall Electrical Company for the installation of the plant, fittings, and appliances for both the lighting and provision of power in the new Technical School, for the sum of £6,375. 18s., has been recommended for acceptance by the Building Sub-Committee.

Tenders Accepted.—The following tenders for switchboard, motor transformers, electrical instruments, &c., at King's-road station were received by the Electricity Committee of the St. Pancras Vestry:

Muirhead and Co.	£5,639	12	11
Siemens Brothers and Co. (Limited)	4,994	8	2
Laing, Wharton and Down (Limited)	4,889	1	7
Easton, Anderson and Goolden (Limited)	4,399	10	0
Thames Iron and Shipbuilding Co. (Limited)	4,185	13	6
Johnson and Phillips	3,843	18	3
Julius Sax and Co. (Limited	3,722	18	8
Acme and Immisch Electric Company (Limited)	3,652	17	4
Crompton and Co. (Limited)	3,621	1	6
Laurence, Scott and Co. (Limited)	3,603	5	0
Electric Construction Company Limited (accepted)	3,489	11	8
Edison and Swan Co. (Limited) (part of work only)	670	17	10

Sales by Auction.—Messrs. Wheatley Kirk, Price and Goulty will sell by auction on Wednesday, the 28th inst., at the Deptford Central Lighting Station, Stowage Wharf, Deptford, S.E., a of surplus quantity plant and stock for the London Electric Supply Corporation (Limited). Particulars appear in another column.

——— Messrs. Wheatley Kirk, Price and Goulty will, on Tuesday, Wednesday, Thursday, and Friday next, dispose of an immense quantity of modern high-class new and other machine tools, engineers' plant, loose tools, stocks and stores, &c., comprising the entire contents of the Union Foundry, Hunslet-road, Leeds, recently occupied by Messrs. Shepherd, Hill and Co., who have obtained well-deserved and world-wide fame as makers of engineering tools. No firm in the kingdom has enjoyed a higher reputation in the past than Messrs. Shepherd, Hill and Co. for these specialities. It is regrettable that in addition to the plant and machinery, the whole of the valuable patterns, drawings, and designs used in the business, and which form its goodwill, are to come under the hammer, and it is to be sincerely hoped that these may fall into energetic hands capable of working them to the best advantage. A set of circumstances which may be described as unusual necessitates the breaking up of this old-established business. The death of one of the principal partners a few years ago followed by that of the acting manager, and the advanced age of the remaining partner, has induced the latter to place the disposal of the contents of the extensive range of buildings comprising Union Foundry in Messrs. Wheatley Kirk, Price and Goulty's hands for realisation. Such an opportunity for acquiring high-class tools at auction prices will doubtlessly be eagerly sought; and the prices reached will, we hope, prove the unique position obtained by the firm's manufactures throughout the world. Catalogues can be obtained of the auctioneers, 49, Queen Victoria-street, E.C., and Manchester, and of Messrs. Beevers and Adgie, 92, Albion-street, Leeds. A number of illustrations are given with the descriptions under the various lots, of which there are 900. Many of the machines illustrated have been supplied to the British and most of the foreign and colonial governments, and are in use by the chief engineering firms at home and abroad, and by the majority of the chief railway companies throughout the world. The sale commences each day at 10 for 11 prompt. Full details are set out in our advertisement columns.

——— Messrs. Fuller, Horsey, Sons and Cassell will sell by auction on Wednesday, the 28th inst., at 1 o'clock, at their offices, 11, Billiter-square, E.C., some nearly new modern electric lighting plant, to be disposed of owing to the space being required for other purposes. Particulars are given in our advertisement columns, and all further information can be obtained of the auctioneers, 11, Billiter-square, E.C.; or of Mr. H. Cuthbert Hall, 46, Queen Victoria-street, E.C.

Liquidations.—At meetings of the shareholders of the Home Telephone Company (Limited), held on the 5th and 26th ult., it was resolved and confirmed that the Company be wound up voluntarily, and Mr. E. A. Horne, the secretary, was appointed liquidator. Creditors of the Company must send in particulars of their claims to the liquidator, at 85, Queen Victoria-street, London, E.C., by December 14th. The business of the Company is being taken over by the National Telephone Company (Limited).

——— The shareholders of the Herculite and Electrical Manufacturing Company (Limited) resolved, at a meeting held on the 17th ult., to wind up the Company voluntarily, and appointed Mr. W. H. Shephard liquidator.

——— On the petition of Mr. Joseph Grove, a judgment creditor, Mr. Justice Vaughan Williams, on Wednesday, made an order for the compulsory winding up of the Common Petroleum Engine Company (Limited).

——— A petition for the compulsory winding up of the South Staffordshire Tramways Company (Limited) has been presented, and is down for hearing at the Royal Courts of Justice, London, on the 21st inst.

Liquidations.—A meeting of the shareholders of the Emile Lansard Syndicate (Limited) is to be held at 171, Queen Victoria-street, E.C., on December 1st, at noon, to receive the liquidator's report on the winding up.

——— A meeting of the shareholders of the Williamson Electrical and Engineering Company (Limited) is to be held at Temple-chambers, 33, Brazennose-street, Manchester, on December 17th, for the purpose of receiving an account of the winding up.

——— A meeting of the Telephone Company of Ireland (Limited) is to be held at 27, Rutland-square, Dublin, on December 15th, at noon, to receive an account of the winding up.

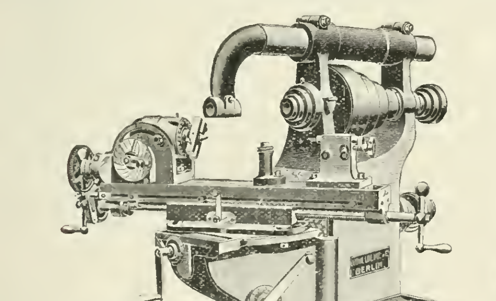
Bankruptcy.—W. H. Akester, electrician, of 897, Fulham-road, S.W., against whose estate a receiving order was recently issued, has been adjudicated a bankrupt.

Appointment Vacant.—Owing to the appointment of Dr. W. E. Sumpner to the principalship of the Birmingham Municipal Technical School, the position of Lecturer in Physics and Electrical Engineering at the Battersea Polytechnic Institute, London, S.W., is vacant. Particulars of the appointment can be obtained of the Secretary.

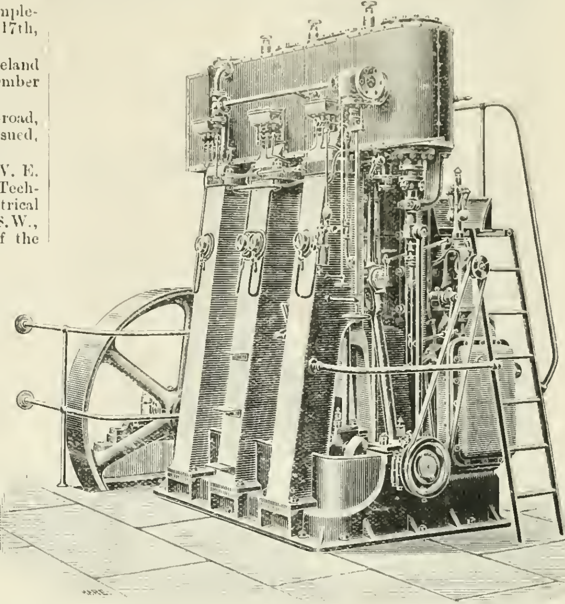
Dissolutions of Partnership.—Mr. W. H. Ward has retired from the Swan Electric Engraving Company, and the business will in future be carried on by Messrs. Joseph Wilson Swan and Cameron Swan.

——— The partnership between Messrs. W. E. Townsend, H. D. McIntyre, and W. R. C. Ralston, trading as Townsend and McIntyre, electrical engineers, of London and Manchester, has dissolved.

Universal Milling Machine.—We illustrate herewith a universal milling machine, manufactured by Messrs. Ludwig Loewe and Co., of Berlin, whose agent in England is Mr. H. F. L. Orcutt, of London. It is claimed that the machine (which is made in four sizes) is adapted to a great variety of uses—fluting milling cutters of every description, twist drills, taps and reamers, nut and bolt head finishing, die-sinking, cam cutting, cutting teeth in spur, bevel and worm gears, and automatically cutting spirals. The table is of extra depth, and slides in long bearings. It has a central feed, automatic in both directions and trips at any point, can be worked automatically at any angle up to 45 degrees, and can be operated by hand from either end. The spiral head can be adjusted from 10 degrees below the horizontal to the perpendicular. The spindle is hollow and the outer end is threaded to receive universal chuck. Aside from the divisions obtainable through the worm and gears, it has an extra plate on the spindle for indexing directly when fluting taps, twist drills, reamers, &c. The tail stock centre has an angular adjustment. The vertical adjustment of the knee is operated through a bearing which projects at an angle, so that the transverse and vertical adjustment can be operated simultaneously. Adjustable dials, graduated to one-thousandth of an inch, are provided for both movements.



Triple Expansion Engines for Electric Lighting, Jet or Surface Condensing.—Messrs. Alexander, Shanks, and Son are introducing a triple expansion steam engine for electric lighting. The makers claim that both in point of materials and workmanship these engines are of the very best class, and that the distribution of power on the crank shaft is productive of the greatest smoothness in motion. Wrought or cast iron front columns are provided at option. All sizes are fitted with an improved arrangement of automatic variable expansion gear of the link type, controlled by powerful and sensitive high-speed governors. Jet condensing engines have air pump, brass lined, and injection cock; and the surface condensing engines have air and circulating pumps. Surface condensers have Muntz metal tube plates and brass tubes, packed with wooden ferrules. A feed pump is provided. The cylinders are lagged and covered with planished steel sheets, and the engines are neatly finished. Sight drop lubricators are provided for the principal bearings, which have specially large surfaces. Plain flywheels are turned for belt driving, and when above 7ft. 3in. diameter are made in halves or sections as may be necessary. The engines are constructed for a working pressure of 160lb. per square inch.



New Firm.—Messrs. Russell and Lennard have commenced business as electrical engineers at 22, Charing Cross-road, S.W. Mr. Russell was engineer to J. G. Statter and Co. and Mr. Lennard was recently with Latimer Clark, Muirhead and Co.

Extension of London Depôt.—The Telegraph Manufacturing Company, owing to the increase in their London business, have decided upon taking further premises, where a stock of their well-known manufactures will be obtainable. The premises are now ready and well stocked, and are situate at 11, Queen Victoria-street, where the Company has been established for some years past. Mr. C. E. Wetton, who represents the Company in London, will be pleased to answer all inquiries.

Mr R. W. Paul. Owing to the necessity for acquiring additional accommodation, Mr. R. W. Paul, electrician and instrument maker, has recently fitted up a new factory at 114 and 115, Great Saffron-hill, London, E.C., with new machinery and motive power, which will enable him to cope with his increasing business. The offices at 44, Hatton-garden, E.C., are retained.

Oil Engines.—The fact that Messrs. Crossley Bros. (Limited) decided some time ago to place on the market an oil engine is a guarantee that in their mature judgment such engines were likely to prove efficient and useful if well made, and with such a record as the firm possess for the manufacture of gas engines, engine users have little to fear on that score. We have before us Messrs. Crossley Brothers' latest lists, and it is not surprising that amongst their largest customers are many of the leading electric light contractors. For country house and similar installations the Crossley oil engines have proved cleanly, efficient and economical. Messrs. Crossley Bros. have reduced the first cost of these engines to the lowest point, and are now offering engines from 2 H.P. to 10 H.P. nominal, at prices ranging from £85 to £185. They are fitted with the latest type of ignition valve, and will burn any common petroleum oil, a fuel which can be readily obtained everywhere. It is claimed for the engines that they combine all the advantages of the well-known Crossley gas engine.

Electro-Harmonic Concert.—The first Ladies' Night of the season will be held at the St. James's Hall Restaurant, Regent-street, W., on Friday, November 30th, at eight o'clock. An excellent programme is provided.

Award.—The Franklin Institute of Philadelphia has awarded the John Scott legacy and medal to Mr. Ralph Hart Tweddell, M.Inst.C.E., in recognition of his inventions in connection with the system of hydraulic machine tools with which his name is associated.

Brentford.—At the last meeting of the Local Board, a letter was read from Mr. Sowerby, asking upon what terms the Board would be prepared to grant him facilities for the installation of the electric light in the district. The clerk was instructed to reply that the Board could not entertain the matter without further information.

Colliery Lighting.—Messrs. J. P. Hall and Co. have in hand an extensive installation of arc and incandescent lighting for the collieries of Messrs. Chatterley-Whitfield (Limited).

Electric Boat Propulsion.—The newest thing in electric boat propulsion on the Thames is stated to be a complete installation, with propeller, which can be fitted to a rowing boat in the same way as an ordinary rudder. The motor is fitted in a water-tight case, and the propeller is mounted on the armature spindle, which for this purpose projects through a stuffing-box on the water-tight casing in the same way as the twin shafts and propellers project from a steamship. The casing, with the motor enclosed, and with the propellor projecting, is lifted over the stern, and two little pintles are dropped into two eye-holes in the stern. The current, which is stored in accumulators stowed under the thwarts, is led to the motor by wire. An ordinary rowboat can, it is said, be fitted in a minute or two with accumulators and the machinery for driving at about five miles an hour. No particulars of cost are given.

Exports of Telegraph Wire.—The export trade of this country in telegraph wire and apparatus connected therewith was very quiet during October, as during that month the value of the exports only amounted to £22,262, as compared with £246,081 in the corresponding month of last year. The returns for the ten months of the year ending with October are, however, more satisfactory, these showing a total of £1,326,856 as against £1,012,305 for the corresponding period of last year, and only £831,638 for the first ten months of 1892.

Fire.—A fire occurred on Wednesday at the works of the British Xylonite Company at Homerton, by which nine persons were injured and the premises greatly damaged.

Grasmere.—The question of the electric lighting of the Local Board's district was mentioned at the last meeting, the Surveyor saying that he had been advised that the cost of supplying the current would be too great to allow of the Board themselves entertaining the question. The Chairman said the matter must be left over to the new District Council.

Hertford.—On September 7th the Town Council carried, by the casting vote of the Mayor, a resolution adopting the electric light for the city, and at the meeting of the Town Council on Friday the Lighting Committee reported that the engineer was engaged in preparing the necessary plans, &c., in anticipation of the Local Government Board inquiry. The Committee recommended that formal contracts should be entered into for the purchase of a site for the electric light generating station. The motion for the reception of the Committee's report was met by an amendment for the rescission of all the resolutions passed in September for the carrying out of the electric lighting scheme. A lengthy and animated discussion ensued, and in the result the amendment was carried by 11 votes to 8.

Leeds.—A special meeting of the City Council was held on Wednesday to consider the question of making application to the Board of Trade for a Provisional Order for the extension of the tramways, including the Roundhay Park electric line. It had been intimated at the last moment that the Board of Trade would not be able to grant an Order in the case of the proposed Roundhay Park extension, which was outside the city boundary, and it was ultimately decided to introduce a Bill into the next session of Parliament, empowering the Corporation to make the proposed extension.

Llandudno.—A special meeting of the Improvement Commissioners was held on Friday, to consider the advisability of applying for a Provisional Order. The Chairman explained that the Board decided last August that it was expedient that an Order should be applied for, and their solicitor had informed them that unless they did so at once the Commissioners would be powerless to oppose a private company which contemplated taking that step. A resolution that the Board now make the necessary application was carried unanimously, and a committee was appointed to carry the matter through.——A public meeting was held on Wednesday to consider the proposed electric lighting scheme of the Llandudno Electric Supply Company (Limited), and the opposition of the Improvement Commissioners thereto. A resolution in favour of the installation of the electric light being entrusted to the Company was, after some discussion, lost by a large majority.

Madras.—According to the *Indian Engineer*, the Madras Electric Tramways Company does not seem to be making progress. By the terms of the concession, and making due allowance for the six months' extension granted to the Company by Government last year, Sections No. 1 and 2 of the tramways should be substantially complete and open for traffic on this date. But they are not. A local paper says:—"There is a general feeling prevalent that the delay manifested in laying down the line is in some degree due to a shortness of funds."

Metropolitan Asylums Board.—At the meeting of the Board on Saturday it was reported by the North-Western Hospital Committee that they had engaged Prof. W. E. Ayrton to report on the question of lighting the North-Western Hospital by electricity, and to prepare a specification and supervise the work; and that they had accepted an offer by the Hampstead Vestry to supply current to the hospital at 4d. per unit. The Committee's report was adopted.

Milngavie.—When erecting several shops and dwelling-houses on the site of the old Calico Print Works, the owner decided to fit them all up for electric lighting, and on Friday evening the current was turned on for the first time. Power is obtained from a turbine driven by the river Allander, which actuates a dynamo capable of supplying 150 16-c.p. incandescents. Messrs. R. D. Smillie and Co. supplied and erected the plant.

Motherwell.—At a special meeting of the Motherwell Police Commissioners on Tuesday it was unanimously agreed to apply for a Provisional Order empowering the Commissioners to introduce electric light, the subsequent action of the Commissioners in the matter being subject to review after the order is obtained. It is estimated that the total cost would be £12,500.

The Pacific Cable.—Mr. Mackenzie Bowell and Mr. Fleming on Friday last opened at Ottawa the tenders for the proposed Pacific cable. Six tenders were, it is said, received covering each of the routes proposed. Before details are announced Mr. Bowell is to communicate them to the different Colonial Governments.

Paisley.—The Caledonian Electric Supply Company having intimated their intention of applying for a Provisional Order authorising them to supply electricity within the burgh, and proposing to make an offer for the transfer of the Provisional Order obtained by the Council, at their last meeting the Town Council heard a statement from Mr. Bryson, electrical engineer, as to the prospects of a Corporation central electric lighting station. He estimated the cost to private consumers at four times the price of gas at 2s. 10d., and said, in his opinion, it was not desirable for the Corporation to undertake the work, but that it would be preferable for them to transfer their Provisional Order if suitable terms could be arranged. It was ultimately decided that the Town Clerk should invite offers for the transfer of the Order.

Personal.—In consequence of the approaching transfer of the dynamo factory of Messrs. Easton, Anderson and Goolden (Limited), in Harrow-road, London, W., to their works at Erith, Mr. Slater Lewis, the manager of the former establishment, has retired, and was on Monday evening the recipient of a handsome present, subscribed by the employees as a token of respect and esteem. In thanking the subscribers, Mr. Lewis referred to the perfect harmony and good feeling which had pervaded the whole establishment during the time that he had had the pleasure of managing it. He also thanked Mr. Goolden and Mr. Atkinson, Directors of the new Company and principals in the late firm of Messrs. W. T. Goolden and Co., for the extreme kindness which had been extended to him since he had the honour of working for them; also, for the handsome testimonials which they had been good enough to give him. Mr. Lewis's services have been retained by Messrs. P. R. Jackson and Company (Limited), of the Salford Rolling Mills, Manchester, and he will shortly be leaving London for the purpose of taking up his new duties, which will include the manufacture of dynamos, motors, and electric mining machinery.

The River Plate.—The *Board of Trade Journal* for November contains an interesting extract from the *Montevideo Times*, dealing with the subject of English trade and foreign competition in the River Plate. The British Minister at Montevideo, Mr. W. Baring, holds the same views as many of his colleagues, that English manufacturers do little to conciliate foreign buyers on catering for their wants, tastes, and caprices.

Ship Lighting.—Messrs. J. P. Hall and Co., of Oldham, have in hand a contract for lighting a large steamer now completing at Messrs. Harland and Wolff's shipbuilding yard at Belfast, the plant comprising two sets of combined engines and dynamos.

Southport.—On Friday, the Mayor, Alderman Dr. Wood, switched on the electric current from the central lighting station at Crowlands for the first time. A description of the plant appeared in our last issue.

Swindon.—At a recent meeting of the Swindon Local Board, the General Purposes Committee recommended that Mr. J. G. W. Aldridge, of Victoria-street, Westminster, be the electrical engineer for the purposes of the Provisional Order for electric lighting for the town. and that the notice applying for a Provisional Order include every street within the district, and all the public buildings belonging to the Board. An amendment to the effect that the Committee should reconsider the question, as the Board were not fully acquainted with the scheme, was not seconded, and the Committee's recommendations were adopted.

Taunton.—Colonel Hasted, R.E., an inspector of the Local Government Board, held an inquiry at Taunton on Tuesday, in reference to an application from the Town Council for permission to borrow £5,000 for the purpose of electric light extension. The Inspector afterwards visited the electric light works, and the decision of the Local Government Board will be made known in due course.

Wells.—At the last meeting of the Town Council the Public Lighting Committee presented a report of the reception of the deputation from the Gas Company consequent on the application from Mr. A. Dixon Brown for a concession for the electric lighting of the town. The Gas Company said they were desirous of favourably considering any application made to them by the Council relative to the cheapening of the public lighting. The Mayor said the Town Clerk was in communication with the authorities of every town where electric light was in use, and he suggested that the information thus obtained should be printed for circulation amongst the Councillors. This suggestion was adopted.

Whitehaven.—It was reported at the meeting of the Town and Harbour Trust last week that the number of applications for the electric current had been more than sufficient to exhaust the supply by the present plant, and no more connections could be made until the additional machinery had been provided.

Winchester.—At the last meeting of the Hampshire County Council the Public Works and Building Committee reported that the new county offices had made fair progress towards completion, and that, while they did not recommend at present the adoption of the electric light, they suggested that the buildings be now wired, in order to save disturbance of the walls at any future date, and that they be authorised to expend the estimated amount of cost, £187. If the electric light were introduced, the total cost of fittings, including a gas engine, was estimated at £800, while the annual charge for gas for the engine would be about £25 to £30. The cost for gas fittings now allowed for was £230, and the annual charge for gas would amount to about £50. If electric lighting were adopted, the initial cost would therefore be, say, £570 more than the charge for gas, while the annual charge would be less. An amendment to the motion for the adoption of the Committee's report was moved, that the electric light be installed, at a cost not exceeding £800; but the Chairman ruled it out of order, as no expenditure over £50 could be authorised except on the recommendation of the Finance Committee. The Committee's report was ultimately adopted.

Worcester.—At the meeting of the Watch Committee of the Corporation on Saturday, the Sub-Committee reported that they had arranged with the Brush Company to work the electric light installation for three months from October 11th, and the Company having consented to the terms proposed, this arrangement was approved.

Worthing.—A special meeting of the Town Council was held on Friday to consider a report prepared by Prof. A. B. W. Kennedy on the electric lighting of the borough. Prof. Kennedy estimated that it would be necessary at first to provide for 5,400 8-c.p. incandescent lamps for private consumers, and for 48 arc lamps for street lighting. It had been suggested that the old waterworks buildings might be utililised as a central station; but, after a careful examination, he was of opinion that neither the buildings nor the plant were suitable for an electric lighting station, and he advised that special works should be erected on a vacant part of the ground. The cost of the initial installation he estimated at about £27,500, and an additional expenditure of £7,500 would increase the maximum output by more that 150 per cent. The calculated cost of the street lamps was £888 per annum, against about £340 paid at present for gas; but while the cost would be two and a-half times more the amount of light obtained by the arc lamps would be forty times greater than was now yielded by gas. At a charge of 8d. per unit, a revenue from private consumers of £2,430 was estimated. Prof. Kennedy was of opinion that a high tension system with accumulators was the best for Worthing. After some discussion it was resolved to apply to the Board of Trade for a Provisional Order, and to defer the further consideration of the matter.

COMPANIES' MEETINGS AND REPORTS.

West India and Panama Telegraph Company (Limited).

The thirty-fifth ordinary general meeting of the members of this Company was held on Wednesday, at Winchester House, Old Broad-street, under the presidency of Mr. C. W. Earle.

The SECRETARY (Mr. R. T. Brown) read the notice calling the meeting, and the minutes of the last meeting, which were signed by the Chairman as correctly entered, and the report of the Directors was taken as read.

The CHAIRMAN: I am sure the shareholders will feel as much as we do on this side of the table the discouraging recurrence of the opening words of the second paragraph of our report. In the last seven reports we have presented to you that paragraph has commenced in five of them with the words, "The traffic receipts for the six months show a decrease," and if I add up the total of the decreases, which are five, and balance them against the two in which there have been small increases, a loss to the Company is shown altogether of about £18,000. If we eliminate the results of the piece of luck we had this time last year in the interruption of the French cable, the decrease in the past half-year in the normal traffic of the Company is about £2,400. At our last meeting I touched upon the causes of these recurring decreases, and I pointed to the increased skill displayed by the merchants who use the telegraph in codifying their messages, by which the average number of words in each message has been reduced by one-half since we have been at work in the West Indies. I do not know whether that influence has increased during the past half-year, because we do not make up those statistics until the end of the year; but I should think it is quite fair to presume that the merchants have not increased the average length of their communications. With regard to the other cause to which I attribute our decrease—and it is the more serious one, the decline in the value of sugar—that decline has gone on since the last time I had the pleasure of addressing you. At that meeting I quoted the price of Muscovado, which is a representative brand of sugar, at 10s. 9d. to 11s. 9d. per cwt, as against 12s. to 13s. The present price, however, is from 8s. 9d. to 10s., a decrease in value of about 2s. per cwt. When it is remembered that in the early days of this Company 1 cwt. of the same sugar sold for 27s. you may imagine what a change must have taken place in the economic conditions of the West Indies; and on that subject some instructive light has lately been thrown by the report of a Royal Commission appointed in September, 1893, to inquire into the condition and affairs of the Island of Dominica. Dominica is one of our stations. The Royal Commissioner was Sir Robert Hamilton, lately Governor of Tasmania, and a very distinguished servant of the State in other departments of the Civil Service. The facts he gave in his reports are of interest to us, and, if you will allow me a few moments, I will just touch on them. Dominica, although poor in comparison with some of the islands, is telegraphically representative of a certain class of our West India stations. The history of Dominica is very interesting to every Englishman, for it has been the scene of very great deeds. It is an island which, situated between the two French islands of Martinique and Guadeloupe, has been a constant bone of contention between the English and the French. They have fought for it and taken it from each other more than once. It was in sight of that island that the decisive victory of Lord Rodney was gained over the French admiral De Grasse in 1782; and the year after Lord Rodney's victory the island of Dominica was secured to the English by the treaty of Paris. At that time, it appears, the English Government sold the lands of that island for a sum of over £300,000. I should like to know what they could get for it now. It is an island of the greatest beauty. I have heard it described with rapture by those who have sailed round its coast or wandered in its tropical valleys. Its superficial extent is about 300 square miles—but in that area there are only five miles of metalled road and only 25 miles of road on which wheeled traffic can travel at all. The consequence is that the produce of the different estates is carried to the ports of embarkation either in boats along the coast or on the heads of the inhabitants over the bridle paths of the island. The Colony has not been a very tranquil one; there have been occasional troubles, and in 1893 a disturbance occurred between the police and the inhabitants, and the police, who were distraining for a land tax, were overcome. The Governor thereupon summoned assistance, by means of our telegraph, from a man-of-war, and the marines were landed. The disturbance was put down, but only after four persons had been killed and two women had been injured. This was the final cause of the appointment of a Royal Commission. You may imagine from what I have said that this is not a very remunerative island for a telegraph station. It is connected with the rest of the world by a duplicate system; two cables land on its shore, and it has, in fact, as much telegraph facilities in that way as the Cape of Good Hope or New Zealand, and about twice as much as the colony of Mauritius. To show you what we get out of it, I may state we sometimes earn £7 in fourteen days by international telegraph messages from this island.

That is 10s. a day. In one month there were no international messages sent out of the island, and only one message of six words was sent to it from outside our own system. For conducting that traffic we have to keep up this station, it being insisted on by the Telegraph Acts of other islands. Instead of this being a commercial company, it is really carrying out a considerable Imperial work in connection with the police arrangements and the protection of the Colonies. It seems to me that with respect to a certain group of these islands, this is the only reason for our existing there. I need not say, however, that we get no assistance from the Imperial Government for carrying out these Imperial services. The telegraph has enabled the Government to reduce their forces in the West Indies; there used to be one more battalion of infantry kept in the West Indies than is now the case. No doubt, that reduction of the forces, which saves a considerable amount of money, is owing to the telegraph facilities we give them. In 1889 a concentration of troops in the West Indies took place, this being entirely permissible by the existence of the telegraph. That was a very wise measure from a military point of view. Instead of having their forces frittered away in these small islands they consolidated them at Barbadoes and Jamaica, where they remain now. There can be no doubt that the moral influence of the telegraph, the people knowing that assistance can be summoned from Barbadoes or Jamaica, or wherever the forces may be, is very great; and the telegraph is also a very great preventive against those scandals which disgraced some of the West India Islands before the telegraph was there. Most of us are old enough to remember what happened in Jamaica in 1864, with the hangings, floggings, and burnings that took place there at that time. There has been nothing of that sort since the establishment telegraph. I forgot to mention that this unfortunate Colony has been giving us a subsidy of £400 a year: but, owing to its impoverished condition, it has not paid this subsidy since June, 1893. We have reminded them of this from time to time, but the Colony has always treated us with consideration, and we have not thought it wise or proper to insist too much on their payment of this amount. The Royal Commissioner recommends that a loan should be raised, and if it is raised I suppose that the debt of the Colony to us will be one of the first payments made by them.

Turning to the accounts, I have, as usual, not very much to remark upon them. There is an apparent decrease in the expenditure of about £300, but this is more apparent than real. In fact, it has arisen—other things being considered—in the advantage we took this time last year, owing to our windfall through the French interruption, to write off an extra £1,000 from the value of our ships, which we thought stood too high. In point of fact, therefore, there has been no economy on the expenditure side. The item of "staff endowment assurance," £125, appears for the first time. You will remember that the shareholders very generously authorised us to spend a part of the money we had saved by the reduction of two in the number of the Directors in doing something for our very excellent staff, and the charge which appears now in the revenue account will no doubt be somewhat increased. When, however, the arrangement comes into full swing, this item will be a little more than appears at the present time; but we shall not go within a considerable distance of the sum we saved by the reduction in the strength of the Board. The increase in the expenses attending repairs and renewals of cables figures under abstract C, and the principal cause of that is mentioned in paragraph 4 of our report. The cable between Jamaica and Cuba failed in a great depth of water. We do not know why it did so, and we can never tell. There is an old saying of a Scotchman, who, in relating the consequences of a certain event, said, "and bang went saxpence." Some little volcanic disturbance at the bottom of the sea has occurred, and bang goes sixpence of your dividend. This repair cost us £4,000. The repairing work was interrupted by bad weather, and we had to put in 25 miles of new cable and also lost a good deal of grappling gear. The sum of £4,000 represents two years' of the Jamaica subsidy, and this is one of the cables connecting Jamaica with Cuba. And yet you are sometimes told that your subsidies are excessive! There is a satisfactory paragraph at the end of the report in which it is stated that the Danish Colonies of St. Thomas and St. Croix have renewed their subsidies for five years. I have written to thank these Colonies, I only wish that the English Colonies were always as liberal as foreign Colonies sometimes are. The English Colonies generally only vote us subsidies for one year at a time. I wish that the example of the small Danish Colonies were followed by the English Colonies. I now beg to move—

'*Resolved, that the Directors' report and accounts to June 30, 1894, submitted to this meeting, be and the same are hereby received and adopted, and that, as recommended by the Board, dividends of 6s. per share on the First Preference shares, and 6s. per share on the Second Preference shares, and 6d. per share on the Ordinary shares (the last free of income tax) be and the same are hereby declared.*"

Mr. WILLIAM ANDREWS seconded the motion.

The CHAIRMAN: If any shareholder has any question to ask I shall be very glad to answer him. After a pause, no shareholder rising to address the meeting, he continued: I will now put that to the meeting. Those who are in favour of it will please to signify the same in the usual manner. To the contrary. Carried. That concludes the business of the meeting, and I am very much obliged to you for having attended on such an unpropitious day.

Mr. TREBBLE proposed a vote of thanks to the Chairman and Directors for their management of the affairs of the Company.

Mr. CHAMBERLAIN seconded the motion, which was carried unanimously.

The CHAIRMAN: I am very much obliged to you for your vote of thanks. It is not a very easy business to manage this Company, with its small traffic receipts and inadequate revenues

Westminster Electric Supply Corporation (Limited).

An extraordinary meeting of this Company was held on Wednesday at the offices, Eccleston-place, Belgravia, S.W., Lord Suffield (Chairman) presiding.

In moving a resolution confirming that passed at the extraordinary meeting of the 24th ult., increasing the capital of the Company for £300,000 to £400,000, the CHAIRMAN said: Since we last met the Board has had the advantage of conferring, not only with our financial advisers, but also with a great many of the largest shareholders of the Company with reference to the issue of the new shares at a premium, and I hope you will see the advisability of our adopting that course. After the resolution has been confirmed the Directors will hold a meeting at which they will finally settle the terms and date of the issue. It is impossible for the moment to give you these particulars because we have not yet decided upon them. The whole matter has had our most careful consideration, and as soon as we have arrived at a decision notice will be sent round to the shareholders explaining what it is.

Mr. J. BROWN MARTIN seconded the resolution.

Mr. W. COOPER said he thought it would be more satisfactory, before the resolution was passed, if the shareholders were informed on what terms the new shares would be issued to the shareholders.

Mr. J. H. POWELL repeated that, as the Directors had not yet come to any resolution as a Board on the subject, it was impossible to state the terms on which the new shares would be offered.

Mr. DARNTON HUTTON said he should like to urge that the shares be issued at par. If the Company were prosperous, and had paid for a long time good dividends, there would not be so much to say against issuing them at a premium as there was in the present circumstances. He thought that to issue the shares at a premium would be taxing the shareholders for the benefit of the Company. Instead of raising money for an amortisation fund, as he supposed the £20,000 which, with a premium of £1 a share, the £100,000 of new capital would yield, he suggested that a better method would be to charge the income of the Company with £5,000 a year.

The CHAIRMAN: We have met simply to confirm a resolution actually passed on the last occasion. At the same time I was very unwilling not to object to hear any suggestion the principal shareholders might wish to make. I can assure the meeting that not only have the Directors already given, but that they will continue to give, their deepest consideration to the question, although, as I previously told you, the Board thought it would be right and wise to charge a premium, and that view was also entertained by a great many shareholders, as well as by our financial advisers.

The resolution was then put to the meeting, and carried. A vote of thanks to the Chairman terminated the proceedings.

Western and Brazilian Telegraph Company (Limited).

The following is the report of the Directors, to be presented at the twenty-eighth ordinary general meeting of the Company, to be held at Winchester House, Old Broad-steet, E.C., this day (Friday), at noon:—

The total earnings for the half-year ended June 30, 1894, amount to £77,603. 3s. 6d., as against £79,373. 10s. 4d., a decrease of £1,770. 6s. 10d. compared with the half-year to June 30, 1893. The working expenses amount to £39,739. 11s. 5d., as against £43,424. 1s. 3d., a decrease of £3,684. 9s. 10d. Including the amount brought forward from 1893 (£1,045. 6s. 6d.), the balance to the credit of the revenue account is £38,908. 18s. 7d., from which has to be deducted £11,672. 10s. for debenture interest, £5,000 for the debenture redemption fund, and £2,000 placed to reserve fund. This leaves £20,236. 8s. 7d. Looking at the improvement apparent in Brazilian affairs, the Directors are of opinion that they can prudently recommend the payment of a dividend free of income tax, for the half-year, at the rate of £2 per cent. per annum, carrying forward £5,630. 6s. 7d. The dividend will be payable as follows: viz., 3s. per share to the Ordinary shares, and 3s. per share to the Preferred Ordinary shares.

The volume of traffic for the period referred to in these accounts shows a large increase in the number of words carried, as compared with the corresponding period of 1893, but owing to the causes before explained, and the low rate of exchange, the income is less: the Directors are, however, pleased to state that the rate of exchange has improved since August.

The traffic over the Pacific and European Company's line connecting Buenos Ayres with Valparaiso, which was opened in March last, has steadily developed, and shows encouraging prospects. The companies interested determined to allow a period of six months to elapse to see how this traffic progressed before settling the proportions of the through rates to be allotted to each company; consequently no credit has been taken for this business, which will be included in the next account, and promises to produce a satisfactory and permanent addition to the Company's income.

Now that the Courts have reopened it is expected that the question in litigation between this Company and the Brazilian Submarine Company on the subject referred to in the last report will soon be heard. The Directors, as before advised, have taken credit for the sum in dispute, but have carried over a larger balance to meet contingencies.

The Directors have to notify that the conversion of Ordinary shares into Preferred Ordinary and Deferred Ordinary shares will be suspended on and after January 1, 1895, until further notice.

County of London and Brush Provincial Electric Lighting Company (Limited).

The following is the Directors' report to be presented at the general meeting to be held at the Cannon-street Hotel, London, E.C., on Monday next, the 19th inst., at two p.m. :—

The Directors beg to submit their first report since the capitalisation of the Company, which took place in April last, up to June 30, 1894.

County of London.—The work necessary for giving effect to the Provisional Orders held by the Company for the districts within the county of London, is in active progress under the contracts mentioned in the prospectus of March 28, 1894, and by which it is provided that generating plant capable of supplying 90,000 8-c.p. glow lamps shall be erected by September 30, 1895. Contracts for the laying of pipes for street mains have been entered into, and are now being executed. It is intended to at once lay sufficient conductors to meet immediate requirements, together with a number of spare pipes into which, without further disturbance of the roadway, additional cables may be drawn when required. The Directors have acquired at a moderate rental, under a 99 years' lease, a suitable site at the Regent's Canal Basin, upon which the generating station for the St. Luke's and Clerkenwell districts will be erected, and they have made arrangements with the owners for obtaining additional land, should it become necessary at any time to enlarge the buildings. The freehold has also been secured of riverside premises in the Wandsworth district, upon which the generating station for that area will be built. At both these stations coal can be delivered out of barges alongside the buildings, and there is an abundant supply of water available for boiler feeding and condensing purposes.

Provinces.—The Company has purchased a controlling interest in the Bournemouth and District Eelctric Supply Company, the extension of whose business during the past year has been very encouraging, and it is expected that the accounts for 1894 will show a substantial profit. The connections to the mains of the Bournemouth Company are now equivalent to about 18,000 8-c.p. lamps. The Company is also largely interested in the Dover Electricity Supply Company. Work upon the station buildings and mains of that Company is approaching completion, and it is expected that it will be in a position to supply current to consumers by the end of the present year. The prospects of the Dover Company are very hopeful, in view of the arrangements already entered into with the Corporation for street lighting, and with the military authorities. Other important lighting contracts at Dover are also in course of negotiation, with every probability of a satisfactory conclusion. At Windermere the water-power of the River Leven at the outlet of Lake Windermere has been secured, and the Windermere and District Electricity Supply Company has been formed for the purpose of utilising this power in supplying current at a moderate price to such towns in the neighbourhood as may desire to avail themselves of it.

Future Annual Accounts and General Meetings.—It is intended to close the financial year in future on December 31st, and to present the accounts to that date at the annual general meeting to be held in March or April following. Under this arrangement the next general meeting will be held early in 1895, when the provisions contained in the Articles of Association with regard to the retirement and election of Directors and auditors will take effect.

NEW COMPANIES, STATUTORY RETURNS, &c.

ARMANNI AUTOMATIC STAMPING COMPANY (LIMITED).—This Company was registered on November 6th, with a capital of £212,000, in £10 shares, to acquire and deal with certain patents relating to stamping, to enter into an agreement with Luigi Armanni for that purpose, and to carry on the business in England or elsewhere, of stampers of metals of all kinds, engineers, merchants, manufacturers of iron, steel, brass, copper, and other metals, factors, &c.

BRAYTON PETROLEUM MOTOR COMPANY (LIMITED).—This Company was registered on November 8th, with a capital of £80,000 in £1 shares, to acquire Letters Patent granted or to be granted to Hugh T. Reid, of 29, Duke-street, St. James', London, S.W., by the Governments of Germany, France, Belgium, Italy, Spain, Austria, Russia, and India, for improvements in hydro-carbon engines, and to carry on in the before-mentioned countries or elsewhere, the business of manufacturers of and dealers in hydro-carbon engines.

EWING ASBESTOS COMPANY (LIMITED).—This Company was registered on November 7th, with a capital of £10,000 in £1 shares, to carry into effect an agreement between William Smith and Mentor A. Chadwick, for the acquisition by the Company of the business carried on by the Ewing Asbestos Company, and to carry on the business of asbestos miners, manufacturers, and merchants, and dealers in engines, boilers, and machinery of every description.

MITCHELL CORBITT AND SONS (LIMITED).—This Company was registered on November 7th, with a capital of £50,000 in £10 shares, to acquire the business and assets of T. W. Spencer and Company (Limited), of Hebburn, and elsewhere, and to carry on the business of manufacturers of and dealers in wire ropes, wire workers, and drawers, telegraph, telephone, and electric light cable manufacturers, lightning conductor, and electrical appliance manufacturers, &c.

RANDALL'S PHONAUTOGRAPH COMPANY (LIMITED).—This Company was registered on November 9th, with a capital of £25,000, in £1 shares, to carry into effect an agreement made between William J. Hailstone and Walter H. Cook, and to carry on the business of manufacturers of and dealers in instruments and apparatus known as "phonautographs," or phonographs, or other appliances for recording and reproducing articulate speech and other sounds.

WALKER, TURNER AND COMPANY (LIMITED).—This Company was registered on November 7th with a capital of £2,000 in £1 shares, to acquire the business carried on by "Walker, Turner and Co., and to carry on the business of manufacturers of and dealers in preparations for cleansing, preserving, scaling and otherwise treating boilers and other parts of machines, engines and other appliances.

RONALD A. SCOTT (LIMITED).—The statutory return of this Company, made up to July 27th, was only recently filed. Out of a nominal capital of £10,000 in £1 shares 5,007 have been taken up, of which 5,000 were issued as fully paid to Ronald A. Scott, electrical engineer, of The Elms, Acton Hill, Middlesex, in part satisfaction of the purchase consideration. Upon the seven signatories' shares the full amount has been called and paid.

ST. MARTIN'S ELECTRICAL MANUFACTURING COMPANY (LIMITED).—The statutory return of this Company, made up to December 21, 1893, was recently filed, when 45 shares were subscribed for out of a nominal capital of £500 in £5 shares. Consequent on the calling of the full amount per share £225 has been received.

SIEMENS BROTHERS AND COMPANY (LIMITED).—The annual return of this Company, made up to October 25th, has been filed. The whole of the nominal capital of £500,000 in £100 shares has been taken up, and upon each of these shares a call of £85 has been made, resulting in a payment of £425,000.

CITY NOTES.

BIRMINGHAM CENTRAL TRAMWAYS COMPANY.—At an extraordinary meeting of the Company, on Wednesday, the resolution previously carried for the reduction of the capital was confirmed.

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ended November 11th were £969, as against £911 in the corresponding period of 1893, being an increase of £58. The total receipts for the half-year amount to £16,719, as against £15,591 for the corresponding period of 1893, an increase of £1,128.

JOHANNESBURG LIGHTING COMPANY (LIMITED).—Negotiations have been pending for some time for the sale of this Company's undertaking to the municipal authorities. They are now practically conducted (says the Johannesburg correspondent of a financial contemporary, under date of October 20th), and the arrangement arrived at merely awaits the formal assent of the Sanitary Board, which will be given on Wednesday next. The shareholders have already accepted it in principle, and have delegated discretionary powers to Sir James Sivewright, who has conducted the negotiations on their behalf. The purchase price it £160,000, payable in cash or 5 per cent. City Bonds, for the issue of which the consent of two-thirds of the ratepayers in public meeting assembled has to be obtained. The Government must also sanction the deal before it can be finally settled ; but no difficulty is expected in that quarter, so that Sir James Sivewright's task may be looked upon as *un fait accompli*.

JOINT STOCK COMPANIES.—The Board of Trade have appointed a committee to inquire what amendments are necessary in the Acts relating to joint stock companies incorporated with limited liability, especially with a view to the better prevention of fraud in relation to the formation and management of companies, and to consider and report upon the clauses of a draft Bill which will be laid before them for that purpose. The following will form the committee, viz. :—Lord Davey, the Hon. Mr. Justice Chitty, the Hon. Mr. Justice Vaughan Williams, Sir William Houldsworth, M.P., the President of the Associated Chambers of Commerce (Sir Albert Rollit, M.P.), Mr. A. F. Wallace (a Director of the Bank of England), Mr. H. B. Buckley, Q.C., Mr. F. B. Palmer, Mr. John Smith (Inspector-General in Bankruptcy), Mr. John Hallams, Mr. F. Crisp, Mr. E. Waterhouse, and Mr. George Auldjo Jamieson. Mr. T. Girdwood Macfie has been appointed secretary.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended the 11th inst. amounted to £892. The amount for the corresponding week last year was £577.

SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).—Shareholders are requested by the liquidator to send in their certificates in exchange for the new securities. Each holder of five fully-paid shares will receive in exchange as follows :—$3\frac{1}{15}$ fully-paid £5 shares in the Edison and Swan United Electric Light Company (Limited) £6. 0s. 7d. debenture stock, £1. 0s. 8d. cash, being dividend and interest to June 30, 1894. Each holder of five partly-paid shares will receive as follows :—$3\frac{1}{5}$ partly-paid £3 shares in the Edison and Swan United Electric Light Company (Limited) £4. 16s. 6d. Debenture stock, and 14s. 2d. cash, being dividend and interest to June 30, 1894.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—With reference to the proposed purchase of this undertaking by the Brazilian Government, the following are the terms of the Company's concession of 1873 :—"At any period after the first ten years reckoned on the day on which the lines shall begin working throughout their whole extent, and until the term of the concession expires, the Government may redeem them, with their respective stations and dependencies. The price of such redemption shall be fixed by arbitrators, and shall take into consideration not only the value of the works in the state in which they then are, without regard to the original cost, but also of the net yield of the lines on an average of the five previous years. And in no case shall the price of redemption be less than the actual cost to the Company of laying down and working the cables."

This Company's traffic receipts for the week ended November 9th (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited) were £3,132.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Nov. 7.		Price Wednesday, Nov. 14.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 14.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£1,012,880	Stock	9 0	Anglo-American	36	38	35	37	6 8 1	Jan., Apr , July, Oct.	38½	38¼
£2,993,560	Stock	18 0	Do. Preferred	71½	72½	70	71	5 19 9	„ „	71¾	70⅛
£2,993,560	Stock	5/0	Do. Deferred	6¼	6¾	6¼	6¾	..	..	6⅜	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 17 1	January and July	..	..
130,000	£10	4/0	Brazilian Submarine	12½	13	11¼	11¾	5 10 8	Mar., June, Oct., Dec.	13	11¾
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	110	114	110	114	4 8 11	June and December	..	—
10,000,000	$100	$1¾	Commercial Cable Capital Stock	135	145	135	145	4 17 9	Jan., Apr.,July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12½	13½	12½	13½	5 18 6	February and August	13⅜	..
6,000	10	10%	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	„ „	..	..
12,931	5	1/8	Direct Spanish (£4 paid)	4¼	4¾	4¼	4¾	4 4 3	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¼	9¾	9¼	9¾	6 2 7	„ „	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	4 3 4	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8	8½	8	8½	5 17 7	Jan., Apr., July, Oct.	8 7/16	8¼
400,000	10	2/6	Eastern	15⅝	15⅞	15⅝	15⅞	4 1 11	„ „	16	15¾
70,000	10	6%	Do. 6 per Cent. Preference	16½	17	16½	17	3 10 7	„ „	16¼	16 9/16
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock xd	119	122	117	120	3 6 8	May and November	121½	118
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	110	106	110	4 11 11	February & August	..	..
250,000	10	2/6	Eastern Extension	15¾	16	15⅞	16⅛	4 6 10	Jan., Apr., July, Oct.	16 1/16	15⅞
£820,000	Stock	4%	Do. 4 per Cent. Debenture Stock	116	120	116	120	3 6 8	February & August	..	—
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	106	103	106	4 15 6	January and July	105½	—
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	106	103	106	4 15 6	„ „	104	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	104	107	104	107	3 15 6	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	107%	110%	107%	110%	3 12 9	May and November	109¾	108
180,227	10	1/3	Globe Telegraph and Trust	8⅝	8⅞	8⅝	8⅞	4 15 9	Jan., Apr., July, Oct.	8¾	8 11/16
180,042	10	6%	Do. 6 per Cent. Preference	15½	16	16½	16	3 15 0	„ „	15 11/16	15¾
150,000	10	5/0	Great Northern	20½	21½	20½	21½	3 19 1	Jan., April, and July	21	20 13/16
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	..	—
17,000	25	12/6	Indo-European	46	48	46	48	5 4 2	May and November	..	..
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	„ „	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	107	110	105	107	5 12 8	March & September	108½	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	104	107	104	107	3 15 8	..	..	—
11,839	8	4/0	Reuter's	3	5	3	5	..	April and October	..	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	103	108	103	108	5 7 11	„ „	106	104½
16,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	100	103	100	103	4 17 10	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	.	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	101	106	101	106	7 10 11	June and December	102	101
88,321	10	9d.	West India and Panama	1⅛	1⅜	1	1¼	..	..	..	.
34,563	10	6%	Do. 6 per Cent. 1st Preference	11	11½	11	11½	6 4 4	May and November	11⅜	11 1/16
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	„ „	..	..
£80,000	100	6%	* Do. 6 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 11 6	June and December	..	..
64,242	15	7/6	Western and Brazilian	9¼	9¾	10	10½	..	May and November	11	9½
33,129	7½	7/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	6¾	..	..	7	6½
33,129	7½	4/6	Do. 5 per Cent. Deferred	3¼	3¾	4¼	4¾	..	..	5¼	3 13/16
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	107	110	103	106	5 14 10	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	107	110	103	106	5 14 10	„ „	.	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	112	118	112	118	5 18 8	May and November	116¾	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 16 6	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	..	2⅜	..
224,850	10/0	2⅞d.	Consolidated Telephone Const. & Maintenance	⅛	¼	1/16	3/16	..	May and November	..	..
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	7/16	9/16	7/16	9/16	..	Yearly	—	..
484,507	5	3/4	National	4⅞	5⅛	4⅞	5⅛	4 17 7	June and December	5 1/16	4 15/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	16	15	16	3 15 0	„ „	.	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	15½	14½	15½	3 17 5	„ „	15¼	—
119,234	5	3/4	Do. 5% Non-Cumulative 3rd Pref.	5½	5¾	6½	6¾	4 6 11	..	6⅜	6 11/16
1,000,000	Stock	4½%	* Do. Debenture Stock, 4½% (red.)	110	113	110	113	4 0 9	January and July —	111¼	110
58,000	5	1/0	United River Plate	2	3	2	3	..	„ „	..	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	88	94	88	94	5 6 5	„ „	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	12½	13½	12	13	..	..	13	..
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	14¾	15¼	14¾	15¼	3 18 8	..	15 5/16	14⅞
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	131	133	131	133	3 15 2	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	4½	5½	4½	5½	3 12 9	—	..	..
£57,400	£100	6%	Do. 5 per Cent. Debentures, 1900	..		..		..	..	..	..
8,322	£5	..	House-to-House Electric	..		..		—	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		—	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		—	January and July —	..	—
45,000	£5	2/6	Liverpool Electric Supply (fully paid)	6⅝	6¾	6⅝	6¾	—	..	..	—
111,000	5	..	London Electric Supply	⅛	⅜	..		.	..	..	—
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	9¼	9¾	9¼	9¾	2 11 3	..	9 7/16	9⅝
£150,000	Stock	4½%	* Do. 4½% Debs. (Bonds of £10, £20, and £40)	113½	114½	113½	114½	3 19 0	June and December	..	..
6,452	£10	..	Notting Hill Electric	6	7	6½	7½	—	..	6 11/16	—
19,980	£5	2/0	St. James and Pall Mall	7¾	8¼	7½	8	..	..	7¾	7¾
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9½	8¾	9¼	3 15 8	—	9 1/16	—
50,000	5	2/0	Westminster Electric Supply (fully paid)	7	7½	7	7½	3 0 0	—	7⅜	7¼
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅜	2⅝	2¼	2⅜	5 14 3	..	2 5/16	2 3/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2¼	2½	4 16 0		2½	2 5/16
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	111	114	110	113	4 0 2	March & September	111½	110
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2¼	2¾	2½	3	—	January and July —	..	..
12,139	5	..	Edison and Swan United	—		—		..	..	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	..	—	..
120,000	2	..	Electric Construction	⅜	⅝	⅜	⅝	..	—	..	..
12,845	2	2 9¾	Do. 7 per Cent. Cumulative Pref.	1½	2	1½	2	..	—	—	..
91,105	2	10/0	Elmore's Patent Copper Depositing	1⅜	1⅝	1⅜	1⅝	..	—	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	.	.	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	26	26	25	20	4 16 1	February & August	26¼	25⅝
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 5 0	March & September	..	—
15,995	£10	0/4	International Okonite Ordinary	..		..		—	..	..	—
10,000	£10	..	Do. 8 per Cent. Preference	—		—		—	December and June	..	—
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	¼	—	¼	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	41	43	41	43	4 3 9	March and July .. —	42¾	41¼
£150,000	100	6%	Do. 5 per Cent. Bonds	100	109	106	109	4 11 9	January and July	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	—		—		..	..	..	—
41,098	£5	..	Do. Preference (fully paid)	..		—		..	—	..	—
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	8	9	8	9	6 11 1	..	..	.
£30,000	10	..	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1%	City and South London Railway	37	39	37	39	2 11 3	May and November	37¾	..
7,000	10	5	Do. 5 Perpetual Preference	13½	14	13½	14	3 11 5	.	14	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	120	122	120	122	3 5 7	May and November	..	..
87,500	£10	1%	Liverpool Overhead Railway	8	8¼	7¾	8 1/16	1 4 7	..	..	..
6,295	10	6%	Do. 6% Preference	13	13½	13	13½	3 15 6	..	—	—
£125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July ..	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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NOTES.

Dr. Hopkinson's appeal to the President of the Board of Trade at the dinner of the Institution of Electrical Engineers to relax the severity of the rules drawn up by his Department, was, it must be admitted, extremely adroit. But Mr. Bryce's reply was no less so. As President of the Board of Trade he was not prepared to enter into the delicate question of the exact number of lives it was justifiable to sacrifice beneath the Juggernaut car of rapid transit; and it seemed to him that the industrial applications of electric energy would be the more quickly adopted the greater the confidence the public had in the safety of the new agent placed at their disposal.

The American electrical engineer, said Dr. Hopkinson, was much less trammelled than his *confrère* in this country, and in America there were thousands of miles of electric tramways. We do not know whether Dr. Hopkinson meant to imply that if English electrical engineers were equally free an equal mileage of electric tramway would to-day exist in the United Kingdom. If that were the implication, it does not seem to us that circumstances altogether warrant it; indeed it is not quite clear to what kind of trammels Dr. Hopkinson referred. The present agitation about light railways relates to the railway regulations, and not a word of complaint has been heard against the Board of Trade electric traction regulations, and it must be remembered that those who were to be ruled by them had a decided voice in their drafting. But if no Board of Trade rules of any sort had ever existed, would one single mile more electric track be to-day in operation in Great Britain? Had the American experiment-at-the-expense-of-the-public style of construction been permitted by the local authorities, it is to be doubted whether the English public would have greatly patronised it or long tolerated it. The Board of Trade may, it is true, be wholly and solely responsible for the high standard of safety and comfort of our railways; but in such a purely domestic matter as a tramway, it is the Local Authority and the man-in-the-street who settle the question of the minimum permissible safety and the maximum permissible unsightliness. And all this is quite apart from the very different light in which Americans and Englishmen regard tramways; either as a means of locomotion, or, thanks to the purchase clause of the Tramways Act, as a mode of investment.

The observations made by Mr. Siemens in the course of his presidential address to the Institution of Junior Engineers, on the fascinations and the follies of inventing are worthy of attention from experienced members of the profession, as well as from those to whom his words were addresed. Inventing has been the ruin of many a man, though it has been apparently the fortune of others. But, if the lives of inventors be examined it will often be found that the unsuccessful inventor is a capable man whose career has been sacrificed to this mania. Mr. Siemens describes a very sad case of this kind. On the other hand, if we turn to the lives of well-known prosperous inventors, and remove from them the inventive faculty and the fruits of their inventions, we find not a mere residuum of mechanical skill, but sound technical knowledge, wide practical experience, keen commercial instincts, strict businesslike habits, activity, perseverance, and all the qualities which command success. A man who is nothing but an inventor is generally half ignorant of the matters with which he busies himself, and totally ignorant of the allied branches. He too often becomes suspicious and jealous, he falls into the temptation of such tricks as taking "fishing" patents; if he meet with a little success he becomes conceited, or if with failures, he is embittered; and when the mania urges him, he will, like Palissy, burn his tables and floor boards while his children cry for food. We fully agree with Mr. Siemens in his views about cheap patents, and we believe that they encourage the worst sort of inventors, and tempt others into the practice.

The long-standing dispute, to which we have several times referred in these columns, between the London County Council and the Vestries, as to the duration of electric lighting loans, has, it would appear, at last received something in the nature of a solution. In 1891 the St. Pancras Vestry started the ball by requesting the loan of £10,000, for 60 years, for the purchase of a site, and one of £60,000, for 42 years, for the construction of electric lighting works. But the Council, finding itself legally unable to lend sums to be devoted to buildings for a longer period than 30 years, obtained parliamentary powers to make advances for electric lighting purposes for a maximum period of half a century. At the beginning of the present year, however, the Finance Committee, in an excess of doctrinaire economic accuracy, split up a loan of £30,000 asked for by the St. Pancras Vestry into its constituent items, and allotted to each a different period of repayment. This super-accuracy proving too much for the Council as a whole, the Committee next recommended a 25-year period, which was adopted. Six months later the Committee, vainly trying to secure something like consistency, recommended that a similar loan to the Hampstead Vestry should be repaid in the same period. The Council, however, promptly extended the term to 42 years. The Finance Committee, ever seeking some standard by which to guide itself, thereupon adopted the 42-year period as a standard. But it had reckoned without the Treasury. Once more it set to work to laboriously investigate the probable life of various electrical appliances. Meters, it came to the conclusion, were good for five years, accumulators for eight, arc lamps for ten, boilers and insulated mains for fifteen, engines and dynamos for twenty, bare-copper mains and culverts for forty, and buildings for sixty; and finally, striking an average, decided that in future the Council would do well to lend for 50 years on land, buildings, culverts, and bare-copper mains, and for 20 years for expenditure on all other purposes. This proposal was adopted by the Council on Tuesday, and as it hits off the golden mean between doctrinaire economics and the encouragement of municipal extravagance, it is to be hoped the plan will satisfy all parties concerned. The net result of immediate interest to the electrical engineer is that a certain well-marked class of mains has received a splendid, disinterested, gratuitous advertisement.

Not uncommonly there is sweet simplicity in the gist of a very complicated subject. This, for example, is the case with the theory of rotatory field electromotors worked by means of polyphase currents; the essential principle of their working, and the vital theory, so to speak, of their efficiency, are matters which are capable of explanation in very simple terms. But, unfortunately, many writers who venture to explain these matters are not careful to disentangle the one central simple fact from the complicated web of outlying secondary considerations which a free use of symbolical mathematics can enshrine in such awful glory. The thanks of all students of the elements of this important subject are due to Prof. S. P. Thompson for the very clear and simple language, enforced by the use of easy graphic methods, by which, in an article which we publish this week, he explains the rudimentary principles of polyphase motors. There is nothing in this article which the veriest mathematical tyro ought not to be able to understand. We would call our readers' attention particularly to the interesting explanation of the use of starting resistances in putting a motor of this class on to a stiff load. To the ordinary user of continuous current motors the idea is almost ineradicable that the use of such resistances at starting must be to prevent a sudden rush, so to speak, of very large current and an excessively high torque. Not so, however, with polyphase motors; for the starting resistance is thrown into circuit for the express purpose of *increasing* the torque. If the reader is puzzled to know how this can be, he cannot do better than read through Prof. Thompson's article.

The Llanfairpwllgwyngyl Light Railway.—We understand that a scheme is under consideration for the construction of a light railway from Menai Bridge or Llanfairpwllgwyngyl to Beaumaris, Anglesea, and surveys of both routes have been completed. At present communication between Beaumaris and the neighbouring towns is restricted to ferries and roads.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
Maranham-Para	Nov. 10.	Nov. 19.
Sierra Leone-Accra	Nov. 13.	Nov. 18
Zanzibar-Mombasa	Sept. 4.	—
Bilbao-Falmouth	Nov. 15.	—
Amoy-Gutzloff	Nov. 10.	—
Hongkong-Amoy	Nov. 16.	—
St. Vincent-San Thiago (for repairs)	Nov. 19.	—

Accident at Blackpool—While a man was attending to a defective arc lamp in the Blackpool streets last Thursday week, he received a severe electric shock, which caused him to hang from the post and call for help. A passer-by who went to his assistance also received an electric shock; but when the workman was brought down it was found that no more serious injury than severe burns had resulted.

The Board of Trade Conference on Light Railways.—The London Chamber of Commerce, in response to the invitation from the Board of Trade, have nominated Sir Edward H. Carbutt, Bart. (Chairman of the Engineering and Allied Trades' Section), and Mr. Emil Garcke (Chairman of the Electrical and Allied Trades' Section), as the delegates of the Chamber to the Conference on Light Railways which is to meet early next month.

Uxbridge Road Electric Tramway.—We learn that the Hammersmith Vestry have given their sanction to the use of electrical power for tramcars in the Uxbridge-road. The system to be adopted by the London United Tramways Company is the overhead-trolley system. Steel tube standards of light pattern placed in the centre of the roadway 120ft. apart, and so arranged as to be capable of being used as standards for electric lighting purposes are to be used.

The Zédé Submarine Boat.—Last week the submarine torpedo-boat Gustave Zede began her trials at Toulon. She is a cigar-shaped vessel, 131ft. long, and displacing, when submerged, about 266 tons. On Wednesday she moved about the roadstead for three hours, never, however, as far as could be seen by those who were watching her from the shore, going beneath the surface. She attained a speed first of about five knots, and subsequently of about eight knots, with the 300 new accumulators with which she has recently been fitted. It appears that, although the boat was probably not submerged for a single moment, those on board experienced some discomfort from the acid vapours.

Storage Battery Litigation.—The Electrical Power Storage Company have commenced a suit for infringement of the Swan accumulator patent, and have issued a writ for injunction against the Chloride Electrical Storage Syndicate (Limited). The other defendants are, Mather and Platt (Limited) and Dr. John Hopkinson, F.R.S.——In reference to the above, at the moment of going to press, we are asked to state that "the Chloride Electrical Storage Syndicate, Messrs. Mather and Platt (Limited), and Dr. John Hopkinson contend they are fully justified in making and using these cells, and that they intend to offer a most strenuous resistance to the claims made on them." Also that "the Chloride Electrical Storage Syndicate are prepared to indemnify all persons who have purchased batteries from them, or who may do so."

Electric-Lighted Lifebuoy.—The Allgemeine Elektricitäts Gesellschaft are putting on the market a new lifebuoy. The new buoy is provided with an electric light, which begins to shine as soon as the buoy is detached. It is supposed to keep three men afloat, with due allowance for heavy clothing. The buoy contains gelatinous accumulators, which are expected to retain their charge for two months, and are capable of feeding a 16-c.p. glow lamp for six hours. A strong glass lens surrounds the lamp, and renders the light visible at a distance of 2,000 yards. The whole lamp is protected by a cage of tinned steel wire, which rises above the body of the buoy. The leads end in strong springs. In the suspended lamp the weight of the apparatus keeps the springs down and the circuit open. When the buoy is detached the circuit is closed. These buoys weigh about a hundredweight.

Electricity v. Gas in Paris.—The Civil Tribunal of the Seine has decided in the lawsuit arising out of the Larue restaurant explosion, in the Rue Royale, Paris, that an electric company which lays its wires, traversed by powerful currents, in the proximity of a gas pipe, without sufficient insulation, commits a grave fault, and incurs responsibility therefor; and, on the other hand, that the employees of a gas company, the industry being essentially a dangerous one, when they are called upon to go at once to their consumers that these may show them an abnormal state of things, fail in the absolute duty of their profession if they pay then no heed to the representations made to them, and they make the Company responsible for this neglect. The accident in question was caused by an explosion of gas which had got out of a pipe perforated by an electric leak, and travelled up the pipes containing the electric wires. The Popp Company was found liable in three-fourths and the Paris Gas Company in one-fourth of the damages, which were estimated at £7,080.

Telephonic Interference.—A correspondent of the *Electrical World* of New York mentions the following interesting example of telephonic interference:—

> "A trunk line of telegraph wires passes through Mechanicsburg, Pa., from Harrisburg, Pa., to Pittsburg, the distance between the first two stations being eight miles. A short telephone line with earth return runs from Mechanicsburg to a small station about a mile west, parallel to the above trunk line, and about 100ft. from it. One calm Sunday afternoon the writer had occasion to transmit two messages over the telegraph line to Harrisburg, whence they were to be sent to Baltimore. After sending both I casually placed the telephone receiver to my ear and I could plainly hear the ticking of telegraphic instruments in the Harrisburg office. To my surprise, I soon heard the Harrisburg operator sending my messages to Baltimore. In this connection it is to be remembered that the Harrisburg-Baltimore line runs due south, while the first-named trunk line runs due west. The two lines, however, terminate in the same switchboard at Harrisburg. Induction probably takes place from one telegraph line to another, and then eight miles away the induced current on the telegraph line influences the short telephone line."

Electrolytic Copper Refining.—We understand, says the *Engineering and Mining Journal* of New York, that the electrolytic copper refining plant of the Anaconda mine, at Anaconda, Mont., which has a capacity of 50 tons a day, is nearly completed. It is said that the cost of refining is about one farthing per pound. A portion of the refined copper is shipped in the form of wire bars, and the balance in crude plates as they leave the electrolytic tanks. It is said that the company is so well pleased with the result of the work that it is preparing to build a large plant for the same process at Great Falls, Mont., where Belt coal is obtainable at about 4s. a ton, and there is an abundant water power. The Anaconda Company is thus preparing to refine its entire output, as, indeed, most American producers now do. The outlook for foreign refiners to get crude material from the States is, therefore, the *Engineering and Mining Journal* is "happy to say, very poor." There is a report that it is the intention of the Calumet and Hecla management to change its smelter at Buffalo into an electrolytic plant.

Utilisation of Electricity in the Construction of Bridges.—A bridge on the arch principle, with a span of 540ft., is in process of construction over the canal near Kiel, at an elevation of 145ft. above the level of the water, to carry the railway from Eckemforde to that town. Four cranes, two of the locomotive and two of the pivoting type, are employed, instead of the usual hoisting appliances, and are all worked by electricity. According to the *Elektrotechnishe Zeitschrift*, loads of 10 tons are raised in 20 minutes, and smaller loads at a much quicker rate. With 850 revolutions per minute, the cranes develop 7 H.P., the electromotive force does not exceed 220 volts. Two compound dynamos, disposed in parallel, act as generators, driven by a steam engine of 25 H.P. Both dynamos and electromotors are of the four-pole type. As the consumption of the motive-power in the cranes was of a very variable character, variable resistances attached to slabs of slate are interposed, as required, by an automatic appliance. The electric circuit comprises three parallel wires ¼in. in diameter, with a total length in both directions of three-quarters of a mile. In order to work the cranes, which have a dead weight of their own of 33 tons, at a speed of 6in. per second, the electro-motor requires 40 amperes and 210 volts.

Ignition of Leaking Gas by a Trolley Car.—According to the *Western Electrician* of Chicago, a number of men were engaged in digging holes in a Brooklyn street to discover a leak in the gas mains. One of them made an excavation 3ft. deep between the rails of an electric line, and at this depth found much escaping gas. A car came along; but the gas had increased to such an extent that the workman sprang out of the hole, instead of crouching down until the car passed, as he had done before. It was fortunate that he adopted this precaution, for as the car passed over the hole the escaping gas was ignited by the sparks at the motor brushes, and rushed up in a sheet of flame on either side of the car with a loud report. The passengers were very much frightened, of course, and some of them jumped from the car, which was quickly stopped. It was found, however, that no one was hurt, and that the car was uninjured. The flame rose to a height of 10ft., and could not be extinguished before the gas was turned off. The workman was congratulated on his narrow escape from serious injury, and the mishap was added to the list of "trolley-car accidents." Of course, the fault was entirely that of the defective gas main; and many similar accidents, in which electricity played no part, can be recalled.

Fatality at the Taunton Electric Lighting Station.—About 6:45 p.m. on Tuesday evening, November 6th, Warren Upham, a pupil of the Corporation, was seen by a labourer (who was washing a portion of the floor) going towards No. 1 alternator (70 unit Thomson-Houston) with an oil-can to replenish the bearings. A minute later he was found leaning against the bed of the exciter and belt-guard behind apparently dead. Medical aid was at once summoned, but of no avail. There were no marks on the body, save an abrasion on the left arm caused by the belt of the exciter as the body lay. The doctor made a post mortem examination of the body and found the organs healthy. He was of opinion that death was due to an electric shock. There was no evidence to show how the shock was received as no one witnessed the occurrence. The Inspector of Factories attended the adjourned inquest on the 15th inst., and expressed himself perfectly satisfied with the precautions that had been taken to guard against accidents. To quote a local paper anent the occurrence, "at the Taunton Electrical Depôt it would be difficult to provide more precautions than at present exist. It is for the assistants to make use of the precautions offered them and there will be no danger." The jury brought in a verdict of death from an accident caused by an electric shock, and wished to add that if possible greater care should be taken to insulate the dangerous parts of the machines, and a safer system of oiling should be adopted.

Electric Traction at Chemnitz.—According to a recent report of the United States Consul at Chemnitz, the trolley system of electrical traction was substituted for that of horses on the city tramways a year ago. The wires are hung from the house walls instead of poles. The method of laying or stringing the wires is by rosettes fastened into the walls or woodwork of the houses, from which hooks, to which the wires are attached, project. In the case of wooden walls, large screws are turned into the walls; in the case of stone walls, a long jagged iron is driven in and cemented. These are then tested with at least seven times the weight that they are intended to bear; owners of property preferred to allow the use of their houses free for a year, to having a post on the sidewalk. The system is simple, cheap, convenient, easily adjustable, and free from much of the ugliness inseparable from the network of wires used for the trolley. The cars have no conductors, the motor man being the only person representing the Company. The saving to the Company thus effected amounts to £2,200 a year. The fare is but 1⅓d. on all routes, including transfers. Fare boxes are attached to the front and rear parts of the car. The increase in traffic since the change from horse to electrical traction is said to be 60 per cent., notwithstanding a strenuous opposition for a long time to the change, and a year of exceedingly hard times. Public opinion was divided between the trolley-overhead and the underground system now working in Buda-Pesth. It was claimed, and pretty satisfactorily proved, that in northern cities, where snow falls heavily and lies on the ground a long time, not only is the trolley best, but the underground system is not satisfactory.

Effect of Cathode Rays on Salts.—In No. 38 of the *Sitzungsberichte* of the Berlin Academy, Prof. Goldstein gives an account of a curious effect which the cathode rays exert on the colour of certain salts. If potassium chloride be made to phosphoresce in a radiation-tube, it quickly assumes a strong heliotrope shade, and eventually becomes bright violet. On heating, the colour changes to blue, and at high temperatures the salt becomes white. The same series of colour-changes may be obtained with this decolourised salt, and also with naturally occurring potassium chloride or sylvine. Several haloid salts of the alkali metals were examined, and with the exception of cæsium and rubidium chlorides all gave after-colours. The chlorides of barium and strontium gave no after-colours. In ordinary air the colour disappears the more quickly the more soluble the salt. The colour of lithium chloride fades almost immediately; the blue colour of sodium chloride last about a day. In contact with water the salts at once lose their colour. In a vacuum or in dry air the deep blue colour of lithium chloride has now lasted for two months without apparent change. The colour of potassium chloride gradually fades and completely disappears in about a week; the behaviour of most of the salts is like that of potassium chloride. The cause of these phenomena is unknown. The salts were as pure as could be obtained. Electrodes of different materials gave the same results. The radiation-tubes contained, of course, a little mercury vapour; but none of the known compounds of mercury with the constituents of the salts have the colours above described. Chemical decomposition is unlikely, since the coloured salt gradually changes into its original condition. The author inclines to the view that during phosphorescence the particles of the salt have been made to take up positions and motions differing from those of the unaltered substance, and that a physical modification of the salt has thus been brought about.

Magnetic Qualities of Gun Steel.—The October number of the *Journal* of the United States Artillery contain a contribution from Lieut. Geo. Squier (U.S.A.) on "Some Tests of the Magnetic Qualities of Gun Steel." The article embodies the results of a series of experiments recently made in the laboratory of the Johns Hopkins University. The steel was a muzzle-ring from a 3·2-inch breech-loading rifle cut from the gun as the last operation. The steel originally came from the Bethlehem Iron Company, of Bethlehem, Pennsylvania, and is a low steel of remarkable physical qualities, forged, oil tempered and annealed. The results of the tests are here given in the author's own words:—

The very superficial tests made indicate that the steel of our new guns, besides possessing remarkable physical qualities, also has excellent magnetic qualities; and, but for the cost, could be used for the construction of electrical machinery with very efficient results. In fact a comparison of the B H curve with Hopkinson's curve for the best wrought iron shows them to be practically the same in character, and when further compared with the curves for the average steel castings from various manufactures in the United States, we find magnetic values about 8 per cent. in favour of gun-steel. This indicates an improvement produced by forging as compared with simple steel castings, and for marine dynamos, and in gun-training motors where space is valuable, steel of high permeability will, probably, be exclusively used in the future. Passing to the hysteresis behaviour, it was observed that the hysteresis curve is of the characteristic "square-shouldered" type, which is often found in steel and almost always in annealed soft iron. This bend in the curve, which is not a decided "knee" in this case, divides the curves into parts corresponding to the stable and unstable conditions in Ewing's theory. The rate of descent from the bend during the reversal of the magnetism is remarkably rapid and uniform, while the comparatively small area inclosed shows the effect of annealing. Hardening steel increases hysteresis loss, so that samples with exactly the same chemical constitution show very different losses, depending upon whether they have been annealed or hardened. From data which has but recently come to hand, it would appear that there is a connection between the magnetic qualities and the physical conditions of steel as indicated by a combination of high physical qualities; for instance, nickel steel, possessing in an unusual degree a combination of high elastic limit and ductility, is also found to possess exceptionally high magnetic permeability.

Atmospheric Resistances at High Speeds.—Some efforts have again been made in France to overcome the air resistance which a locomotive encounters when running at a high speed. *La Nature*, for October 27th, contains a very interesting article by M. Max de Nansouty, descriptive of the experiments of M. Ricour, originally made in 1887. In these, inclined planes were placed in front of the engine, and, by adopting this means, making the slanting planes four in three, and filling up the spokes of the wheels, the resistance was diminished by one-half. This resulted in a noticeable increase of useful work, and an economy of 10 per cent. in the coal consumption. The results are so satisfactory that M. Ricour has fitted his apparatus on forty engines belonging to the Paris-Lyon-Mediterranée Railway for general traffic. Similar experiments were carried out in 1890 by M. Dresdouit, chief engineer to the State railways, and they were of more prolonged character. The engines in this case were ran 300,000 kilometres, and, by means of this apparatus, they saved six to eight per cent. coal consumption, and sometimes as high as twelve per cent. M. Max de Nansouty tells us, however, "*il est vrai que le chaffeur et le mécanicien étaient excellents.*" A few other experiments were tried with seemingly the same satisfactory results. The main point, however, is that, on an average, a benefit of four to five per cent. is obtained by the use of these inclined planes; and it is asserted that this is more than the saving obtained from locomotives with compound and other systems. If the statement be true, says *Nature*, our locomotive superintendents had better take heed, as nothing has yet been done in this direction. We are not told, however, how the apparatus behaves with a side wind. On the other hand, experiments tried long ago in this country showed no useful result at all.

Light Railways and the 4ft. 8½in. Gauge.—The following is from a letter that appeared in *The Times* of Tuesday last:—

In the letters that have lately appeared in *The Times* on the subject of light railways for agricultural districts, one point that has been specially urged is the importance of being able to convey the agricultural produce from the farms to market without break of bulk, by the light railways being made standard gauge. But in some previous letters on the subject in *The Times* a narrow gauge has been spoken of, and referred to apparently under the impression that light railways necessarily implied narrow gauge. This is, however, a misconception, although the idea has been often previously assumed. Light railways are simply railways constructed with much lighter rails and sleepers than the main lines, and laid upon the surface of the ground with comparatively little preparation of earthwork and ballasting—analogous, in fact, to the temporary lines regularly used by contractors in the construction of railway works. The question of gauge in the present case practically affects the cost little more than in adding the few inches' difference in length of the sleepers between standard and narrow gauge. The sleepers in the present case would be light steel sleepers riveted to the rails, and the line really a "portable railway," admitting of being readily shifted about in position amongst the farms as change of circumstances may require. Now, in the present case of agricultural railways, the question of gauge is of vital importance, and it is really an essential element in their success. The present difficulty that they are required to meet is that the farmer is in many cases unable to get his produce conveyed to market for sale at a profit on account of the heavy cost of conveyance from the want of good roads; and if, notwithstanding the saving in cost of conveyance effected by light railways, the farmer were handicapped by the expense of unloading and reloading at the junction with the main line, he would really be little, if any, better off than before. This applies also to the return traffic in manure, coals, &c., and for the success of the scheme an essential point is that there shall be no break of gauge, and the main-line trucks shall be brought direct into the farms without the contents being required to be handled in transit. All who are practically acquainted with the subject are aware that agricultural produce will not stand the cost of any intermediate unloading and reloading, such as would result with a break of gauge; and the desired object of assisting agriculture would be defeated, unless the produce is loaded direct at the farms into the trucks that will take it to market.

——The *Engineer*, in the course of a vigorous leading article entitled "Light Railways for Farmers," in which it argues that farmers do not very much require such lines, has the following cogent remarks as to gauge:—

It has been proved over and over again in every country under the sun in which a railway system exists, that the cost of a road is very little affected by the gauge. It is quite true, all the same, that there are numbers of light railways in existence which have cost very much less per mile than normal lines. But this was scarcely, if at all, due to the reduction of the gauge. It is obviously wholly a consequence of the inferior character of the road. The inclines are steeper, the ballasting is worse, the curves are sharper, and so on. The difference is kindred in character to that between the price of a good horse and of a small pony or donkey; and the difference would have been very much the same whether the gauge was 4ft. 8½in. or 3ft., or 2ft. 6in.. About this there is really no room for dispute. Every railway contractor in the kingdom, every civil engineer versed in railway work, knows all about it. There is no longer any question. There is nothing to discuss. There is a saving due to the narrowness of the gauge, but it is scarcely worth having. Reduced to its simplest aspect, the light railway is cheap because it is inferior in every respect to the normal railway. It is not, as some folks would have the world believe, just as good, but cheaper because it carries only four persons on a seat instead of five. The gauge of a line is the least important factor in determining its cost.

ELECTROMAGNETIC THEORY.—LIX.*

BY OLIVER HEAVISIDE.

Continued from p. 59, Vol. XXXII.

§ 223. That the study of the theory of a physical science should be preceded by some general experimental acquaintance therewith, in order to secure the inimitable advantage of a personal acquaintance with something real and living, will probably be agreed with by most persons. After, however, the general experimental knowledge has been acquired, accompanied with just a sufficient amount of theory to connect it together and render its acquisition easier and more interesting, it becomes possible to consider the theory by itself, as theory. The experimental facts then go out of sight, in a great measure, not because they are unimportant, but because they become subordinate to the theory in a certain sense, and, we might also add, because they are fundamental, and the foundations are always hidden from view in well-constructed buildings. So it comes about that a great theoretical work like Maxwell's treatise on Electricity and Magnetism contains so little explicit information regarding the experimental facts of the science. Theory always tends to become abstract as it emerges successfully from the chaos of facts by the processes of differentiation and elimination, whereby the essentials and their connections become recognised, whilst minor effects are seen to be secondary or unessential, and are ignored temporarily, to be explained by additional means.

There is the same tendency in the most abstract and logical of all sciences—pure mathematics. Geometry, for instance, has most certainly an experimental foundation, like any other science. We make our geometry, in the first place, to suit the state of things in which we are born and live. We all make our acquaintance with geometry first through our senses, and become saturated, so to speak, with the essence of the geometry of nature, even though this be unaccompanied by any intelligent comprehension and expression. Now take a hint from nature, and we can see plainly how much it is to the advantage of the learner that he should continue, in the first place, to acquire geometrical ideas through his senses, though now, of course, with his attention specially directed to the subject, freely assisted by models, solid and skeleton, before being set to work upon the more intellectual theory on a formal basis. For, disguise it as we may, no strictly formal basis, apart from experience, can ever be possible. There is always something very considerable to start with of an experiential nature in the background, besides the formal axioms and definitions and postulates which would be unintelligible without it. A straight line can never be intelligibly defined *per se*. One must actually know the practical straight line before any definition of the abstract straight line can be understood. Then our understanding and acceptance of the definition is a recognition that it states what we knew already, in accumulated experience, though we may have never openly thought about it. As regards an axiom, such as the one that asserts that two straight lines cannot enclose a space, its acceptance involves the existence of a very extensive experience of the geometry of nature as it is found to be. How impossible, then, must it be to prove anything rigorously as absolute truth, independent of nature. We come down to axioms, definitions, and postulates at last, and these are only understandable by experience.

There is also no self-contained theory possible, even of geometry considered merely as a logical science, apart from practical meaning. For a language is used in its enunciation, which implies that developed ideas and complicated processes of thought are already in existence, besides the general experience associated therewith. We define a thing in a phrase, using words. These words have to be explained in other words, and so on, for ever, in a complicated maze. There is no bottom to anything. We are all antipodeans and upside down.

It is by the gradual fitting together of the parts of a distinctly connected theory that we get to understand it, and by the revelation of its consistency. We may begin anywhere, and go over the ground in any way. Some ways will be preferable to others, of course, since they may be easier, or give broader and clearer views, but no strict course is necessary. It may not even be desirable. It may be more interesting and instructive not to go by the shortest logical course from one point to another. It may be better to wander about, and be guided by circumstances in the choice of paths, and keep our eyes open to the side prospects, and vary the route later to obtain different views of the same country. Now it is plain enough when the question is that of guiding another over a well-known country, already well explored, that certain distinct routes may be followed with advantage. But it is somewhat different when it is a case of exploring a comparatively unknown region, containing trackless jungles, mountains and precipices. To attempt to follow a logical course from one point to another would then perhaps be absurd. You should keep your eyes and your mind open, and be guided by circumstances. You have first to find out what there is to find out. How you do it is quite a secondary consideration. Later on, no doubt, much easier and perhaps better ways will be found, so that a crowd can push along. It is obvious, I think, that complaints of the want of perfection of the ways and manners of work of explorers on the part of men who are accustomed to more rigorous methods have a considerable element of the ludicrous in them. However harmless in intention, they may operate unfairly in effect, if they lead, as sometimes happens (of which a case was quite lately brought to my notice), to the rejection of honest work which failed to be appreciated by the judges, who had no doubt different ways of working and thinking, and different experiences. When this result arises, it has the effect of putting a learned society in the unfortunate position of *appearing* to exist not merely for the encouragement of research along established lines, but also for the active discouragement of work of a less conventional character. That this is the case in reality it is impossible to believe. But then, papers are so cheap, and one more or less does not matter. Again, the probable fact that the judges were animated by benevolent motives, and only desired to turn the misguided author from the error of his ways into more rigorous paths approved by themselves, does not make the matter any the better for the author. He has his own ways, and must follow them, even though he be told (virtually) that his work is valueless, and not worth printing, and of course, by inference, that he must not continue to send more of it.

Now, mathematics being fundamentally an experimental science, like any other, it is clear that the Science of Nature might be studied as a whole, the properties of space along with the properties of the matter found moving about therein. This would be very comprehensive, but I do not suppose that it would be generally practicable, though possibly the best course for a large-minded man. Nevertheless, it is greatly to the advantage of a student of physics that he should pick up his mathematics along with his physics, if he can. For then the one will fit the other. This is the natural way, pursued by the creators of analysis. If the student does not pick up so much logical mathematics of a formal kind (commonsense logic is inherited and experiential, as the mind and its ways have grown to harmonise with external Nature), he will, at any rate, get on in a manner suitable for progress in his physical studies. To have to stop to formulate rigorous demonstrations would put a stop to most physico-mathematical inquiries. There is no end to the subtleties involved in rigorous demonstrations, especially, of course, when you go off the beaten track. And the most rigorous demonstration may be found later to contain some flaw, so that exceptions and reservations have to be added. Now, in working out physical problems there should be, in the first place, no pretence of rigorous formalism. The physics will guide the physicist along somehow to useful and important results, by the constant union of physical and geometrical or analytical ideas. The practice of eliminating the physics by reducing a problem to a purely mathematical exercise should be avoided as much as possible. The physics should be carried on right through, to give life and reality to the problem, and to obtain the great assistance which the physics gives to the mathematics. This cannot always be done, especially in details involving much calculation, but the general principle should be carried out as much as possible, with particular attention to dynamical ideas. No mathematical purist could ever do the work involved in Maxwell's treatise. He might have all the mathematics, and much more, but it would be to no purpose, as he could not put it together without the physical guidance. This is in no way to his discredit, but only illustrates different ways of thought. There have been enormous advances made in pure mathematics in the last half century, as is right and proper to match the advance in physical science. But along with this has come a tendency for purists to object to the introduction of physical ideas in mathematics, with a possible lack of rigour as result. It may be that there is no lack of rigour sometimes, but an increased generality and simplified treatment. Maxwell was severely taken to task by a distinguished purist for his use of Green's Theorem in Spherical Harmonics, a method which is excellently to the purpose, and which commends itself to the electrician, and it is probably quite rigorous. But no doubt there is frequently a lack of rigour. I have seen with much pleasure some remarks on this point in the Preface to the recently published second edition of Lord Rayleigh's treatise on Sound, which I cannot do better than reproduce :—

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* This series of articles will form Vol. II. of Mr. Heaviside's work on "Electromagnetic Theory." All rights of reproduction are reserved.

> In the mathematical investigations I have usually employed such methods as present themselves naturally to a physicist. The pure mathematician will complain, and (it must be confessed) sometimes with justice, of deficient rigour. But to this question there are two sides. For, however important it may be to maintain a uniformly high standard in pure mathematics, the physicist may occasionally do well to rest content with arguments which are fairly satisfactory and conclusive from his point of view. To his mind, exercised in a different order of ideas, the more severe procedure of the pure mathematician may appear not more but less demonstrative. And further, in many cases of difficulty to insist upon the highest standard would mean the exclusion of the subject altogether in view of the space that would be required.

Particularly notice the words "not more but less demonstrative." This is exceedingly true, especially in the subject of the expansion of functions in series of other functions, which occupies so large a part of the treatise in question. And I would add that if the physicist does sometimes get carried too far, the proper time to find out the reservations and corrections is later on, in order not to interrupt his work. But this purification is more especially suitable for the purist to undertake. If one sort of work is as necessary as the other, it is certain that the physicist would get very little work done by trying to do both, having the fear of the rigourists before him. What is more hateful than a physical work done in propositions and corollaries? It is bad enough in pure mathematics, and I wish purists would take a lesson from Fourier, Thomson and Tait, Maxwell, or Rayleigh, and tell their tale differently and make it interesting by letting in a little imagination. I have had occasion to go through a considerable part of a very big Theory of Functions in search for what I did not find. The work is most admirably painstaking and severely rigorous, but how different from physical mathematics, how hard to read from its severe formalism, and how narrow it seems from the want of physical illustration. Perhaps the subject might be greatly lightened by having a physical theory to rest upon or to illustrate.

When mathematics is cleared away from physics it becomes set in logical form. But it is to be remembered that the men who have in the past initiated great advances in mathematics have usually been men who were employed in working out physical questions. They supplied the purists with raw material to be made coherent and elaborated. The expansion of functions in series, already mentioned, arose physically. It is an enormous and endless subject, and there is a striking difference in the ways in which it is regarded by the physicist and the rigourist, with the peculiarity that the former is far in advance of the latter. To understand this, consider that a physicist can have practical certainty that a certain expansion is possible, because his physical problem tells him so, when he seeks and finds the solution, even though he has not investigated the properties of the functions used in the expansion. He does not arrange long and severely disagreeable demonstrations to prove what he *knows*; although it be a fallible kind of knowledge, it only differs in degree from most mathematics in this respect. But eliminate the physics, and put it simply as a question of functions. Given certain functions, can an arbitrary function be expressed in terms of them? What a pretty piece of work there must be to answer this question! This is true even in the case of circular functions in the particular case rigorously treated by purists. But by changes in the conditions the physicist gets an endless variety of expansions of one and the same arbitrary function in circular functions, and what becomes of the rigorous demonstration then? Then there is an endless variety of other sorts of functions, every one of which can represent an arbitrary function in an endless number of ways, as is perfectly clear from physical considerations. It is evident that for comprehensive rigorous demonstrations (not special) we need enlarged ideas about functions, and perhaps the purist would obtain the necessary broadness of view by a study of the physics in which such comprehensiveness of expression is found. Certainly the purist is bound to complete the logical treatment some day, but the hard-bound rules of the purist make it difficult. Thus at present, although the purist carries his mathematical developments so far in some directions as to be far beyond physics, out of sight in fact, yet in other respects the purist lags behind. And this is true in other matters than that mentioned. For a physicist may use daily with success, and as a matter of course, methods which he knows work usefully to his assistance, but which are logically unintelligible to a purist, and which have to wait for a proper development.

The best result of mathematics is to be able to do without it. To show the truth of this paradox by an example, I would remark that nothing is more satisfactory to a physicist than to get rid of a formal demonstration of an analytical theorem and to substitute a quasi-physical one, or a geometrical one freed from co-ordinate symbols, which will enable him to *see* the necessary truth of the theorem, and make it be practically axiomatic. Contrast the purely analytical proof of the Theorem of Version well known to electrical theorists, with the commonsense method of proof by means of the addition of circuitations. The first is very tedious, and quite devoid of luminousness. The latter makes the theorem be obviously true, and in any kind of co-ordinates. When seen to be true, symbols may be dispensed with, and the truth becomes an integral part of one's mental constitution, like the persistence of energy.

There is a curious analogy to be found between extensions of mathematical ideas and extensions of electrical theory. Take, for instance, Maxwell's theory in the form presented in Vol. I. of this work, Chapter II. If we do not inquire too minutely into the consequences, we may easily be temporarily under the impression that the two circuital equations and their accessories express the dynamics of a quite self-contained system. But when we go to the very verge of the system, and find that mechanical forces of the ordinary kind are involved when electromagnetic disturbances pass through the suppositional ether which supports them, we come to a stop. Now, there is nothing impossible or incredible in the result. It is simply unintelligible at present. The plain meaning to be given to it without introducing additional data is that the ether, as regards electromagnetic disturbances traversing it, should be regarded like any other dielectric; that is, as having a *substantial* existence. To complete the matter evidently requires a theory of the ether itself, and the suggestion is that it should not be regarded as an elastic solid (generalised) in which the actual displacements in bulk represent the electromagnetic disturbances. But, however this may be (and the matter is difficult and speculative), the point here is that on the outskirts of the theory we come to matters needing interpretation and a larger theory.

So it is in mathematics. The fundamental notions are so simple that one might expect that unlimited developments could be made without ever coming to anything unintelligible. But we do, and in various directions. To say nothing of the interpretation of negative quantity (which is a sort of imaginary), there is *the* imaginary, which has only become understood and its properties developed comparatively recently. But, besides these, there are much more obscure and ill-understood questions, such as the meaning and true manipulation of divergent series, and of fractional differentiations or integrations, and connected matters. It is customary to keep to convergent series and whole differentiations and regard divergent series and fractional differentiations as meaningless and practically useless, or even to ignore them altogether, as if they did not exist. The latter is the usual attitude of moderate and practical mathematicians, for obvious reasons. If they can be ignored, why trouble about them at all?

But when these things turn up in the mathematics of physics the physicist is bound to consider them, and make the best use of them that he can. I am thinking more particularly here of the solution of the differential equations to which physicists are led by quasi-algebraical processes. The reader will see to what I refer by reference to §203, Vol. I., when I allude to the definiteness of meaning of the operator R″ in the equation E = R″C, R″ being a complicated function of a differentiator. See also §221 later on. When C is explicitly given as a function of the time we have to find E to match through the operator R″, and when it is E that is given, then C has to be found by the operation on E of the inverse of R″. It is in the carrying out of these processes in the investigation of various electromagnetic problems that we are obliged to regard certain kinds of divergent series as representing fully significant functions, and the execution of the processes involved in R″, which assumes various algebraical forms, as being legitimate and feasible, however ill-understood may be the theory involved therein.

Nor is the matter an unpractical one. I suppose all workers in mathematical physics have noticed how the mathematics seems made for the physics, the latter suggesting the former, and that practical ways of working arise naturally. This is really the case with resistance operators. It is a fact that their use frequently effects great simplifications, and the avoidance of complicated evaluations of definite integrals. But then the rigorous logic of the matter is not plain! Well, what of that? Shall I refuse my dinner because I do not fully understand the process of digestion? No, not if I am satisfied with the result. Now a physicist may in like manner employ unrigorous processes with satisfaction and usefulness if he, by the application of tests, satisfies himself of the accuracy of his results. At the same time he may be fully aware of his want of infallibility, and that his investigations are largely of an experimental character, and may be repellent to unsympathetically constituted mathematicians accustomed to a different kind of work.

There is another point of view. Convergent mathematics is often excessively unpractical in the labour it involves in the numerical interpretation of results. I have noticed this particularly in spherical harmonic expansions, where the labour is sometimes prohibitive. Under these circumstances the substitution of equivalent divergent series which may be readily calculated becomes a matter of great practical importance. If the example fails, others may readily be given. But what about the theory of functions which deliberately ignores the treatment of divergent series? Can it really be *the* theory of functions? Is not a more comprehensive theory needed, including both convergent and divergent functions in a harmonious whole?

This finishes our preliminary canter, and we may now set to work upon our special subject.

(To be continued.)

PRINCIPLES OF TRANSFORMER DESIGN.

BY ALFRED STILL.

(Concluded from page 67.)

Notes on the Design and Manufacture of Transformers.—An attempt will now be made to deal with a few of the practical points in the manufacture of transformers, and at the same time to consider some of the minor effects, such as temperature rise, magnetic leakage, &c., which have not been included among the foregoing general principles of design.

At the end will be given a summary of the most useful formulæ, and a convenient method of procedure in getting out designs of new sizes of transformers.

The Power lost in a transformer is made up, partly of the copper losses and partly of the iron losses.

The percentage "drop" in volts depends upon the copper losses; the power absorbed on open secondary circuit depends mainly upon the iron losses; and the efficiency is determined by the total losses.

Losses in the Copper.—The total watts lost in the coils of a transformer are—

$$C_1^2 R_1 + C_2^2 R_2, \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where C_1 = primary current, R_1 = primary resistance,
C_2 = secondary current, R_2 = secondary resistance.

The losses due to eddy currents are quite negligible, even for conductors of fairly large cross-section, especially in the case of transformers with closed iron circuits. The state of things is then comparable to that of buried conductors in dynamo armatures, which, as is well known, give no trouble from this cause. The apparent increase of resistance due to unequal current density is also hardly worth considering, especially as, when large conductors are used, they generally consist of flat copper strip, which is more easily bent and takes up less space than a round wire or cable. The apparent increase in resistance of a copper rod $\frac{5}{8}$in. diameter, carrying an alternating current at a frequency of 80 periods per second, is only about 3 per cent. Hence, for all practical purposes, the $C^2 R$ losses only need be considered; but the resistances must be calculated for the (estimated) temperature attained by the coils under the ordinary working conditions.

An increase in the resistance of 1 per cent. for every 2·6 C., or $4\frac{3}{4}$ F., rise of temperature should be allowed.

The volts lost in the primary winding are $C_1 R_1$, and in the secondary $C_2 R_2$.

It follows that the percentage "drop" on secondary terminals due to ohmic resistance, when the transformer is on constant pressure mains, is:—

$$\frac{100 \times (C_1 - \text{open circuit current}) \times R_1}{E_1} + \frac{100 \times C_2 \times R_2}{E_2}, \quad (7)$$

where E_1 and E_2 are the volts at terminals of primary and secondary windings respectively, when no current is taken from the transformer.

Losses in the Iron Core.—Strictly speaking, these are due to two causes; eddy currents and hysteresis.

The eddy current losses in a properly designed transformer are very small. They are generally supposed to vary as the squares of the induction, and frequency, and thickness of stampings. The following formula may be used for the watts wasted by eddy-currents per pound of well-insulated iron plates:

$$\text{Watts per lb.} = \frac{1 \cdot 4}{10^{10}} t^2 n^2 \mathsf{B}_{\prime\prime}^2, \quad . \quad . \quad . \quad . \quad (8)$$

where t = thickness of plates in inches,
n = the frequency in periods per second,
$\mathsf{B}_{\prime\prime}$ = the maximum induction in lines per square inch.

The watts lost by hysteresis depend very considerably upon the quality of the iron. In any one sample this loss varies approximately as the 1·6th power of the induction, if the whole range of magnetisation is considered. For the straight part of the magnetisation curve (referred to in connection with formula 2) which corresponds with the low inductions as used in transformers, it has been pointed out by Prof. Ewing that the losses do not increase so rapidly, but more nearly as the 1·5th power of the induction, and for this reason the law $\mathsf{B}^{1 \cdot 55}$ is adopted in the formula given below.

The number of alternations per second does not appreciably influence the hysteresis loss per cycle, excepting when the latter is very slowly performed; hence the watts lost per pound of iron for any particular maximum value of the induction will be proportional to the frequency. The following formula applies to a good quality of transformer iron, and gives the watts lost per lb.

$$w = 0 \cdot 88\, n\, \mathsf{B}_{\prime\prime}^{1 \cdot 55} \times 10^{-9}, \quad . \quad . \quad . \quad . \quad (9)$$

where $\mathsf{B}_{\prime\prime}$ is the maximum value of the induction in C.G.S. lines per square inch, and n is the frequency, or number of complete periods, per second.

To obtain the watts lost per cubic inch multiply by 0·28.

For an induction of 16,000 lines per square inch and a frequency of 100, the hysteresis losses in transformer iron vary between one quarter of a watt and half a watt, or even more, per pound. The iron from which formula (9) was obtained gave 0·29 watts per pound at this induction and frequency. A loss about $1\frac{1}{4}$ times as great is perhaps more common, but this is rather more than it should be where a high efficiency is important.

The following table gives the losses in a good quality of transformer iron, for various inductions and for frequencies of 80 and 100 periods per second. The thickness of plates is assumed to be 0·014″.

Iron losses per lb.

$B_{\prime\prime}$	$n=80$			$n=100$
	Eddies.	Hysteresis.	Total.	Total.
8,000	0·0112	0·084	0·095	0·1125
9,000	0·0141	0·100	0·114	0·1472
10,000	0·0175	0·1175	0·135	0·1744
12,000	0·0252	0·154	0·179	0·2325
14,000	0·0343	0·194	0·228	0·295
16,000	0·0448	0·232	0·277	0·360
18,000	0·0567	0·289	0·346	0·450
20,000	0·0700	0·338	0·408	0·531
25,000	0·1095	0·468	0·577	0·756
30,000	0·1575	0·630	0·787	1·035
35,000	0·2140	0·805	1·019	1·341
40,000	0·2800	1·00	1·280	1·688
45,000	0·3545	1·22	1·574	2·080

The formula which agrees most nearly with these results is, for $n = 80$.

$$\text{Total watts lost per lb.} = 5{\cdot}35\ B_{\prime\prime}^{1{\cdot}6} \times 10^{-8}. \quad . \quad . \quad . \quad (10)$$

For $n = 100$ the losses are 1·3 times greater, and not 1·2 times greater, as they would be if eddy currents were absent, showing that the total losses for the same inductions increase more rapidly than n.

Thickness of Stampings used in Transformers.—Thick plates cannot be used in transformers, as the eddy current losses would become very considerable. On the other hand, no advantage is gained by using plates thinner than 0·013″ or 0·012″, and makers of transformers confine themselves almost entirely to gauges ranging between 0·016″ and 0·012″. Sheet-iron cannot be ordered to gauge numbers on account of the variation in these, which renders them worse than useless; each manufacturer has his own system of numbers, and there appears to be no attempt at uniformity. The best thing to do under the circumstances, is to state the required thickness in inches, and accept the nearest stock size. Some makers have a system of gauge numbers based upon the gradual increase in weight of the sheets per superficial foot; this might possibly facilitate calculations of weight, &c., if it were generally adopted.

Insulation between Stampings.—This may be thin paper, or varnish, or even the oxidised surface of the plate itself. With paper insulation, the ratio between space occupied by iron and total core space, is frequently about 0·85, or a little less; with a thin coat of varnish on the plates, this ratio may be as much as 0·9. There is a great advantage in reducing as much as possible the space taken up by insulation in the core, as in this way the length of the copper circuit is also reduced. In the old form of Mordey transformer, with air gaps between the stampings, the length of copper circuit (other things being equal) was nearly double what it is in the present form, in which the gaps have been filled up, and the core made "solid."

Efficiency of Transformers.—The efficiency of a transformer at any output is given by the expression—

$$\frac{\text{secondary watts}}{\text{secondary watts} + \text{watts lost in copper} + \text{watts lost in iron}}, \quad (11)$$

where *secondary watts* stands for the actual power supplied to the circuit from the secondary terminals.

Since the copper losses increase as the square of the output, it follows that the most economical load for a transformer is that which makes the copper losses equal to the iron losses. (This may be mathematically deduced from the above expression of the efficiency.) This is why, in a transformer with comparatively small iron loss, the maximum efficiency frequently occurs before the full load is reached.

Temperature Rise.—A large rise in temperature is no sign of inefficiency in a transformer. It has the disadvantage of increasing the resistance of the copper circuit, and consequently the copper losses; but it is not otherwise objectionable unless it is sufficient to soften or injure the insulation. Heating of the iron core reduces the eddy-current losses on account of the increased resistance of iron. To prevent excessive heating a cooling surface of about 4 sq. in. per watt lost in the transformer should be allowed.

Magnetic Leakage.—In some transformers there is a greater drop in volts on the secondary terminals when current is taken off than can be accounted for by the ohmic resistance of the winding. This is due to a bad arrangement of the coils, which allows an appreciable amount of the magnetism generated, to leak across the air-space of the primary, without passing through the secondary coil. This leakage magnetism will be proportional to the strength of the primary current; and it follows that, as the load comes on the transformer, fewer magnetic lines will be enclosed by the secondary, the result being that the volts generated in the secondary will be lower. Note also that it is *only* the *increase* of the stray magnetism *due to rise of secondary current* which produces the extra drop on secondary terminals; a comparatively large magnetic leakage would be of very little consequence if it were not that it becomes greater as the transformer is loaded up.

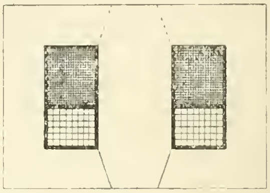

FIG. 9.

By a proper arrangement of the windings, this effect of magnetic leakage may be practically eliminated. For instance, if the primary and secondary turns were wound on side by side in the same space, and not in separate sections, there would be no lines generated by one set of coils which were not enclosed by the other. But there are many objections to this arrangement; the actual difficulties of winding would be very great, and the insulation of the wires would have to be very high in order to sufficiently reduce the chances of a breakdown between the primary and secondary circuits.

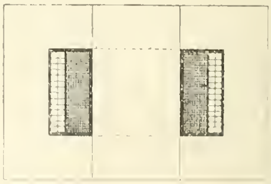

FIG. 10.

The sections, Figs. 9 and 10, are respectively those of a Westinghouse and a Mordey transformer, from which it will be seen at a glance that the drop due to magnetic leakage will be considerably greater in the former than in the latter. In the transformers tested by Dr. Fleming in 1892, the leakage drop for the Westinghouse was over 1 per cent., while, for the Mordey transformer it was only about 0·04 per cent.

General Remarks on Design.—No attempt will be made in this Paper to describe the various forms of existing transformers or to consider the many possible arrangements of iron and copper. In the case of a new design, sketches should be made and examples worked out. This takes very little time, especially as approximations only are needed in the first instance. In designing a transformer, its cost, efficiency, and durability must always be borne in mind. Sometimes, but not often, the weight, or space occupied, or appearance has also to be considered.

In getting out cost of material, it must be remembered that the copper costs about two and a-half times as much as the iron. Copper wire may be taken at 9d. per pound on the average, and the iron stampings at 3¾d. per pound.

By putting sufficient weight of material in a transformer, almost any efficiency may be obtained; but it is a mistake to go too far in this direction, as the cost increases very rapidly for a comparatively small gain in efficiency. No transformer should be considered by itself, but always in connection with the whole system of which it forms a part. If this is done, it will frequently be found that a considerable reduction of the open circuit losses in the transformers will really produce very little change in the all-day coal consumption at the central station. It is, therefore, a mistake to try and reduce these losses beyond certain limits, unless it be done by using a better class of iron, in which case the gain is generally considerable, even though the cost per pound may be comparatively high.

In a good transformer for lighting purposes, with a maximum "drop" on secondary terminals not exceeding 2 per cent., the losses should be about—

For a 3-kilowatt transformer: 70 watts in the iron; 60 watts in the copper.

For a 6-kilowatt transformer: 100 watts in the iron; 110 watts in the copper.

The coils of transformers generally consist of varnished double cotton-covered copper wire or tape, wound on wooden bobbins, lined with ebonite or mica. The primary and secondary coils should also be separated by a good thickness of insulating material. Sometimes an earthed metal shield, consisting of thin sheet brass or copper, or of a complete layer of insulated copper wire, is inserted between the primary and secondary windings; it has the disadvantage of increasing the chances of a breakdown, and of occupying a certain amount of space which might be more usefully filled by the coils themselves. If the primary wire is wound on in long layers, the difference of pressure between the ends of two consecutive layers will sometimes be very great. In this case it is usual to insert a thickness of varnished silesia or other insulating material between the layers of wire. Winding the primary in two or more sections side by side gets over the difficulty in another way.

With regard to the space taken up by the windings, this is easily estimated, if the bobbins are cylindrical; but, when they are rectangular, as they frequently are, it is more difficult, on account of the bulging which occurs when the wires are drawn over a flat surface. For instance, in the case of a bobbin of square section with 5″ sides, the depth of winding at the sides might be about 1⅛ times the depth at the corners; while, if the same wire were wound on a bobbin 12″, square the depth of winding at the sides would be 1¼ times greater than at the corners.

The stampings forming the magnetic circuit are frequently built up in such a way as to make the pieces in each layer bridge over the joints in the layer below. This system of lap joints reduces the resistance of the air gap to a negligible amount. The exciting ampere-turns required to overcome the air-gap resistance may be only about the two hundredth part of those required to overcome the resistance of the iron itself; but there is no great advantage in this. An appreciable air-gap does not necessarily imply a loss of efficiency, and butt joints are not really objectionable, except for mechanical reasons, and because they generally lead to an increased humming noise in the transformer.

For instance, in a 3 kilowatt transformer, a butt joint leaving an air-gap of $\frac{1}{16}$th of an inch might necessitate a magnetising current six or seven times greater than that required for the iron only. This, it is true, will make the open circuit primary losses 40 to 50 times greater; but as even then these are not likely to exceed about 2 watts, they need hardly be considered.

The effect of increasing the frequency of the current supplied to a transformer, is to raise its efficiency by diminishing the losses in the iron. The watts lost in eddy currents will remain practically constant, but the hysteresis losses will be less. It follows that a transformer for use on low frequency mains, must be either less efficient, or more expensive than one designed for a higher frequency.

Similar Transformers.—When one transformer of a new type has been completely designed, the getting out of other sizes on the same lines is a comparatively easy matter.

Let l stand for any lineal dimension, which we may use as a base of comparison.

Δ = the current density in the copper coils.

t = the number of turns of wire.

B = the induction in the iron.

N = the total flux.

a = the ratio between sectional area of copper space, and actual cross section of copper.

This ratio a will vary with the size of the transformer; being larger in the small sizes, because the insulation, and the bobbin itself, will occupy relatively more space. It might be about 4 in a 2-kilowatt transformer, only 3½ in a 5 kilowatt, and still less in larger sizes, especially if rectangular conductors are used.

The *output* of a transformer = E.M.F. × current. But *volts* are proportional to $\mathsf{N}\,t$ or to $l^2\,\mathsf{B}\,t$, and *amperes* are proportional to $\frac{l^2\,\Delta}{a\,t}$.

Hence,
$$\textit{output} \propto \frac{l^4\,\mathsf{B}\Delta}{a} \quad \ldots\ldots \quad (12)$$

Also, the losses in the iron are equal to the total weight of iron multiplied by the watts lost per pound, or:
$$\textit{Iron loss} \propto l^3\,\mathsf{B}^{1\cdot6}. \quad \ldots\ldots \quad (13)$$

The losses in the coils are proportional to the total volume of copper and to the square of the current density, or
$$\textit{Copper loss} \propto \frac{l^3}{a} \times \Delta^2. \quad \ldots\ldots \quad (14)$$

Also *cooling surface* of transformer $\propto l^2$. . . . . . (15)

From the above expressions, we can obtain the relation between *output* and l when we have settled how the losses (or efficiency) shall vary in the different sizes.

For instance, for the condition of equal cooling surface per watt lost in the transformer, the output will vary approximately as l^3, or as the weight.

For the condition of equal cooling surface per watt lost in the iron, and of equal "drop" on secondary terminals in all sizes, the output will vary more nearly as l^4; but the copper coils will get too warm in the larger sizes, unless the proportions are altered accordingly. For either case, the weight of iron in the core varies approximately as the $\frac{3}{4}$ths power of the output. The weight of finished transformers of the same type, including case and fittings, is often proportional to the $\frac{2}{3}$rd power of the output. In this case, the larger sizes generally get rather hotter than the small sizes.

The following method of working may be found convenient in getting out new sizes.

The watts wasted in the iron, and the total full-load drop in volts must be known; or the efficiency at different loads must be given, from which these losses can be obtained. As a general rule the iron losses will vary as $(\text{output})^{\frac{3}{4}}$.

Assume that *output* $\propto l^4$.

From this the leading dimensions are obtained, and the weight of iron. Divide total watts lost in core by weight of iron; this gives the watts per pound, from which $\mathsf{B}_{''}$ is obtained, by reference to curves or tables giving iron losses at different inductions. Multiply $\mathsf{B}_{''}$ by cross section of iron in core to get the total flux N.

By applying formula (1) the secondary turns are now calculated. Next choose the size of wire (from any wire table giving resistance), so as to produce the required "drop," and slightly alter the number of turns, if necessary, so that the wire fits in properly. Correct N to suit the new number of turns, and make any slight alterations to cross section of core by adding or removing stampings. (This will again involve a slight correction in the amount of "drop" due to secondary, owing to alteration in the length per turn of wire in the coil.) Now calculate primary winding, and see how it fits on. Make final adjustments by trial if necessary. Alterations in the proportions of the different parts may also be tried, if there seems any chance of improving the efficiency or reducing the cost.

Summary of Formulæ.—In any choking coil or transformer:

$$E = \frac{4{\cdot}44\,\mathsf{N}\,n\,T}{10^8} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where E is the $\sqrt{\text{mean square}}$ value of the induced E.M.F.,
N is the maximum value of the magnetisation, or total flux,
n is the frequency in periods (∿) per second,
T is the number of turns of wire in the coil.

Magnetising force required, in ampere turns per inch length of magnetic circuit :—

In *iron* (average quality) use the empirical formula :

$$\text{Ampere turns per inch} = \frac{\mathsf{B}_{''}}{9{,}000} + 3, \quad . \quad . \quad (3)$$

where $\mathsf{B}_{''}$ = the induction per square inch of cross-section, which must be between the limits 12,000 and 40,000.

In *air* :

$$\text{Ampere turns per inch length of air gap} = 0{\cdot}313\,\mathsf{B}_{''}, \quad (4)$$

for all values of $\mathsf{B}_{''}$.

Magnetising current : In a good closed magnetic circuit transformer this is approximately given by the expression :

$$\text{Magnetising current} = \frac{\text{total watts lost in iron}}{\text{primary E.M.F.}} \times 1{\cdot}4,$$

where the multiplier 1·4 stands for the reciprocal of the "power factor."

$$\textit{Watts lost in copper coils} = C_1^2 R_1 + C_2^2 R_2. \quad . \quad (6)$$

Watts lost per pound of iron (good quality), when thickness of plates = 0·014in., are approximately

$$5{\cdot}35\,\mathsf{B}_{''}^{1{\cdot}6} \times 10^{-8}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

including eddy current losses, and for $n = 80$. If $n = 100$ the losses will be 1·3 times greater.

The weight of a cubic inch of sheet iron, as used for transformers, is generally about 0·278lb., or 1lb. represents 3 6 cubic inches.

When the stampings are merely varnished and built up without paper between them, the space occupied by the insulation may be taken as 10 per cent. of the total space.

MR. ALEXANDER SIEMENS' PRESIDENTIAL ADDRESS TO THE INSTITUTION OF JUNIOR ENGINEERS *

Your Council have done me the honour of electing me to be your President for this session, and my first duty is to express to you my thanks for the confidence in my ability of filling the position, and to ask your kind indulgence if my performance fails to come up to your expectation.

The name of this institution indicates that its members have only recently joined the ranks of the profession, and have just commenced to realise the difference between engineering at a college and the actual tasks presented in the routine of business. It is not my intention to say anything to night about the education of civil engineers, as this topic has been dealt with by two of my predecessors not very many years ago ; but I wish to draw your attention to a particular class of problems, which from their very nature cannot be easily dealt with at a college. These problems are not confined to any branch of engineering, but are common to all of them, and have to do with the advancement of our knowledge and of our ability to utilise the forces of nature.

Few works of any importance can be carried out by the civil engineer without circumstances occurring which are peculiar to the case, and which compel him to exercise his ingenuity to meet them by suitably modifying his methods. Another factor, which operates in a similar manner, is the constant development of new requirements in the course of the progress of civilisation, and every novelty introduced brings in its train a fresh set of requirements, which makes demands on the resources and the versatility of the engineering mind. These problems constitute, in fact, one of the principal attractions of the engineering profession and, in my opinion, entitle it to be considered as the profession most in keeping with the injunction that man shall make nature subservient to him. When we look round and see how the civil engineer has transformed the conditions of living during the last hundred years, we cannot help being impressed with the change that has been brought about, and nothing is more natural than the thought that a further development of our resources and an increased command over natural forces are in store for us, and only wait for the right man to reveal them to mankind.

That such men deserve special recognition has long since been admitted, and when, in the reign of James I. all monopolies were abolished, an exception was made by granting the privilege of the "sole working or making of any manner of new manufacture within the realm to the true and first inventor of such manufacture, which others, at the time of making such letters patent and grants, should not use, so they be not contrary to law, nor mischievous to the State, by raising of the prices of commodities at home, or hurt of trade, or generally inconvenient." On this statute, all the patent legislation of this country is based, and the effect of the law is, that inventors are granted a monopoly for a limited number of years, on condition that they fully describe and make patent to everybody the particular nature of the useful novelty which they claim to have discovered or invented. It is rightly assumed that, on the one hand, the time and money expended during the development of the novelty give the inventor a claim for compensation and that, on the other hand, the usefulness of the invention is greatly enhanced if an opportunity is provided for everybody to obtain the description and full explanation of the latest developments in manufacture. A proof of the correctness of these principles is the unanimity with which all civilised nations have adopted them, although the methods of applying them vary a good deal.

The success which has attended the efforts of many inventors, and the constantly widening field for the utilisation of natural forces exert an ever-increasing fascination over our imagination, and when a young engineer enters practical life, it is not to be wondered at if he dreams of the improvements he may introduce, and of the reward he will earn for his ingenuity. This is the right spirit with which to enter on life's work, for all true progress is based on genuine enthusiasm and proper self-confidence, which enable us to devote to our studies that earnestness and thoroughness without which no real advancement is possible.

It is a popular superstition that inventors are heaven made, and that they can produce useful novelties to order in any branch of manufacture where a want exists, if only their attention is drawn to it.

The history of the invention of the steam engine is a well-known illustration of the point I wish to emphasise. According to the popular version, Watt, as a small boy, saw the lid of a tea-kettle move up and down, when the water was boiling, and this suggested to him the construction of the steam engine. As a matter of fact, Watt made himself acquainted with what had been done before (a point altogether ignored in the popular version), and had to work very hard before he brought his invention to a successful issue. His example is typical of the true method of progress, and we may generally say that in order to approach a problem with the most certain prospect of success it is necessary :—(1) To define, as accurately as possible, the want that exists, or the particular object that is to be attained. (2) To be well acquainted with the scientific principles which come into play. (3) To know how the want is met, or the object attained in practical life. (4) To find out what proposals have been made by others in the same or in a similar case. A careful attention to these requirements will prevent much disappointment and waste of energy, as will be obvious to all of you without further explanation.

It may indeed seem curious to you that I should dwell on such palpable truths which must be patent to everybody who gives his attention to the subject, but you will very soon find out that inventions are brought forward every day by zealous people who have neglected to make themselves masters of one or more of these necessary preliminaries to bringing out a successful invention. In some systems of patent legislation, endeavours have been made to aid the struggling inventor by a preliminary examination into the novelty of the invention ; but this is avowedly not conclusive, and does not protect the patent against attacks for want of novelty, or lack of utility. It is, therefore, difficult to comprehend what object is served by this preliminary examination, and it is easily seen that this benevolent intention of assisting the inventor becomes really nothing more than an additional obstacle in his path.

When the regenerative gas furnace had been invented, a patent was applied for in Prussia, and the description of the invention was examined by the proper authorities. Let me just remind you that, in a regenerative gas furnace, the heat of the waste products is utilised to warm chambers filled with a chequer work of fire bricks, and after a certain time the currents of gas and of air are reversed, so that the gases pass through the heated brickwork before meeting, while the products of combustion heat up another set of chambers. The Royal Commissioners in Prussia decided that for want of novelty no patent could be granted for this invention, and they gave as their reason that the Knights of St. John, about five hundred years ago, had been in the habit of warming bricks or large stones in the kitchen fire, and utilising them afterwards for heating their bedrooms.

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* Delivered November 16, 1894.

This refusal of a patent occurred nearly 40 years ago, and is, perhaps, an extreme instance of official wisdom; but it is obviously impossible for any man who spends his life in an office examining patent applications to appreciate rightly the practical bearing of the proposals submitted to his judgment. As a result of this we see that law-suits about patents are quite as frequent in countries which have instituted a preliminary examination as in those where patents are granted without it. In fact, a new type of patent suits is created by inviting opposing parties to lay their arguments before the examiner, and by requiring the inventor to refute them. Between such a suit and a suit for infringement before a law court there is little difference as far as time and money are concerned; but a gained law-suit establishes your claim to an invention, while the favourable decision of a patent examiner carries practically no weight at all. This is no reproach to the official who has to conduct the inquiry as to the novelty of an invention; but the system must be blamed by which an inventor is put to all this trouble without obtaining a definite advantage.

At the same time, we must always recollect that it is much easier to find fault than to suggest a remedy, and the case of patent law is no exception to the rule. There is the initial difficulty of determining whether a modification that somebody suggests in a manufacturing process is a patentable invention or not. Such a question was raised in connection with the famous Bessemer process of making steel. Sir Henry Bessemer rightly argued that cast-iron would be transformed into steel if part of the carbon contained in it could be removed, and he proposed to do this by blowing air through molten casti-ron to burn out the carbon. Events have proved that this process really takes place; but the difficulty at first experienced was that, during the blow, no indication could be obtained of the percentage of carbon left in the molten mass. This made the quality of the steel produced a matter of chance, and it is very doubtful, whether the Bessemer process would ever have become an important factor in the iron and steel industry, if it had not been suggested by Mr. Mushet to continue the blow until all the carbon had been removed from the cast-iron, and then to introduce "spiegeleisen," a highly carburetted cast-iron containing manganese, in such quantities that the mixture contained the right percentage of carbon. With this addition, the Bessemer process has become what it is; and the modification introduced by Mr. Mushet appears to be both novel and useful, and for this reason, a patentable invention. As a matter of history, his patent was not considered valid, for the reason that an addition of "spiegeleisen" was part of the regular manufacture of steel at Sheffield, although there the steel was produced in pots in the well-known manner.

In other countries this question is treated differently, for instance, in France an inventor can prevent other people using well-known devices if he is the first to apply them in a novel way, or to a novel machine. By such an interpretation of his patent M. Gramme succeeded in securing for himself the monopoly of using copper wire brushes to take the current off at the commutator of dynamo electric machines. It was of no avail to prove the use of such brushes in telegraph instruments, or in magneto-electric machines; the French law recognised that Gramme was the first to utilise such brushes in dynamos, and confirmed his monopoly. In this particular case the privilege was of no great value, for copper plates served the same purpose equally well, and did not fall under the patent.

In all the cases we have contemplated up to now the advancement of manufacture was attempted by men who devoted their lives to a particular branch of industry, and were actively engaged in carrying it on. As is to be expected, the subject-matter of their proposals has, in most cases, a solid foundation, meeting an existing want, or extending the application of known devices; for such men are versed in the practical requirements of their daily work, and of necessity make themselves acquainted with all that is new to their own branch of industry. Nearly all the large establishments have, nowadays, a special staff of workers, who do nothing but investigate inventions or experiment with modifications of manufacturing devices and processes. In addition to these private investigators, most technical colleges undertake similar research, and accounts of their work are published in the technical journals of all countries, resulting in a rapidity of advance that could not be realised without the aid of our modern means of communication. A natural consequence of this mutual reaction on each other of many workers is the subdivision of labour, which is carried further every day, and makes civilised man increasingly dependent on his fellow-workers. At the same time, it is evident that the share of each worker in the advancement of his art, or in the introduction of useful novelties, must become smaller and smaller, as each step is at once made known to most of the persons concerned. To an attentive observer it must be quite obvious that those people have the least chance in the race who are not well acquainted with the branch of industry in which they wish to introduce improvements, and who do not study the technical literature bearing on the subject. Contrary to expectation, these are precisely the people who clamour for cheap patents, and who inundate the Patent Office with their inventions.

In 1883 the cheap patents were at last granted, and the effect has been that the number of patents taken out, which during the ten years ending 1882 was on the average 5,506 annually, has grown to 25,000 during the year 1893, their number having steadily increased ever since the new law was introduced. This class of inventors not only ignores what is already known, but they treat with very little respect the so-called details, which have to be worked out before any proposals assume a practical shape. Unfortunately for them, it is the question, how these details are to be carried out, which decides, in most cases, the fate of an invention, and a seemingly brilliant idea will often prove delusive because some small factor in the problem has been overlooked. In a similar manner they do not realise that the knowledge of scientific principles might be an assistance in their efforts; or if they study science at all, they think they can acquire the necessary knowledge by a short study, and without much trouble. Some of these inventors even go further, and claim that their ideas are genuine novelties in every respect, and that objections, based on scientific reasons, are only expressions of professional jealousy. Poor Galileo is quoted as an example of a man whose ideas were in advance of his age, who was not appreciated by his contemporaries, and who has been proved to have been in the right by posterity. When a man brings this argument forward, it is quite useless to quote the natural laws which make the carrying out of his invention impossible. He will gravely assure you that scientific men will have to re-consider the conclusions which are not in accordance with the new invention, and they will find out the error of their ways. It would not be surprising if it were not that nowadays education is so universal, and the means of learning all about a branch of industry so easily attainable, so as to prevent people from falling into the errors I am speaking about. But some examples of proposals seriously laid before our firm will convince you that a sanguine inventor is quite independent of college or of workshop, and that in this case, as in many others, truth is stranger than fiction. The extracts have been chosen from letters actually received over ten years ago; for obvious reasons, all dates and names are omitted.

About fourteen years ago our firm fitted up the Royal Albert Dock with a system of arc lights, and not long after the following communication was received:—

> "Having studied the subject of the 'Utilisation of Natural Forces for the purposes of Electric Lighting,' we have found a method which is as cheap as it is possible. We understand that you have under your control the lighting of the Royal Albert Dock by electricity. For that purpose there are, we believe, four engines, to each of which there is an average of three men. As a matter of course, electricians and other operatives directedly connected with the production of light are omitted. Well, gentlemen, the result of our studies is that we have constructed a machine which will produce sufficient motive power to work as many electric machines as would be required to light the Royal Albert Dock *and* Victoria Docks for sixteen continuous hours without expenses of coals, &c. Another decided advantage is that two men are all required. The money simply spent in coals for one week to supply the steam engines at present there would be sufficient to keep one of our engines or machines going for a month, including the expense of labour. It is with great pleasure that we submit this idea (to you in the first place) to be approved of or otherwise. Lack of funds prevents us, as inventors, from patenting our discovery; but if suitable arrangements can be made, it will be parted with on moderate terms. This is an invention, the principles of which are simple, construction cheap, and mode of working easy. The machine can be constructed in nearly every town in the kingdom. The 'machine together with 'purchase' connected with it may be easily patented; and, thus defended, the patentee may go to work without fearing any piratical attacks from others. There is a rough model of one of the machines in London, where it may be seen: as soon as this letter is satisfactorily answered, the address will be sent."

From the tone of the letter it is evident that the writers had some idea of business, and were prepared to make moderate terms with anybody who would help them to bring out their invention. This is not always the case, as the next example will show:—

> "I believe I am in possession of a valuable idea to which electricity may be applied with enormous advantages, and if it succeed, no doubt would be largely used. Having had the matter before one or two gentlemen who have made electricity considerable study I may say that they are perfectly satisfied as to its success, if properly carried out, and suggested my laying it before you with a view to an experiment. The machinery required would not consist of much. If you are disposed to assist me so as to ensure a proper experiment being made, I should, of course, give you the necessary information under secrecy, as, of course, if it turned out a success I should like to patent it, if possible."

No offer is made of a share in the profits in return for assisting in carrying out the experiments most probably because such inventors have no idea of the difficulties attending experiments and their cost. The popular idea is that a truly great invention ought to be made on the lines that Prof. Hughes followed when he constructed the first microphone by the help of a match box and a few pieces of broken carbons. It is certainly true that a genius will accomplish much with apparently insignificant means; nevertheless a good many experiments were necessary before a practical form of microphone was settled upon, but of these the general public knows nothing.

The next inventor whose communication I bring to your notice is a little more explicit than the last, but hardly more likely to derive any advantage from his ideas :—

> "Pardon the liberty taken in addressing these few lines to you on the subject of aerial locomotion. I have been trying to get some one willing to assist me in carrying out an idea which I have reasoned out in accordance with natural law, and also by experiment to accomplish actual *mechanical flight*, wherein weight is assistance, not an obstacle. I have been referred to you as a gentleman likely to assist me in carrying out the object. I am only a mechanic, and all I could offer in return would be a participation in the triumph. My plan is simple, easily understood, the expense and place of construction being the only difficulties. I purpose to rise from the earth, navigate the air in any direction; wind being scarcely more an obstacle than upon a vessel in the water, it can be used to carry a weight as a mode of transit, or passengers for pleasure or otherwise; in fact, the machine would be a *mechanical bird* whose construction I cannot explain till some gentleman of scientific views will make a definite arrangement with me in order to carry out this grand undertaking. A few lines on the subject of time and place for an interview would confer a great favour on yours, &c."

Although this proposal sounds ridiculous enough, and is on the face of it impracticable, it is sad to reflect on the waste of time and energy which must have been caused by it, and on the disappointment which this inventor must have experienced. Fortunately inventors are a hopeful race, and it is marvellous how difficult it is to persuade a man that his ideas are based on a fallacy.

When I came to England in 1867 I made the acquaintance of one of our workmen, whose business it was to lacquer brasswork. He had the peculiarity of coming to his work only long enough to earn sufficient to keep him from starving; the rest of his time he devoted to the construction of a machine for generating power. He had been a lawyer of good standing in one of the minor German states; but, unluckily for him, he had "a mechanical turn of mind," which induced him to give up his practice and to come over to England, where he hoped to realise a fortune from his invention. In 1867 he assured me another fortnight's work would complete the machine, and a new era would commence in the world's history. In spite of all arguments, of all ridicule, and of all the disappointments, he continued working at this machine until he died about two years ago without being any nearer to his goal than he was twenty years ago.

Other professional men have had peculiar views with regard to mechanical problems, as the next letter will show :—

> "I was yesterday in the Crystal Palace and saw what I believe was a multiplier of power. I have had a dynamo-electric magnetic apparatus working on the sulphuric acid and zinc system and it has frequently occurred to me that if the gathered-up wire or power thrust into the machine could be increased to an indefinite extent it could be productive of wonderful effects. Now this appeared to me done in the machine I saw in the Palace, but it appeared to me the thing required was velocity and common use. I have made a diagram on paper of a pail of water turning a small water wheel regulated by the tap in the pail. This would give velocity, but no power to speak of; but if this velocity could be communicated by a pair of hydraulic bellows, then power and velocity would both be gained. If the idea is feasible and you would like to take it up, I would be glad to form a company to carry it out on any terms you may approve of. I cannot carry out the idea myself for three reasons: advancing age, defective money, and, I am sorry to say, considerable laziness. I am a registered medical practitioner and a Crystal Palace season ticket-holder, and the reason I apply to you is because I have a friend in one of your employés named Mr. J— H—, although, as I do not know his address, of course I could not communicate with him.'

There are some cases where a really useful invention seems to lie within the grasp of the inventor; but his want of thorough knowledge of the subject stands in his way. From numerous examples of such failures I will only mention the following :—

> "For some little time back I have been considering the practicability of lighting railway carriages by electricity and procuring the electricity by friction on the wheels of the carriages when in motion, with an accumulator in each carriage, so that when the train stopped at any station the accumulator would have a sufficient storage of the electric fluid to keep up the supply for a few hours if necessary. This mode of lighting carriages would be a great economy to the railway companies, not only in oil but in labour, and it would be a benefit from its superior light. The electric light could also be used for the lamps in front and stern of the train, thereby showing the lights at a much greater distance than at present. Before applying for a patent for the application of the electric light I would feel greatly obliged to you by giving me your opinion on the same, and if you approve it, would you have any objection to join with me. I hope to hear from you soon respecting my interview with you on Friday."

You know, of course, that train lighting is being carried out successfully on these lines; only the accumulators are charged by a dynamo driven from the axle, instead of generating the electricity by friction, as proposed.

> "I beg leave respectfully to submit to you a plan for constructing the wheels of steamboats, &c., on a new principle and also to adopt the system in other propellers. The plan proposes to form a wheel having on its outer sides or periphery a powerful magnetic principle to act on the water with this power or friction as the wheels of an engine on the rails. The magnets may be of unlimited power so as to act (*sic*) the largest attractive force on the water, and the wheels may be constructed on any plan. The object is to obtain greater efficiency and speed."

Strange as this proposal may sound, the last letter which I shall lay before you surpasses it in originality and vigour of expression :—

> "I am not a madman—I am not an inventor—nor am I a mechanic—but I have been thrown amongst engines, stationary, locomotive and marine, a great deal. A simple accident has revealed to me the *modus operandi* by which steam can be generated with any degree of power and employed in the propulsion of vessels without the cumbrous details of boiler or steam chest, &c. I do not go to some capitalist who may rob me of the thought —nor some other who would wish to clap me into an asylum as a dangerous lunatic—but to practical engineers like yourselves, who can, if my idea is the mere dream of a fool, instantly annihilate it with practical objections. If you will permit me to call upon you—five minutes is all I want—if I cannot satisfy you that I have not wasted your time, I will submit to be kicked out of your premises."

All these letters were received by our firm within the space of two years, and a great many more could be found, without doubt, if a further search were made, as the stream of such letters has been flowing in uninterruptedly ever since I can remember. It is certain, therefore, that a numerous class of people exist who are under the impression that they can advance a branch of industry by suggesting ideas that are plausible to them, quite irrespective of the existing experience or of natural laws. As a rule very little is heard of them in public, because these ideas are seldom of any value; but if by chance an outsider makes a successful suggestion the most is made of it, and the example is quoted by everybody as a proof that special knowledge is by no means required.

My object to-night has not been to hold up to ridicule the endeavours of people who may be mistaken, but who worked hard enough and earnestly enough in many instances to deserve a better fate, nor do I wish in any way to discourage you from trying your hand at inventing; but I want to impress upon you the necessity of making yourselves thoroughly acquainted both with natural laws and existing practice. You cannot master your subject without careful study and hard work, but if you devote your time to the acquisition of this knowledge you will be well fitted to contribute your share to the progress of engineering.

PHYSICAL SOCIETY.

The ordinary meeting was held in the rooms of the Chemical Society, Burlington House, on November 9, 1894, Prof. A. W. Rücker, F.R.S., President, in the chair.

Dr. J. LARMOR's Paper on

"The Significance of Wiener's Localisation of the Photographic Action of Stationary Light Waves"

was read by the Secretary, Mr. Elder.

The experiments by which Wiener demonstrated that, when stationary, plane-polarised optical undulations are produced in a photographic film by reflection of a stream of plane-polarised light at a metallic or other backing, the photographic action occurs at the antinodes of Fresnel's vibration-vector, and not at the nodes, have been employed by its author and others to decide between the various theories of light. Using the terminology of the electric theory of light, we may say that the photographic action takes place at the antinodes of the electric vector, which corresponds to Fresnel's vibration, and not at the intermediate antinodes of the magnetic vector which corresponds to McCullagh's and to Neumann's vibration.

The crucial experiment of Wiener relates to the case when the angle of incidence is 45deg., so that the direct and reflected waves which interfere are at right angles to each other. When the light was polarised in the plane of incidence, the photographic plate developed a series of bands; but when it was polarised in the perpendicular plane, these bands were absent.

The argument employed is that the photographic effect will be greatest at those places in the stationary wave-train where the vibration is most intense, and the conclusion has been drawn from it that the actual vibration is represented by Fresnel's vector, and not by McCullagh's: in other words, that the vibrations of polarised light are at right angles to the plane of polarisation. The force of this argument, as against McCullagh's theory, would, however, be evaded if the vector of that theory were taken to represent something different from the linear displacement of the ether, or if vibrations were excited in the molecule by rotation instead of translation, or by stress.

Now, there are about 10^3 molecules of the sensitive medium in the length of a single wave of light; thus, in the stationary wave-train all the parts of a single molecule would at any instant be moving with a sensibly uniform velocity, which increases and diminishes periodically. It does not seem clear, however, that alternating stress might not be as potent a factor in disintegration as alternating motion.

The author proceeds to discuss the question from the point of view of an elastic-solid-ether theory, and he points out (from dimensional considerations) that even a very rare medium of very low rigidity might powerfully influence the movements of foreign bodies suspended in it, provided the linear dimensions of such bodies were sufficiently small.

A theory based on difference of rigidity without difference of inertia, after McCullagh's manner, would have to be realised by ascribing to the atom an atmosphere of intrinsic ethereal strain instead of endowing it with great inertia; and this could only be possible in a rotational ether, and would, in fact, form a mechanical representation of the electric theory.

The difference between the dielectric coefficients of a material medium and a vacuum is simply and naturally explained by the hypothesis that the material molecules are polar, owing to their associated atoms having equal and opposite charges. An electric force thus tends to pull the two constituents of a molecule asunder; and its full intensity is exerted in this manner, not merely its differential intensity over the range of the molecular volume. But a magnetic force would have no such tendency, even were the molecule magnetically polarised, because the two poles of a magnetic element cannot be dissociated. On the electric theory, therefore, there is abundant justification, both for the magnitude of the effect produced, and for its localisation, as determined by Wiener. The author has endeavoured to show elsewhere that the principles of MacCullagh's theory of optics are in substantial agreement with all the general features of our electrical and optical knowledge. It is definitely implied in the electromotive, as distinguished from an electrodynamic character of the electric theory of light, that the atomic charges vibrate in unison with the light-waves, quite unimpeded by any material inertia of their atoms.

A letter was read from Prof. Lodge, criticising the manner in which Wiener's results had been summarised by Dr. Larmor; the summary at the commencement of the Paper being characterised as misleading. The letter concluded with an expression of admiration for the work done by Dr. Larmor in working out electricity and optics, starting from McCullagh's theory of light.

Dr. STONEY objected to the suggestion that atomic charges could vibrate unimpeded by material inertia. We had not merely to consider the bodily translation of a molecule, but the relative motion of its parts. Radiation absorbed by a gas acted on its atomic charges, part appearing as translational energy of the molecules, part as energy of their internal motion, and the ether acting as an equaliser of molecular energy.

Prof. MINCHIN did not understand why the polarised light in Wiener's crucial experiment should be incident at 45°. He also found it hard to imagine what vector other than the simple displacement of the ether could be the vector of MacCullagh's theory.

Mr. Burke communicated a Paper,

"On a Suggestion of Professor J. J. Thomson in Connection with the Luminescence of Glass due to Cathode Rays."

More than a hundred years ago Beccaria observed that when vacuum-bulbs were broken in the dark, a light consisting of a faint glow was produced in the place where the bulb lay. Beccaria was led by his experiments to attribute this effect to the rushing of air against the glass walls of the exhausted vessel; and in his "Recent Researches in Electricity and Magnetism, Prof. J. J. Thomson indicates its possible close relationship to Mr. Crookes's theory of the luminescence of the glass in Geissler's tubes. The author, however, has made numerous experiments on the breaking of glow lamps, and on the admission of air to an exhausted chamber by the breaking of a thin plate of glass or of a piece of bladder closing an aperture in the walls. In these cases, and in other cases where it was possible for fragments of solid to be projected against the walls of the vessel, a luminous appearance was obtained; while in other cases, where such solid fragments would be absent, no luminosity was observed. The author concludes that Beccaria's phenomenon was due to the impact of glass against glass, and not to the rush of air against the walls of the broken vessel.

Electric Lighting of Sydney.—Arrangements have, it is reported, been made for the introduction in the New South Wales Parliament of a Bill to sanction the Sydney City Council undertaking the electric lighting of the town.

ELECTRIC LIGHT AND POWER AT THE NEW COPENHAGEN FREE HARBOUR.

(FROM OUR COPENHAGEN CORRESPONDENT.)

Electricity will be extensively used at the new Copenhagen Free Harbour, which, although not yet completed, has just been opened, both for the lighting of the streets, the quays, and the buildings, and for supplying the motive power to elevators, cranes, ventilators, pumps, &c.

In the silo warehouse the installation will comprise ten electromotors of 15 to 18 effective horse-power each; three of these motors are in the cellar and seven on the top floor. Had electricity not been available here, steam would probably have had to be resorted to, entailing a separate installation. The seven motors are at a height of some 105ft. above the ground, and all things considered, electricity will, no doubt, prove both the handiest and cheapest power.

The central electric station has been built according to Mr. Dahleruger's plans, and under the control of the Copenhagen harbour authorities. The Allgemeine Electricitäts Gesellschaft in Berlin has contracted for the whole installation, including cables. They have also taken over the whole working of the station for a certain sum per kilowatt-hour, leaving the central station. The sum charged provides for interest and a sinking fund, so that the complete plant at the end of 30 years becomes the property of the free harbour company, which, however, has the option of buying the plant at any time according to a sliding scale. The production and distribution of electricity for lighting and motive power purposes has been kept completely separate; but in such a manner that each set of machines can work for either purpose, whereby it has been possible to make one reserve machine do.

The boilers and engines are of 500 H.P. For the lighting during the night there is a large accumulator battery, capable of simultaneously feeding 600 incandescent lamps, or a corresponding number of arc lamps. There are three tubular boilers, with 105 square metres heating surface, and four vertical compound engines of 125 H.P. each, specially constructed for working dynamos by the Allgemeine Electricitäts Gesellschaft. Behind the large engine-house is a smaller building containing a surface condenser for the steam and the feeding pumps for the boilers. Three of the engines each work a six-pole dynamo, the fourth working two four-pole dynamos, each of which has half the capacity of the former ones.

Over the inner area the cables are underground. To some of the more distant parts the cables are carried overhead on poles of wood and iron. The total length of cable in the free harbour is about 30 kilometres, exclusive of the wires in the buildings. The installation comprises 1,200 incandescent and about 100 arc lamps, and the electric power transmission will ultimately comprise 7 cranes, 11 elevators, 1 passenger elevator, 8 hoists, 10 grain elevators, and various pumps and ventilators.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, November 23rd.

Physical Society.

5 p.m. Meeting at rooms of the Chemical Society, Burlington House. The following Papers will be read:—(1) "The Measurement of Electromagnetic Capacity," by Fred. Womack. (2) "Mirrors of Magnetism," by Prof. S. P. Thompson and Miles Walker. (3) "Students' Simple Apparatus," by Prof. W. E. Ayrton and Others.

Northern Society of Electrical Engineers.

8 p.m. Smoking Concert at the Palatine Hotel, Hunt's Bank, Manchester.

TUESDAY, November 27th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. The following Paper will be further discussed: "The Machinery of War-Ships," by Albert J. Durston.

WEDNESDAY, November 28th.

Society of Arts.

8 p.m. Ordinary Meeting. The following Paper will be read: "Experiments in Aeronautics," by Hiram Maxim.

FRIDAY, November 30th.

Royal Society.

4 p.m. Anniversary Meeting.

Electro-Harmonic Society.

8 p.m. Ladies' Night at the Banquet Room, St. James's Hall Restaurant, Regent Street.

Institution of Civil Engineers.

8 p.m. Students' Meeting. The following Paper will be read: "Sub-Aqueous Excavation at Newry," by Charles H. Olley.

The Electrician.

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MATHEMATICS AND—MATHEMATICS.

Our readers will be gratified to find that Mr. OLIVER HEAVISIDE is at length about to continue his articles on "Electromagnetic Theory." No doubt there are many of our readers whose acquaintance with some of these articles is of a nodding kind rather than one of a more intimate nature ; but we think that even these readers take off their hats as they nod, for they know that no man has worked so hard to clarify and develop the theory built up by MAXWELL on the ideas of FARADAY. And not only is Mr. HEAVISIDE the most learned of MAXWELL's followers, and the man who wields the most powerful mathematical weapon, but, curiously enough, he is almost the only one who has attempted to make the subject known to practical electricians.

A glance through the transactions of learned societies will show how this subject may be treated by men who are only a little better than mathematicians. We say better, because even a little knowledge of nature must improve the pure mathematician, and only the very smallest knowledge of nature suffices to differentiate the pure mathematician at Cambridge from the mathematical physicist. Let us look up an elaborate Paper on this subject by a mathematical physicist. We are practically engaged in electrical work, but we think it good occasionally to think of the soul instead of the mere body, and we know that somehow or other the mathematicians can tell us more about the soul of our subject than we ourselves know. Well, how much of such a Paper can any of us understand ? There are three or four people in the whole world at the present time (certainly not more than five) who have practical notions of things, and who are also able to thoroughly understand such a Paper. If you question the author of the Paper, who has written perfectly accurately of current and potential, you will find that he knows absolutely nothing of amperes and volts, that he has not the slightest interest in wires or batteries or dynamo machines. And yet those pages of his Paper which bristle with mathematical expressions may contain a story which to us is of very great interest, only the author cannot talk our language, and we do not know his. We have almost no common sympathies.

With Mr. Heaviside we are in the company of a very clever, good-natured elder brother, who has exactly the same likings as ourselves for all sorts of experimental work, and who tries to explain deep things to us in language that we can understand. Sometimes he cannot get down to our level; but he always tries to do so, and we ought to try harder to second his efforts than we have hitherto done. It is absolutely certain, it has been proved as clearly as almost any physical fact is ever proved, that electromagnetic energy travels through the space external to a wire, and not *in* the wire itself, as we used to believe. Is there any electrician who does not know this? Is there one of us, however scornful of mathematicians, who would not give a deal to be able to see clearly, say as clearly as Mr. Heaviside sees it, how the thing occurs? We are willing to give a good deal, but we are not willing to give all that we possess, and that is the price demanded by the mathematician. He says, you must give up all chances of obtaining practical knowledge of electrical things, you must by years of study get familiar with elaborate mathematical expressions, and at the end the sort of notion which you will have obtained is the notion that I have, and not the notion that you think you may have.

What Mr. Heaviside says to us is a very different thing. He will probably be rather angry at our way of putting the matter; but this is how we read him. Look over that elaborate mathematical Paper again; you will notice in page after page of it the same mathematical expressions endlessly repeated, for the benefit solely of the printer. They are really very few, and every one has a definite and very interesting meaning. Suppose we do not print them as they stand—let us use *Mnemonics*. The mathematicians do not need mnemonics; even those of them who have the very worst memories have become so accustomed to these expressions that they glance over a page of new work in half a minute and understand it all. Here is a frightful expression which we see repeated in every other page. Well, then, let us (as Maxwell did) call it *curl*. But once for all let us try to understand what it means, and we all at once discover (like M. Jourdain, who made the same sort of discovery) that the idea underlying *curl* has been familiar to us for years, and that if we had not the idea we should know nothing whatsoever about our ordinary practical work. The Greek mathematicians thought it well to make their pupils spend years in leading up to the proof of the 47th proposition of the first book of Euclid. Would there be great harm in telling pupils now-a-days that this proposition is really an axiom, and so save all those years of study? We study for two reasons. One is this, that the mere study is a mental gymnastics; the other to gain knowledge. The best kind of study gives both knowledge and mental power. We electricians have no lack of mental power; if ever practical men had mental gymnastics in greater degree than we, we should like to hear of them. But even our best friends will say that our knowledge of what goes on in the electromagnetic field is rather limited. As, then, our profession may be relied upon to give us an intellectual training, as we have no examinations to pass, as our mathematical tools are for use, not show, it is very important that those tools should be of the very best and very latest labour-saving make. Our teachers act on the principle that each of us must only use such tools as each of us himself can make. Prof. Tait is of opinion that no man ought to be allowed to use a table of logarithms until after he can himself calculate logarithms. We presume that he would allow no boy to use a watch until he was able to make one. These teachers of ours gave us all the Euclid we could stand. How unhappy they must be in not being able to teach us multiplication by the Trireme method, and how abominable it must seem to some of them that the decimal system was ever invented. There are still plenty of useless jobs to be done to keep boys dull. Think of making a man spend one year at geometrical conics and the next year at analytical conics, and dosing him with more and more perfect proofs of Taylor's theorem. These are the memories which cause an electrician to regret his lost youth. Do electricians ever need to solve a triangle, unless it is a simple right-angled one? Are there not curves more interesting to us than conic sections? And, seriously, however beautiful Taylor's Theorem may be, does the electrician ever need it? When shall we see a good list made out of the mental tools most needed by the electrician?

Mr. Heaviside has already taught us the easy use of some mathematical tools that we used to look at with much awe. He has nearly succeeded in his endeavours to make us see clearly the results which follow from the two fundamental equations of electric and magnetic force; he has given us pictures as well as formulæ. To a select few his mathematics are more delightful reading than the "Autocrat of the Breakfast Table," and with no more malice. To a wider circle his prose is better than anybody's "Table-Talk."

REVIEWS.

The Electric Current. By R. Mullineux Walmsley, D.Sc. (Lon.), F.R.S.E., &c. (London: Cassell and Co., Limited.)

Writers, especially writers of technical works, would in a measure safeguard themselves from irrelevant criticism and, at the same time, save reviewers no little trouble, if they would only be good enough always to mention in the course of their customary prefatorial remarks the class of readers for whom they think they are catering. In the pre-technical education age this was perhaps unnecessary. In those days a scientific work was outwardly and visibly either a treatise, a school text-book, or a popularly-written exposition of scientific principles, and their most striking applications. Nowadays all this is altered, and excellent books are constantly being published for the edification of one does not exactly know whom. The author of "The Electric Current" having left us in the dark on this important point, we can only *surmise* that he intended it for that ever-increasing class of individuals who, having mastered at school or at evening classes the elementary principles of electricity, are anxious for business reasons or love of knowledge to keep in touch with the latest theoretical and industrial developments. This class includes, amongst others, those about to enter a technical college, lawyers, barristers, and mechanical engineers, and to such we can certainly recommend Dr. Walmsley's book. It is up-to-date, well-printed, well-illustrated, and the subject is treated with considerable freshness, to prove which we need only say that the narrow limits imposed by the title are rigidly adhered to, electrostatics being merely mentioned by the way in connection with Lord Kelvin's voltmeters.

The volume is divided into three parts, dealing respectively with the production, the laws, and the applications of the electric current. Amongst other things Part I. contains a clear explanation of the connection between heat of combination and electromotive force, together with tables enabling one at a glance to gauge the result of any alteration in the metallic elements of a cell. Thermo-electricity also is dealt with in an interesting manner. The thirty pages devoted to "Electro-Magnetism" form at once an excellent summary of the subject, and a striking example of that "breathlessness" characteristic of so many latter-day science books, in which everything is given a practical twist, and the cream of everything is collected in the smallest possible space. Starting with our old school friend the "suspended solenoid," the reader is rattled along past corkscrew rules for determining the direction of the magnetic whirl round a wire carrying a current, Sturgeon's and Henry's electro-magnets, **B** and **H**, **B** and μ, and hysteresis curves, club-footed, iron-clad, Edison-Hopkinson dynamo, Hughes' printing telegraph and Brush arc-lamp electro-magnets, being confronted at the end of the rush with that strange looking variety of the electro-magnet, the octopus-shaped field-magnet of Mr. Mordey's alternator.

Part II. is mainly devoted to the measurement of the electric current, and contains amongst other items a lucid and detailed description of Mr. Boys' radiomicrometer. We may mention in connection with this section that π, 2π and 4π dance in and out without any explanation of their strange behaviour, and since on p. 436 it is thought necessary to point out in a footnote the elementary fact that π represents the ratio of the circumference of a circle to its diameter, one would have thought that *à fortiori* "the exits and entrances" of 2π and 4π needed elucidation.

Part III. is extremely well up to date, perhaps too much so, since such comparatively untried processes as electric tanning and the electrical purification of sewage figure among the latest actual applications of the electric current.

Readers with an elementary knowledge of electricity and desirous of gaining in an expeditious manner further insight will do well to read "The Electric Current."

Electricians and Their Marvels. By W. Jerrold. (London: S. W. Partridge and Co.)

As a small book of lightly-written and interesting, but by no means accurate literature for schoolboys who are interested in the applications of electrical science, this work may, perhaps, find a fitting place. It may be conceded that in kindling the first spark of love for science in a youngster's breast it is more necessary to be entertaining than accurate, better to be amusing than strictly up-to-date. The boy, it may be said, will have plenty of time to get rid of his false impressions after the thirst for any sort of impressions at all has been created in him. If so, there will be no objection to letting him read the little book before us, for, though there are many things he will have to unlearn and impressions he will subsequently have to get rid of, he will very likely enjoy its perusal. We cannot admire the author's choice of material, in some respects; and there is a great deal of reference to the superstitious and erroneous ideas of the ancients which can serve little or no useful purpose. Edison, of course, gets the lion's share of the author's notice, his many electrical and distinctly non-electrical inventions being equally belauded; but Morse, Tyndall, Siemens, and others, are noticed, and the reference to "Silvanus P. Thomson" may do duty for two distinct electricians, or more, if for any. The book is fully illustrated, and is bound in pictorial covers.

Provisional Orders of the Board of Trade. By Francis J. Crowther. Second Edition. (London: Jordan and Sons.)

From a cursory glance at the second edition of this excellent little manual, it might be supposed that it was in danger of losing one of its best features, namely, compactness; since the less than fifty pages of the original edition are expanded into more than one hundred in the second. Increase in bulk has, however, in this instance not been gained at the expense of clearness. In the first edition the various steps to be taken in connection with the procuring of a Provisional Order were usefully arranged in order of date, but the references to the various kinds of Orders were jumbled together. In the present edition the different kinds of Orders are dealt with in separate sections, resulting in considerable repetition, but also in greater ease of reference.

NOTES ON ROTATORY FIELD MOTORS.

BY PROF. SILVANUS P. THOMPSON, D.SC., F.R.S.

The following notes, compiled for the use of students at the Technical College, Finsbury, are printed as being probably of service to others in aiding their comprehension of the operation of this little-understood class of machinery.

1. Elementary Theory of Rotatory Field Motors.

It is assumed that a rotatory magnetic field can be produced in known ways by the proper combination of polyphase currents, whether 2-phase or 3-phase. It is desired to know the relations between the speed of revolution of the magnetic field, the speed of the revolving part of the machine, the torque, and the efficiency of the machine.

Let Ω stand for angular speed of the rotatory magnetic field $= 2\pi n$ in a bipolar machine, or $= 2\pi n \div m$, where m is number of pairs of poles if machine is multipolar; and n is the frequency of period.

Let ω stand for angular speed of the rotating part, or *rotor* of the machine, $= 2\pi n_2$, where n_2 is the actual number of turns per second; (or, $2\pi n_2 \div m$ for a multipolar machine).

Let T stand for the torque between the fixed part (or *stator*), and the turning part (or *rotor*).

Let W stand for the power (total watts) communicated by the stator to the rotor.

Let w stand for the power (useful watts) actually used in turning the rotor.

$\Omega - \omega$ is the *slip* of the rotor with respect to the field, or is the difference of their angular speeds. If the field has an angular speed $\Omega - \omega$ greater than that of the rotor, it is clear that the inductive action on the circuits of the rotor will be exactly the same as if the rotor were revolved backwards with a speed $\Omega - \omega$ while the field stood still.

$W - w$ is the power wasted in heating the conductors of the rotor, since it is the difference between the total power supplied to the rotor and the power it utilises.

Now W is proportional to T and to Ω, and, therefore, by choosing suitable units may be written $W = T\,\Omega$.

And w is proportional to T and ω, and may be written $w = T\,\omega$.

Hence, dividing the last equation by the preceding,

$$\frac{w}{W} = \frac{\omega}{\Omega}.$$

From this we see that the efficiency of the rotor is the same as the ratio of the two speeds.

Further, the rotatory field motor is simply a sort of running transformer, of which the stator and rotor windings constitute respectively the primary and secondary. Now, if ω were made $= \Omega$ there would be no induced currents in the rotor conductors, the stator would then simply act as a choking coil; hence, it follows that if the condition of supply of the primary currents is that of constant voltage, the magnetic flux through the machine, rotating with speed Ω, will have an approximately constant value at all loads, just as the flux in the core of an ordinary transformer has. Further, if there is very little magnetic leakage in the gap between stator and rotor (as is, indeed, the case in well-designed motors) neither the primary circuit nor the secondary circuit will have any appreciable self-induction, and the currents in the rotor conductors will be in phase with the electromotive forces induced in them. Whence it results that the maximum currents in them will always occur when the conductors are in that part of the field where the flux-density is a maximum. And as the flux is constant at all loads, it follows that the torque will be proportional to the currents in the rotor. But these are proportional to the slip $\Omega - \omega$; hence, also, it follows that T will be proportional to $\Omega - \omega$, and may be written $T = b\,(\Omega - \omega)$, where b is a constant depending on the strength of the field, the radius of the rotor, and the length and resistance of the conductors of the rotor.

We may now write:—

$$\text{useful watts } w = b\,.\,\omega\,(\Omega - \omega)\,;$$
$$\text{total watts } W = b\,.\,\Omega\,(\Omega - \omega)\,;$$
$$\text{wasted watts } W - w = b\,.\,(\Omega - \omega)^2.$$

Hence we may at once apply the now well-known diagram of motor efficiencies, by drawing (Fig. 1) a square A B C D, having its side A B numerically equal to Ω, and cutting off a piece, B F, equal to ω. The area A F H D represents the total watts supplied, the area A F G K, or G L C H, the watts utilised, and the square K G H D the watts wasted in heating the conductors of the rotor. The efficiency will approach unity as F moves up toward A; and the output will be a maximum when $\omega = \frac{1}{2}\Omega$, the efficiency being then only 50 per cent.

In good modern rotatory-field motors the slip is only, at the most, about 4 per cent., except for very small sizes of machine, where it may be 10 per cent. at full load.

In the above investigation no account has been taken of the loss due to heating in the conductors of the primary or stator circuit. This, like the ordinary C^2R loss in the exciting circuit of any dynamo, is but a small percentage of the whole energy supplied. Neither has any account been taken of hysteresis losses in the iron of the stator, which also have to be supplied, as it were, by additional excitation, but are small in a well designed machine. Losses by hysteresis, or by eddy-currents in the iron of the rotor will, like the friction of the journals, deduct from the available power, but these are necessarily very small since the reversals of magnetism in the rotor are proportional not to Ω but to $\Omega - \omega$.

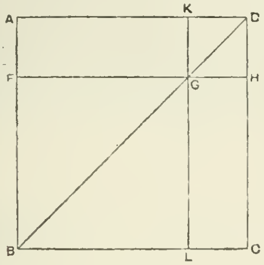

Fig. 1.

2. Resultant Magnetic Flux in Motor.

It was pointed out above, from consideration of transformer analogies, that the magnetic flux in the motor is of approximately constant value at all loads. Further, it can be shown to be a consequence from the law of hysteresis that (in a bipolar motor) the flux through the rotor core will be of approximately uniform density, and, therefore, that in the gap between rotor and stator it will be distributed with a density which varies as a sine function around the periphery from point to point, though constant at all loads, and rotating with speed Ω. Let the density of this flux in the direction in which it is a maximum be called **B**. This flux-density, like the flux-density in a transformer core, is the result of the magnetising actions of both the primary and the secondary windings. Kapp has given a discussion of the reaction which may be summarised as follows:—

Take a line, **B**, to represent (Fig. 2) the maximum of the flux-density in the motor; it may be considered as revolving around one end as a centre. This field is due to the joint action of the impressed field excited by the primary currents in the stator, and of the induced field excited by the secondary currents in the rotor. These rotor currents are in phase with the resultant field (if there is no magnetic leakage), proportional to it, and to the slip. They tend to produce a cross-magnetising reaction. They may be represented by a length, i, set off along the side **B**. This current i tends to produce a cross-magnetising field proportional to itself. Let the line c at right angles to **B** represent this cross field. Here $c = k\,i$ where k is a coefficient depending on construction. Complete the triangle **B** $c\,a$ by drawing the line a. Then a represents in magnitude and phase the magnetic field that must be impressed by the primary currents in the stator, since **B** is the resultant of a and c.

Further, since the torque is proportional to both **B** and i—that is to **B** and c—the area of the triangle a **B** c will represent the torque.

Moreover, since i is proportional to the slip, and to **B**, and to a constant depending inversely on the resistance R in the rotor circuit, we may write:

$$i = \frac{\mathbf{B} \times \text{slip}}{R};$$

$$\text{or slip} = \frac{i\,R}{\mathbf{B}};$$

and substituting $c \div k$ for i,

$$\text{slip} = \frac{c}{\mathbf{B}} \times \frac{R}{k};$$

but $c \div \mathbf{B}$ is $\tan\beta$, hence slip is proportional to $R \tan\beta$.

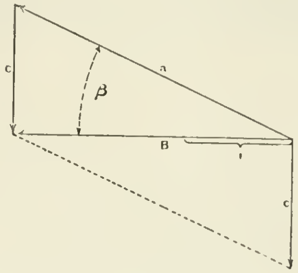

Fig. 2.

3. Conditions of Operation.

There are three chief stages of operation to be considered; and for the present we will consider the supply voltage constant, and the machine devoid of magnetic leakage.

(*i.*) *Starting.*—Here $\omega = 0$, and slip $= \Omega$. Rotor currents enormous, primary currents also enormous. Therefore, β the angle of phase-difference between primary currents and resultant field very large. Torque enormous if no magnetic leakage.

(*ii.*) *Running at Light Load.*—Here ω is very nearly equal to Ω; and as slip is small, rotor currents will be small, and their reaction small. Angle β will be small, and a will not be much larger than **B**.

(*iii.*) *Running with Heavy Load.*—Here $\Omega - \omega$, the slip, must be considerable enough to allow of the generation in the rotor of currents considerable enough to produce the necessary torque at the actual speed of rotation.

In addition to the above, if the speed is artificially brought up to synchronism by supplying from without power to overcome friction, &c., there will be no rotor currents and no torque. If the speed is artificially increased beyond this, so that the rotor runs faster than its field, power will be consumed in driving it, and it will act as a generator, pumping back current into the supply network, as pointed out by various writers.

4. Starting Torque if Impressed Field is Limited.

Suppose, now that for any reason (notably in consequence of even a small amount of self-induction in either stator or rotor, such as would occur if there is any magnetic leakage) the impressed field a is limited in value. This will in fact be the

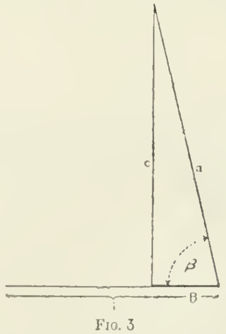

Fig. 3

case if even without interior self-induction or leakage the supply is not at constant voltage.. Then, when, as at starting, the slip is great, the triangle a B c will become of the form of Fig. 3; for if slip is proportional to R tan β, and R is small, tan β must be very great, or β will be near 90°, and the torque (represented by the area) will be very small. If we increase R we necessarily decrease tan β, making B greater and the area greater, and so get a greater starting torque. This is why introducing a non-inductive resistance into the rotor circuit at starting enables the machine to start with a greater torque.

5. Relation between Torque and Slip.

In order to get an equation for the torque in terms of the slip, and the resistance of the rotor we note that from Fig. 2 it follows that

$$c = a \sin \beta,$$

and

$$\mathsf{B} = a \cos \beta.$$

Now, from the equation slip $= \frac{c}{\mathsf{B}} \times \frac{\mathrm{R}}{k}$, we get $\frac{\text{slip}}{\mathrm{R}} \times k = \frac{c}{\mathsf{B}}$.

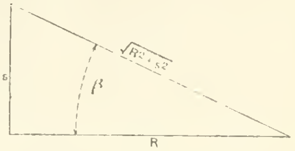

Fig. 4.

Therefore, by merely altering the scale of Fig. 2, we can rename the sides of the triangle as shown in Fig. 4, where s stands for the slip.

From this we see that $\sin \beta = \frac{s}{\sqrt{\mathrm{R}^2 + s^2}}$, and $\cos \beta = \frac{\mathrm{R}}{\sqrt{\mathrm{R}^2 + s^2}}$.

Therefore the torque T, which is proportional to $c \times$ B, is proportional to $a^2 \sin \beta \cos \beta$; and, therefore, writing q as a constant depending on construction, we have—

$$\mathrm{T} = q \cdot \frac{s\,\mathrm{R}}{\mathrm{R}^2 + s^2}.$$

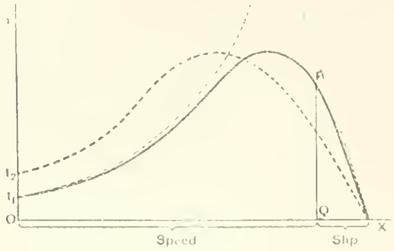

Fig. 5.

And here we are also assuming that a, the impressed field, is constant; or that, in other words, the condition of supply is no longer that of constant voltage without magnetic leakage.

If we wish to see graphically what this equation means we may plot out the relation between T and s as a curve, assuming a definite value for R.

Take the line O X (Fig. 5) to represent the speed of rotation of the magnetic field, and cut off from it a part, O Q, to represent the speed of the motor. Then the remainder, Q X, represents the slip. This is equivalent to plotting the slip backwards from X. The vertical ordinates then represent the values of the torque as calculated from the equation. For example, when Q X is taken as s; P Q is plotted to represent the corresponding value of T. Thus, we get a curve X P t_1, beginning at X when the slip is zero, which rises steeply, comes to a maximum, and dies away to the value O t, which is the torque at starting. The torque has a certain maximum value for which $\beta = 45°$. It will be noted that the steep end part of the curve is nearly straight, being an asymptote to a straight line which would represent the relation between torque and slip if the magnetic field is constant and there were no magnetic leakage. In fact, this lines corresponds to the expression $\mathrm{T} = b(\Omega - \omega)$ in the first paragraph of these notes. Or if in our present equation we consider values of s which are small compared with R, the equation might be written $\mathrm{T} = q\frac{s}{\mathrm{R}}$. At the other end of the curve, where slip is great, the curve is hollow. Here we may approximate by supposing that s is very great compared with R, or that R^2 is small compared with s^2; in which case the equation reduces to $\mathrm{T} = q\frac{\mathrm{R}}{s}$. This is the equation to a hyperbola (also shown in dot). When the motor is at rest $s = \Omega$, or O Q = zero, giving at O t_1 the value $\mathrm{T} = q\frac{\mathrm{R}}{\Omega}$. That is to say, *at starting* the torque is proportional to the resistance of the rotor. If we then assign a higher value to R, and plot out a new set of ordinates, we obtain a new curve (shown in dotted line) which also starts at X, rises to a maximum of the same height as before, and then falls, but this time to t_2. The effect then of introducing more resistance is to raise the torque at starting; but it also has the effect of causing the maximum torque to occur when the slip is greater. The motor gives out practically the same power as before, but runs with a greater difference of speed between its speed at light load and its speed at full load. And the efficiency at full load is diminished. If, with a 5 per cent. slip and a 95 per cent. efficiency, we do not get a sufficient starting torque, we can get it by introducing resistance, and contenting ourselves (at full load) with, say, a 10 per cent. slip, and a 90 per cent. efficiency. And one understands the reason for the modern device of constructing the rotor so that a resistance can be put in at starting, and then short-circuited as soon as the rotor has got up a fair speed.

A CURIOUS MAGNETIC PHENOMENON.

In the course of some experiments made at the Central Technical College, early in 1890, to investigate the nature of the field in the air gap of a magnet for a d'Arsonval galvanometer, Mr. C. O. Lloyd noticed that when a magnet is broken, and the pieces are put tightly together, there is not only a consequent point, or at all events a leakage of lines of force at the fracture, but there is an image or ghost of a similar consequent point, symmetrically situated with respect to the general shape of the whole magnet. We have received from Prof. Ayrton a report made at the time by Mr. Lloyd, and illustrated by a number of diagrams. These have been reproduced from the original iron filings by the following ingenious method. A sheet of cardboard was covered with a thin layer of paraffin wax, and the filings were dusted on and tapped in the usual way. A gas flame was lightly passed over the surface, and thus fixed the filings. A sheet of black carbon manifolding paper was laid on the filings, and a piece of white paper on this. The paper was rubbed with something hard and smooth, and many good impressions could be thus taken. Unfortunately, these reproductions are not very sharp; the original filing diagrams, if they had been accessible, would have enabled us to secure better photographs.

In each of the accompanying diagrams the actual fracture of the magnet is on the right hand, and the "image" on the left. The actual fracture is concave towards the middle of the magnet, and the "image" is similarly disposed, as if it were an optical reflection. The following is an extract from Mr. Lloyd's report on his experiment:—

> "As it seemed a little doubtful whether or not this* was only an accidental result, I proceeded to repeat all the conditions as nearly as possible

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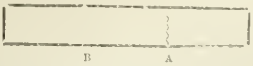
[*] That is, the appearance of an image with the curved broken magnet. Ed. E.

on a straight-bar magnet. For this purpose I procured a broken magnet, the break being at A. I wound it from A to B with about 30 turns of stout wire, and passed 60 amperes round it, completing the magnetic circuit in the form of a square with several pieces of iron. The result



was Fig. 5 with the two halves loosely put together, and Fig. 6 when put tightly together, and the accuracy with which the previous phenomena observed are repeated is sufficient testimony to its being a definite result. There is, indeed, a marked repetition of the original crack similarly situated at the opposite end of the magnet, and a shifting of the consequent poles to the far side of this.

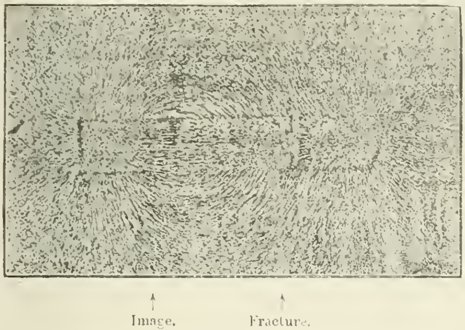


Fig. 5.

Tightening the crack, as observed before, seems to make the *sympathy crack*,* more marked, while taking a little distance seems to destroy it.

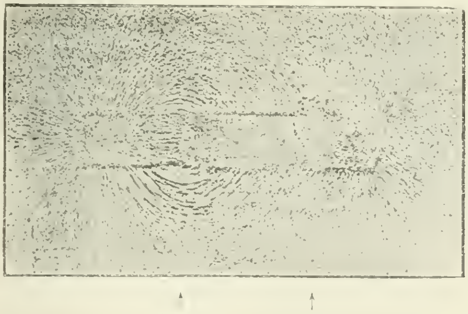


Fig. 6.

My pencil drawings, however, seem to show that it reappears when the two parts are very far apart. These, and other points, can only be seen by further experiment.

I next took a lines of force diagram with a perfectly good magnet, wound it with a similar coil over about a third of its length in the middle, and passed 60 amperes round it, with the result that there was no change in it.

Prof. Ayrton has recently repeated these experiments, and finds that fine iron filings and a rather strong field are necessary to bring out the effect. Mr. Lloyd appears to have obtained his diagrams just after removing a magnetising solenoid carrying some thousands of ampere turns. The effect is very remarkable, and if only for the reason that, at present, no explanation whatever is apparent.

Royal Society.—The following Papers were down for reading yesterday: Prof. A. Schuster, F.R.S. and W. Gannon, "Determination of the Specific Heat of Water in Terms of the International Electric Units." W. E. Wilson and P. L. Gray, "On the Temperature of the Carbons of the Electric Arc, with a Note on the Temperature of the Sun."

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* That is "image."

RESEARCHES ON THE OCCLUSION OF ELECTROLYTIC GASES BY POROUS BODIES, ESPECIALLY BY METALS OF THE PLATINUM FAMILY: ITS APPLICATION TO GAS BATTERIES AND PRESSURE ELECTRIC ACCUMULATORS.*

BY L. CAILLETET AND E. COLLARDEAU.

It is well known that when electrolysing water with platinum electrodes, the hydrogen and oxygen separated by the current do not appear immediately after the circuit is made. Further, after the circuit has been broken, a difference of potential persists between the two electrodes, so that if we circuit them through a conductor there is a current in the reverse direction to the one which was originally passed through the voltameter. These effects are explained by the recombination of the hydrogen and oxygen gas occluded by the platinum. The duration of the current so obtained is very short.

We thought that by taking as electrodes substances capable of storing a large amount of gas, there would be some likelihood of our obtaining better effects from the point of view of the duration and amount of the discharge current, without at the same time meeting with the inherent inconveniences of the Grove gas battery, which only has a very small output, owing to its large internal resistance and the slowness with which the recombination of the free gases takes place. We first of all tried spongy platinum. We enclosed about 6 grammes of this in two small bags of silken material, into each of which passed a platinum leading-in wire. These bags, placed in water acidulated by sulphuric acid to the extent of $\frac{1}{10}$th, and connected to the poles of a battery, were saturated with gas liberated by the passage of the current, and furnished a discharge far more powerful and prolonged than that which would have been obtained by using the same weight of platinum in the ordinary metallic non-spongy condition.

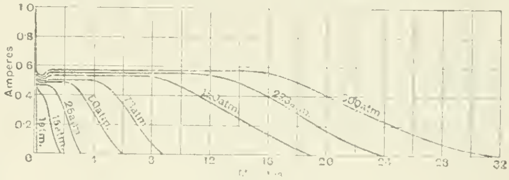

Fig. 1.—Platinum Curves.

The apparatus working in this way just like a veritable occluded-gas battery. We thought that great pressure would increase the absorptive power of the spongy platinum. To verify this we placed the apparatus in a steel vessel, and by means of an hydraulic pump we applied pressures up to 600 atmospheres. As we anticipated, the duration of the discharge current increased greatly with the pressure. The apparatus had become a storer of electrical energy, useful for capacity, electromotive force, and output measurements.

The curves Fig. 1 give the results obtained with an apparatus containing 6 grammes of spongy platinum, and discharged through a circuit of 2 ohms. The abscissæ are current strengths, and the ordinates time in minutes. It will be seen that at atmospheric pressure the duration of the discharge is only about 10 seconds. The initial electromotive force of 1·8 volt falls continually to zero.

When we work at higher pressures the discharge curve is gradually modified, and exhibits three phases. (1) A period of very rapid fall followed by a slight increase of current. (2) A period of constant current. The amount of this current increases slightly with the pressure. During this period the electromotive force is about 1 volt. (3) Lastly, a second fall, less rapid than the first.

If we calculate the capacity of this accumulator we find that 1 kilogramme of spongy platinum can store 56 ampere hours at a pressure of 580 atmospheres. Now, the practical capacity of commercial lead accumulators varies from 10 to 20 ampere-hours per kilogramme.† As to the amount of the discharge current it may easily reach 100 amperes per kilogramme.

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* *Comptes Rendus*, Vol. CXIX., No. 20.

† It is, of course, well understood, as M. Mascart pointed out after the reading of our Paper at the Academy that the figure we give for commercial lead accumulators refers to their *practicable* capacity, and relates to total weight and not merely to the weight of active material. It is well known that for some time past it has been possible to construct lead accumulators having a higher capacity, but this advantage is counterbalanced by the very rapid manner in which the apparatus is put *hors-de-service*

From the commencement of our experiments we observed that when using equal quantities of spongy platinum at either pole, the liberation of the hydrogen bubbles occurred much sooner than that of the oxygen bubbles. We concluded that in order to obtain the best results from a given weight of material it was necessary to divide it unequally between the two poles. We found that the proportion to adopt was three parts at the negative pole against one part at the positive pole.

Finally, we endeavoured to ascertain something as to the efficiency of the arrangement; that is to say, as to the ratio of the quantity of electricity restored on discharged to that supplied during the charge. We found that this efficiency reached very high values (95 to 98 per cent.) when the charge was not pushed to the last limits, and when it was immediately followed by the discharge. When these conditions are not fulfilled, the charge is gradually dissipated on open circuit and the efficiency is reduced.

We investigated, in the same manner, other metals of the platinum group. M. Joly, director of the chemical laboratory of the École Normale Supérieure, where these researches were carried out, was good enough to specially prepare for us the necessary quantities of metal in a state of great purity.

Iridium gave results exactly analogous to platinum. Ruthenium is slightly attacked at the positive pole by the acid solution, which becomes a deep brown colour. In spite of this it also occludes electrolytic gases, and makes an accumulator the capacity of which increases with the pressure. But its electromotive force is not constant. It falls continuously from 1·6 volt to zero without showing any tendency to remain stationary at any moment during the discharge, and this just as much at a pressure of 100 atmospheres as at atmospheric pressure. Of all the metals like platinum, palladium is the one that yielded the most interesting results. Its occluding properties for hydrogen are well known since Graham's experiments. This physicist found no trace whatever of oxygen in his experiments with sheets and wires of this metal. We also were able to observe that an accumulator formed by two sheets of palladium only possesses, even under great pressure, an excessively small capacity, and this owing to the almost immediate saturation of the positive sheet, which liberates oxygen the moment the circuit is closed. By using spongy metal (obtained by the calcination of the cyanide) the results obtained were totally different, and we achieved results much superior to those given by other metals of the platinum species. Even at the ordinary pressure, the accumulator after having given a rapidly-falling discharge current followed by a slight rise, yielded then a constant supply. Platinum sponge only did this at a pressure of from 20 to 30 atmospheres. As the pressure increases, the same general effects as with platinum are observed, but for equal pressures and weights of active material the capacity of the accumulator is three to four times greater. Thus, at a pressure of 600 atmospheres, the capacity reaches 176 ampere-hours per kilogramme of spongy palladium.

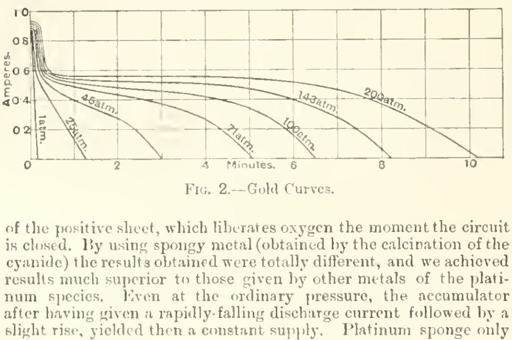

Fig. 2.—Gold Curves.

Gold precipitated from the chloride by sulphurous gas has also been found to be a useful material with which to make an accumulator having a variable capacity according to the pressure. Its capacity is, however, less than that of palladium or platinum. The form of the discharge curve (Fig. 2), moreover, is somewhat different to that given by these metals.

Finally, with silver, tin, nickel and cobalt, tested under the same conditions, chemical change takes place at the positive pole. The same is the case with carbon in its various states. It is true there is a certain storage of electrical energy in these bodies, but a high pressure has no effect upon the results. The effects observed are probably due to change of a chemical kind, similar to that to which lead accumulators owe their properties. In the case of carbon in particular the gas which is liberated at the positive pole is not after the electrode is saturated, pure oxygen, but a mixture of this gas with a very large percentage of carbonic acid. This phenomenon has already been noticed.*

To sum up. Among the various substances investigated only the noble metals, which are not subject to chemical change on contact with the electrolyte or the products of its decomposition, seem suitable for the purpose of making occluded gas accumulators, the capacity of which increases with the pressure. In the case of some of those metals, the capacity may reach high values, markedly superior to those which is obtained in current practice, with the commercial lead accumulator.

M. Berthelot points out, in connection with the preceding interesting communication, that platinum, palladium and analogous metals form when cold with free hydrogen and oxygen, and especially with the first body, true and definite combinations. Platinum especially gives rise to two successive hydrides, the one stable up to about 200°, the other dissociating when cold ;* it is particularly the latter, the formation of which is influenced by pressure. We have here true chemical combinations and not, as was once supposed, gases occluded or condensed in virtue of some mysterious property. The existence of these combinations and the reciprocal actions between the hydrogenated and oxygenated compounds of the noble metals explain the formation of the accumulators which our colleague has just discovered, and also the electric current generated between two platinum electrodes charged with these two gases as well as the current generated without any auxiliary electromotive force between two platinum electrodes plunged into acidulated water.†

THE CANNON-STREET ACCIDENT.

BOARD OF TRADE INQUIRY.

Major CARDEW, acting for the Board of Trade, at Winchester House, opened on Monday last an inquiry into the causes of the accident in Cannon-street, on November 12th, when a horse was killed by an electrical shock, and several persons sustained injuries.

Mr. Russell Griffiths appeared for the Aldermen ; and the Commissioners of Police for the City, and the Commissioners of Sewers, the lighting authorities for the City, were represented by their solicitor, Mr. E. A. Baylis ; Mr. R. W. Wallace, instructed by Messrs. Ashurst, Morris and Cripps, appeared for the Company.

GEORGE CLARK was the first witness called. He stated, in reply to Major Cardew, that on November 10th, just after one o'clock, he was driving a horse drawing a brougham through Cannon-street, having come into the City by way of Fleet-street. The roads were wet and the mare he was driving was young, so he was driving carefully. Just as he was about to turn into Budge-row the mare pitched forward and turned on her side, and her legs became stiff directly. Witness jumped down to go to the horse, and as soon as he touched the ground he felt a shock go up both legs. He dropped the reins and went and leaned against a window-ledge. After the mare's legs stiffened out her body kept "jumping." What witness felt was like "pins and needles," only more painful ; he could not keep his knees still. He could not get near enough to touch the horse. The paving of the road was wood. A constable came and assisted to get the brougham away from the mare, which by that time was dead. The mare struggled for about four minutes—she foamed at the mouth, bled at the nostrils and groaned. Witness had not been able to go to work since. He still felt the effects of the shock in his side, and was under medical treatment. Shortly after the brougham was taken away from the horse he heard a rattling noise, and saw smoke coming up from the pavement near the corner of Walbrook.

By Mr. GRIFFITHS : He was driving on the wood-paved roadway, and the horse did not go on to the pavement.

By Mr. WALLACE : He felt the effects of the shock still up one side and in the head. The least noise made him jump.

JAMES HUTCHINGS, head warehouseman at 21, Budge-row, said he was standing in the loophole of the warehouse when he saw a horse and brougham come from Cannon-street into Budge-row. The horse tumbled forward on to its fore legs and nose, and then turned over on to its side. He thought the horse had merely stumbled, and jumped down to assist in getting it to its feet again. He was going past the horse to the body of the carriage, but had not got the length of the horse when he felt a shock which nearly brought him to the ground. He got away from the spot as quickly as possible and warned other people from going over the place. The explosion which he did see occurred about ten minutes after the horse fell.

By Mr. GRIFFITHS : He did not touch any part of the horse or the harness, and had not reached the brougham when he felt the shock.

CHARLES JOSEPH WILLY, a postman, said he was proceeding along Cannon street, coming from Queen-street, and saw the brougham in front of him at the corner of Budge-row. He saw the horse tumble and people gather round. The horse and brougham being in his way he turned in to the left, crossing the beginning of Budge row, and got on to one of the manholes on the pavement. At that moment he felt as though sparks were going through every part of his body. He had one foot on the plate of the manhole and the other on the pavement. He was drawn towards the ground, but not thrown down. He had two shocks, one on the lid and one on the flagstone, as his feet went down one after the other When he got both feet clear of the cover he did not feel any further shock. He got away and went on to deliver a parcel in Walbrook. He was just getting on to the pavement outside witness's shop, and a gentleman was asking him if he was hurt, when the street box at the corner of Walbrook blew up, knocking him across the road and against the "Cannon" public house. A piece of stone struck him on the finger, and a piece of iron stuff came down on his toe. His mouth was full of concrete. He went off

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[*] Debray and Péchard, *Comptes Rendus*, 1887.

[*] *Annales de Chimie et de Physique*, 5th series, Vol. XXX., pp. 524-530.

[†] *Loc. cit.*, p. 537.

then—he had had enough of it; he merely went round to give his name to the sergeant of police. He was still sensible of ill effects from the shock.

By Mr. GRIFFITHS: He had been walking about a good deal during the morning, and the soles of his boots were damp. The concrete which filled his mouth was in the form of dust. He went back to look at the place where the explosion had occurred after he had been blown across the road, and saw that three or four of the flagstones had been moved. The cover of the box was blown to pieces, so far as he could remember.

By Mr. BAYLIS: He did not notice any smell of gas or anything else peculiar at the time of the explosion.

By Mr. WALLACE: He was too fully occupied with the concrete in his mouth to think about smells. He had now resumed his ordinary work.

H. M. HOWELL, clerk, of Botolph House, Eastcheap, said he was standing at the corner of Walbrook, near the street box there, when the explosion took place. He could scarcely tell whether he was knocked down or not, but he was much dazed. He remembered trying to get away as quickly as he could to find a doctor's or a chemist's. He looked back as he was running away, and saw a man lying down and groaning. He could not say whether or not it was an electric shock he experienced. He tried to keep his presence of mind, as he had money belonging to his employers in his pockets and feared he might be robbed if he fell.

WILLIAM FRANK WHITE, of 55, Caistor Park-road, West Ham, builder and contractor, got off a bus in St. Paul's-churchyard and walked down Cannon-street. When about to turn into Budge-row he saw the horse fall. Witness was proceeding on his way, and when he reached the pavement received a severe shock. He was at the time standing on the street box. He heard the explosion in Budge-row and saw smoke ascending, but did not smell any gas.

ALFRED HASLETT, mining engineer, of 64, Cannon-street, saw the horse fall on his way to his office, and later was on his way to make a call in Walbrook; upon reaching Budge-row he saw a boy get a shock, and shortly after saw the street box blown up. He heard three sharp reports, quickly, one after another; dark smoke and flame came up with the explosions. The flame was blue, it was not a gas flame. He told a police constable to go to the Electric Lighting Company and get the current switched off, and was then making for the pavement when he received a shock in the left leg, and was thrown to the ground. When he got up and reached the pavement he found he could not lift his left foot from the ground, and he was taken to Guy's Hospital, where he was put under medical treatment.

THOMAS COWLEY, carman, was loading a van in Budge-row. When the horse fell he went over to render assistance, but had only gone two or three steps when he received a shock in his heels. He left his horse in charge of a boy, who afterwards drove him to the hospital.

P.C. BRADLEY, 665, saw a crowd at the corner of Budge-row, and went to take the name and address of the driver of the dead horse, when he heard two loud reports, and saw the lid of the box in Budge-row lifted up. A kind of bluish flame came up out of the box, and rose to the height of about two yards, being accompanied by dense smoke. He went to inform the electric light people of what was happening. He got a very slight shock when near the horse.

P.S. COOPER, 34, gave similar evidence.

Mr. FRANK WITHERS spoke to hearing the explosion and finding the basement window of his father's shop blown in and a blind iron broken, and an assistant from the shop, H. FREEMAN, said he had, when going into the basement at intervals between eleven o'clock and one on that day, detected a smell as of india-rubber burning. This odour became gradually less after the explosion. Several police-constables were called by Mr. Griffiths and corroborated their reports as to previous explosions of street boxes in St. Paul's Churchyard, Harp-lane, Ludgate-hill, and other places.

Mr. DAVID COOK, engineer and manager of the City of London Electric Lighting Company, then gave evidence. Having explained the plans and diagrams put in, he stated that the primary cause of the accident was the crossing of two high pressure cables which were being tested and put to work for the first time. One of these cables was for the supply of current to the Watling-street transformer station, the other for the Milk-street transformer station. The Milk-street cable was inadvertently put into the Watling-street terminals at Bankside, while the Watling-street cable was laid with its inner conductor touching the lead covering of a third cable. For convenience the Watling-street cable was made alive by current from the transformer station. When the signal was given, the man at the transformer station switched on. Then the inner conductor, as already explained, was against the lead covering of another cable, and therefore the inner of the whole high pressure system was put to earth, throwing an unusual strain on the insulation of the outer and the primary main. Their cables were all tested under a much higher pressure than anything that could be put on them by a test of this kind: but, unfortunately, the insulation of the cable broke down at the junction box at the corner of Cannon-street and Budge-row, this being caused by a mechanical abrasion of the outside covering. When the mistake was discovered the attendant at the transformer station cut the cable out; but before this was done the leak in the junction box had developed into a short circuit—that is to say, to the best of their belief it had done so. Since the explosion occurred in St. Paul's-churchyard in January last they had had men constantly employed searching for gas in their conduits. Four times since March last letters had been written to the gas company complaining of gas leakages in Cannon-street within one hundred yards of the spot where the explosion took place. Since January they had written to the gas company 88 times calling their attention to similar leaks. Hitherto they had thought the safety of the public sufficiently ensured by systematic inspection; but to increase it, if possible, he should recommend his Directors to provide a complete system of ventilation for their conduits at a cost of over £2,000. He wanted to show the public that they were doing all they could to prevent accidents. At the same time he wanted to direct the attention of the Board of Trade in the strongest possible manner to the question of the responsibility of the gas company is respect of these explosions. In the case of the St. Paul's Churchyard explosion Major Cardew had exonerated them from having set light to the gas electrically; but it was not until some months afterwards that he learnt how that explosion was caused. Two employés of a customer of theirs in Ludgate Hill smelt gas strongly, and went into the cellar to search for it with a naked light. They found it. After the flash up in the cellar they discovered that the gas had been coming from their (the Electric Lighting Company's) conduits. One of the boys clapped his cap on the pipe to put out the light, which was burning like an ordinary burner, and drove it back into the conduits. They heard two explosions, but said nothing about it.

Major CARDEW: Unfortunately, you came after the gas company, and your regulations require you to keep your conduits free from gas.

Mr. COOK: If it is possible to do that.

Major CARDEW: I do not think we can go into that at this inquiry. You can produce any evidence you like to show that it is impossible, through unforeseen difficulties, to keep the pipes free from gas.

Mr. COOK: In that case we shall expect the Board of Trade and the public to look benevolently upon anything we do.

Major CARDEW: When you blow up the public you cannot expect them to look benevolently on you.

Mr. WALLACE: You must not say we blow up the public. There must be something to blow up.

Major CARDEW: That is begging the question, rather. We have had no evidence of gas in this case. Nobody detected any smell of gas.

Mr. WALLACE: That is quite likely. After the explosion there would be no gas to detect; it would be burnt. Before the explosion it would be in minute quantities and underground in our closed-up conduits.

Mr. COOK said millions of cubic feet of gas were being poured into the subsoil of the metropolis every year. It must go somewhere. It got into their pipes, into the sewers, and so on. He merely mentioned this to show how difficult it was to keep the conduits clear. He had not a word to say against the officials of the gas company.

Major CARDEW repeating that it was not proved that this explosion was due to gas,

Mr. WALLACE said if they were not agreed as to the facts, it would be necessary to call scientific evidence as to how the explosion occurred. It seemed to him if they took for granted things which must exist in order that an explosion might be caused, it would save a great deal of evidence being given. There were only two ways in which an explosion could occur, through the electrolysis of water or by the escape of gas into the conduits of the Company.

Major CARDEW: I think there is another way. My impression is that when such a large arc can be produced in a concentric main, the inner and outer discharge across to each other, and where such a very large current can pass, and must pass, before it fuses that, the generation of heat in the confined space is sufficient to expand the air in that space and cause an explosion.

Mr. COOK: In that case it would explode at the box where the arc took place.

Major CARDEW: Certainly.

Mr. COOK: But the evidence shows the box cover lifted before the explosion in the other. I think that is incontestably proved.

Major CARDEW: It seems to have been simultaneous.

Mr. WALLACE said the witnesses did not agree as to that.

The inquiry was here adjourned until the next day.

TUESDAY, NOVEMBER 20TH.

Mr. DAVID COOK was recalled to resume his evidence. The Witness read over a corrected copy of the statement made by him on the previous day, and it was put in as evidence. In further reply to Major Cardew the Witness explained that all the high-pressure cables were concentric. The cables were all tested at very high pressure—10,000 volts between the inner and outer, and 5,000 volts between the outer and the earth. These tests were while in water, and after being in water 24 hours as usual. The fusing current was about 700 amperes. The power that would pass through the cables before the fusing took place would be about 1,400 kilowatts, or, roughly, about 2,000H.P. Witness was not aware of any regulation limiting the number of lamps to be lit by one cable. There were 46,000 lamps in the district to be supplied at the same time from the same cable, but these could not possibly be put on at once. About 70 per cent. of the lamps could be put on at one time. To light, say, 10,000 lamps there would be a primary current of about 200 amperes necessary. Witness proceeded to explain that the system of interconnection between districts would not be maintained when the whole of the system was got into working order, though it would be kept up as a stand-by in case of breakdown. Nearly all the damage that had been done had been done by arcs. Referring to the ventilation of the boxes Witness said there had been no provision for ventilation; but as the telephone tubes gave a current of air, and as there was a systematic method of inspection pursued, these measures were deemed sufficient for the purpose.

Major CARDEW drew the attention of the Witness to the Board of Trade Regulation No. 15, providing measures for preventing the accumulation of gas or water in the boxes, and for preventing the surface of the street becoming electrically charged. Witness said that the cables were laid, he thought, before the date of that regulation; but since the issue of the regulations the cables which had been drawn in had all been lead-covered. The lead covering had been adopted ever since Witness was the engineer of the Company. In this detail of Regulation No. 15, the Witness admitted that the Company had not strictly complied with it;

or, rather, he would say that when these cables were first drawn in this aspect, the question did not appear as important as at the present time. Witness had now given orders to cover all the parts of the cable between the iron pipes with copper strip (a sample handed in). There would be several layers, securely fastened at the ends of the pipes. Witness's experience went to show that in dealing with distribution by high-pressure currents a metallic covering was necessary. Referring to the lead coverings, which would melt at low pressure, the Witness said he was willing to go into experiments; but at present he deemed lead sufficient for its purpose. The street boxes gave the Company no trouble in regard to water; the lids, being puttied down, answered the purpose. Witness was about to recommend his Board of Directors to put in a system of ventilating pipes. It was his opinion that if the City Commissioners of Sewers permitted his Company to ventilate the explosive mixture of gas and air which went into the conduits by replacing some of the guard posts at the corners of the streets with hollow posts, some arranged to take the air down and some with an up-draught, there would be no further danger to the public in explosions. In regard to switching on power immediately after the accident, witness admitted it might have been better to have switched on through a fine fuse first.

After the evidence had been read over to the witness, he added details of the depth of the pipes in Bodge-row, &c. At the Cannon-street end the pipes were 2ft. 6in. deep, and at the other end, going west, 1ft. 4·7in. deep. It was practically a uniform slope from 2ft. 6in. to 1ft. $4\frac{3}{4}$in.

Mr. GRIFFITHS took the Witness through an examination as to the date of aiguing the contract to show that the Company might have made any alteration up to the date of their signing of it. In regard to the cause of the accident, of course there had been a mistake in not identifying the cable by electrical test. Mr. Griffiths read some correspondence between the Board of Trade and the companies from whom the City Electric Lighting Company took over the contracts, with the view of showing that some of the difficulties had been foreseen, but Witness said that while his Company had taken over the contracts they were not bound to carry out the suggestions of those other companies—some of which he did not think were good suggestions.

Mr. BAYLIS led the Witness through the details of testing the cables (among other things), and Witness explained that he was making arrangements for such periodic testings of the cables as would obviate any future accident of this kind. The first consideration of the Company had been to secure the public safety, and for this they had spared no expense.

Mr. F. L. FOULGER, representing the Gas Light and Coke Company, attended, and asked to be allowed to give evidence. He had tested the ground near the accident and the boxes with steel rods and Ansell's leak detectors, but he had utterly failed to find any trace of coal gas, and he desired to emphatically deny that coal gas was present. In further course of evidence the witness suggested that the arc lampposts should be made into ventilators, being plugged with sawdust or mould from the top down to about 10ft. from the ground, where a pipe should be allowed to carry out the discharge to the air, at a height beyond the reach of any one putting a match to it or a fusee. The witness, speaking of explosive power of gas and air, quoted the highest explosive mixture as 90 per cent. of air and 10 of gas. The witness was questioned about the general question of leakages of gas in the City, but he referred to another witness yet to be called for these details. In regard to securing the public safety, witness said he had no doubt whatever that the Gas Company would contribute in any reasonable way towards anything that would prevent accidents, for the Gas Company was as much interested in the public safety as the Electric Light Company.

General WEBBER gave evidence respecting the ventilation of the street boxes, and the plugging of the pipes with spun yarn. Witness said the whole question of the ventilation of the street boxes in the City had been gone into by him carefully, following on many years' experience, both in connection with telegraph street boxes and those of other electric light companies in London and elsewhere. The prevention of the entrance of gas into the boxes appeared to be the one measure essential to public safety, seeing that more than one House of Commons committee had declined to allow street boxes to be ventilated by attachments to private houses. He did not dispute for one moment that ventilation by means of inlet and outlet pipes would not be an excellent thing if they were arranged so as to secure a strong current of air to pass up and down. But he was sure the very next best thing was to construct the boxes gas-tight, with glazed bricks or other suitable materials, and close all the unused pipes by wooden plugs, or tarred yarn, or something of that kind. He thought it should not go before the public from this inquiry that these street boxes, even without ventilation, were a source of danger, because they were not so, except in the most unusual circumstances.

Mr. WAGNER, analytical chemist, of 101, Leadenhall-street, explained how he had examined the boxes at Walbrook and Dowgate-hill in search of coal gas on the evening of November 19th. At the Walbrook box Witness found no coal gas, but at the Dowgate-hill box he found 12 per cent. At Walbrook he took two samples, each of one and a-half pints, and at Dowgate hill he took one sample of three or four pints.

Mr. LISTER, traveller for Woolf and Co., electric engineers, deposed to having smelt gas in the vicinity of the accident prior to and on the day of the accident.

The inquiry was then adjourned to Friday, November 23rd, at 11 o'clock a.m.

Electric Power in Rolling Mills. A Pittsburg company proposes to build a rolling mill for the manufacture of structural steel, in which, the *American Manufacturer* says, electricity will be the power employed. This will be the first iron mill to be operated by electricity alone.

NOTES ON ELECTRIC TRAMWAYS IN THE UNITED STATES AND CANADA.[*]

BY H. D. WILKINSON.

In the Paper communicated to this Institution I have endeavoured to lay before you some notes on the working of electric tramways on the continent of America. I have not gone so much into descriptions of material and plant as into those questions which I heard constantly being discussed with reference to the return circuit of electric tramway systems and the marked electrolytic action in some cities on underground pipes and cables. While the single-trolley system is almost entirely universal, I took pains to find out such details of the double-trolley system in Cincinnati, and the underground conduit in Chicago and Washington, as I judged would interest the members of this institution, not only on account of their using an insulated return but also on account of possible practical utility in their mode of working. For the details of these systems I must refer you to the original Paper; but, in order that the points put forward on the various systems may be made clear, I have had some diagrams prepared which show the general scheme of each. Considering, first, the predominating single-trolley overhead system—the mileage of which to-day in the United States and Canada exceeds that of all the steam, cable, and horse traction systems put together by 50 per cent., and to which, owing to its exceedingly adaptable and flexible character, the enormous development of electric traction in those countries has been due—we have the current supplied to the cars through the medium of a bare copper wire stretched centrally over the rails of the track at a height of about 19ft. from the ground. The current is collected from this wire by means of a thin steel tube and trolley wheel mounted on the roof of the car, the wheel running on the under side of the wire, and being kept up to the same by springs on the tube. The current is conveyed by an insulated wire to the controlling and reversing switches and fuse to the motors, a lightning arrester also being in circuit.

The overhead trolley wire is divided into sections of one-quarter or half a mile in length, insulated from each other, and supplied with current from the power station by separate insulated feeders, as shown in Fig. 1. As each section is independently supplied, it follows that the size of the trolley wire does not depend on the length of line, but simply on the length and average load per section, and is therefore uniform in size throughout, and generally about $\frac{1}{3}$in. in diameter. On this system the current passes from the electric motors to the iron frame of the car, and thence by the wheels to the rails and earth. As the earth presents an almost infinite mass compared with the rails, it was assumed in the first instance that a return of least resistance would be secured by well earthing the negative poles of the dynamos. The coal bill, however, stimulated inquiry into the losses in transmission of electric energy. On many lines of five to 10 miles the voltage at the most distant section between trolley wire and rails was only 50 per cent. of that generated at the station. Some improvement was made by sinking deeper earths into moist soil and connecting the same to more points on the rails. But at the best this was unreliable and variable, and it was noticed that improvement was more marked when attention was turned to the rails themselves as the best return conductor. High-resistance fish-plate joints were bridged over by iron and then by copper wires, and the rails at their nearest point of approach to the power station were connected by overhead return cables to the dynamos, thus affording a reliable metallic return, while at the same time the earth formed part of the circuit.

The diagrams illustrate the stages of development in the return circuit: Stage I being that just described, viz., bonded rails and return cables. In Stage 2 we have the rails connected at intervals to water and gas pipes: this step creating, from the traction companies' point of view, a most satisfactory rise of potential on the line, and improvement in speed of cars at the distant points on their system; but also raising the potential of the pipes above that of the earth, and bringing into existence electrolytic pitting and corrosion, followed by leakage and danger, and producing, as the secretary of the gas company in Washington described to me, a feeling akin to sitting on the top of a volcano. The electrolytic consequences ensuing on this method of "helping out" the return circuit led to a reconsideration of the matter. It was found impracticable to root out all such connections, or to provide such inspection as should prevent its recurrence; but the action was mitigated by clamping copper bands round the pipes at affected points, the same being connected to cables leading directly to the negative collecting bars in the power station.

All this pointed to the advantage of a metallic return, and led to the use of the supplementary wire shown in Stage 3. This consisted of a bare copper rod, wire, or cable, laid on the sleepers between the rails throughout their entire length, connected by twisted and soldered wires to the rails on each side of the fish-plates, and cross-connected to a similar wire in the adjoining track every 30 yards. But on all lines which I have seen being laid in this manner the wires have been uniform in section throughout (about ⅜in. diameter for the central wire, with smaller wires to bridge the rail joints), instead of increasing in section as they approach the power station in proportion to the increased volume of-current. Unless proportioned to admit of constant density of current, I fail to see that this attains the desired end.

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[*] Supplementary Paper read before the Institution of Electrical Engineers, November 8th. [We regret that the clearness of this Paper should suffer from the lack of the diagrams illustrating it, but we have been quite unable to obtain copies for reproduction. Ed. *E.*]

The appreciation of this fact led to the adoption in Cleveland, by Mr. Charles W. Wason, of return feeders connected to the rails every 500ft.—shown in Stage 4. The feeders were increased in section and number as the lines neared the generating station, and added to from time to time to meet the increased traffic. Other engineers whom I met were considering the adoption of such return feeders on their lines as a means of improving their efficiency of transmission.

Through all the stages thus far the idea has been retained that the negative poles of the dynamos must be connected directly to earth at the power station. Doubtless, if there are no return feeders and poor rail-bonds, or if the return feeders are of insufficient section to carry the current ousted from rails so bonded, a portion of the current will take to the earth and metallic bodies within it on its way back to the generators; but, although it will cost a little more, I think we can afford to dispense entirely with the alternative earth path, and should do without it. The safety of buried pipes and cables would thus be assured, and the efficiency of transmission increased.

It may be urged that the rails are perforce in contact with earth, and, therefore, the alternative earth path is always present. The answer to that is: Let the negative poles of the dynamos be connected to the rails direct by insulated cables, but not to earth at the station, and the current will then be kept within the rails and return feeders. The only chance for current to pass to earth would be as a shunt round bond joints of high resistance or insufficient conductivity; and, should this occur, it will only cause electrolytic corrosion at such joints, and not on underground pipes and cables.

Having arrived at this point, I now divide the exclusively metallic return so obtained under two heads—viz., feeders and rails. If we put return feeders to every half-mile of rails, as we put them to every half-mile section of trolley wire, the bonds become of lesser importance—that is, firstly, they need only be of section sufficient to take the maximum current *per section*; and, secondly, they will be of uniform sectional area throughout. All the return current is then collected by the feeders, and returned to the generators direct. Each feeder collects or drains off the return current for a certain distance on each side of its point of attachment to the rails; and when current is collected in this manner at several centres along the route it cannot all rush to one spot, near the power station, where the density is not only seriously increased, but voltage and power are wasted. But if we do without return feeders altogether, then the current is returned entirely by the rails, and the bonds are of great importance.

Since the original Paper was communicated, rail-bonding has been much improved, and I believe we can thoroughly rely upon these joints as permanent connections. Adequate area of contact with the rail, and that of a permanent character, are the main points.

I have taken exception to the supplementary wire; but if increased in section, say every quarter of a mile, as it approaches the power station, it would do nearly as well as insulated feeders, provided the connections from the rails to the generators were made at the nearest point to the power station by insulated cables. On lines where the route rounded curves or loops it would not do as well, because the current might find a short cut across corners if the earth favoured. By this method, also, current would be "bunched" at one point, instead of being collected and returned at intervals by feeders.

I now come to the double-trolley overhead system. In the original Paper I have given an account of my visit to Cincinnati (Ohio), where this system is in operation. I went there to look into the system with an open mind and ascertain whether there were any adequate advantages to be gained for the use on one track of two overhead wires and two trolleys instead of one. The idea and the principle were, of course, complete insulation from earth. I need not repeat here what I have already reported as having seen in Cincinnati; but I may summarise by saying that I found one of the trolley wires in connection with earth, although not in direct connection. I could light the lamps in a single-trolley car by changing the trolley wheel on to one of the double-trolley wires which ran over the same track. However, no direct path for the return current through the earth would be offered by one wire being earthed, because there was (as there must be with this system) a complete return circuit of insulated feeders from the sections of negative trolley wire to the generators, in a similar manner to that on the positive side. In other words, the return circuit was a complete duplication of the outgoing circuit, and the dynamos delivered their current outwards by insulated feeders, and received it back by insulated feeders of equal capacity. Any connection of either trolley wire to earth, therefore, could not cause a flow of current directly from the rails to the generators, since the latter were not in connection with earth *at the power station*. That this fact was an advantage, in view of electrolytic troubles resulting from return currents through earth, I could not doubt; but, notwithstanding the mechanical and commercial success of the double trolley in this city, I could not but reflect that, if we are to have overhead wires at all, *one* is better than *two*, and there might be other ways of effecting the same object.

This led me to look at the single-trolley system again, and to ask myself the question, "Would not the same immunity from return earth currents be secured if, instead of earthing the generators and favouring an earth path, the return current should be collected direct from the rails by insulated feeders in communication with the negative side of the generators?" I am convinced that it would, and that the gaining of such immunity by insulated return feeders, connected at half-mile intervals to the rails on a single-trolley system, quite compensates for the extra cost.

Thus I am led back to the same conditions as in Stage 5; and this conclusion strengthens the position of the single trolley, while, so far as any superior advantage is to be gained, it disposes of the double trolley.

At the same time, I am bound to admit that, notwithstanding the increased amount of overhead work, and the extra insulation required at points and crossings, no serious mechanical difficulty presents itself in the double trolley; and the Board of Affairs of that city have acknowledged its practicability and success in authorising considerable extensions. To the gentlemen connected with both systems in Cincinnati, who courteously gave me opportunities of making observations on any part of their systems, and whose names I have mentioned in the original Paper, I expressed at the time, after visiting the power stations and travelling over ten miles in double and single-trolley cars in the city and suburbs, my gratification in finding the double trolley work so well; but a somewhat over-zealous though well-meaning reporter put as one of the head lines of an article on my inquiry into that system, that "London will copy." I should be very sorry to disappoint that gentleman or his readers in their good wishes for our metropolis; but I have advance points which I think show that simpler systems can be made equally advantageous.

In the three-wire system, of which I have prepared a diagram of the outside circuit, two 500-volt generators are connected in series, the middle wire being to earth, and the free positive and negative terminals connected to the feeders radiating from the station. The single overhead trolley wire is used, divided, as usual, into sections insulated from one another, so that the outside line work is precisely the same as in the two-wire system. Instead, however, of these sections being all of positive potential, they are connected alternately to the positive and negative feeders. Thus, only a small part of the total current used in propelling the cars returns by the rails or earth to the station, and that only when the load is not balanced on the different sections of opposite potential. For this reason I heard that the system was to be tried in districts affected by pipe corrosion on some of the great lines in Massachusetts, but with what result I have not heard. There is, however, a line in successful operation at Portland, Oregon, which I have not seen; but am pleased to say that the authors of the next Paper, Mr. R. W. Blackwell and Mr. Phillip Dawson, can give us details of the practical working of this system, gathered on the spot.

I have also laid before you some notes on the conduit or slotted rail system, which has been working successfully for some time in Chicago and Washington, D.C., as I judged that the members of this Institution should be put in possession of such information as could be obtained on the spot. To avoid repetition, I must refer you to the original Paper for details of this system, but I have the drawings here for your reference. In the conduit there are two rigid copper rods supported from above at intervals on insulating blocks and gun-metal clips. The rods were in the first instance stretched continuously, but were afterwards divided into sections, with sleeves and springs to take up for expansion. I went up and down the line on the cars, which worked smoothly and perfectly; and by entering a manhole got my head in the conduit, so that I could watch the running of the trolley wheels as the cars went by. The sparking was inappreciable, and the system worked perfectly. The mechanical details at points and curves were well worked out.

I have seen other conduit systems on paper, and there are probably several that would work equally well if given so fair a trial as that in Washington; but I have not thought it worth while to bring any system before a body of practical men, capable of designing as good systems as any others at present on paper, without having seen it myself in actual successful work and the system described has certainly gained public and administrative confidence, and I believe has sound commercial prospects of further expansion.

I was very pleased to see Messrs. Siemens's defence of the Buda-Pesth conduit line, which is both exhaustive and timely. Somehow or other, an impression has prevailed that a $1\frac{1}{4}$in. slot is inseparable from an electric system ; whereas the case at Buda-Pesth was that advantage was taken of the wheel flange slot already existing, and this was necessarily somewhat wide. There is no difficulty in making the slot $\frac{5}{8}$in., and bedding the insulated wires of the collector in a $\frac{1}{2}$in. steel carrier. The conduit and slot in the centre of the track, however, is the most satisfactory, as it is not subjected to any continuous wear from the travel of the cars.

Of the two systems of electric street tramways, the single trolley is most suitable for out-lying districts, and the conduit for towns.

Although necessarily moving slower in town streets on account of the traffic, and therefore not showing all their good points, it must not be overlooked that electric cars have tractive power to tackle ascents of 1 in 10 ; and the running expenses per car mile are cheaper than by horses. The approximate total cost of buildings, machinery and rolling stock is the same in both the trolley and conduit systems, and amounts to from £1,200 to £1,500 per motor car. The overhead work and poles with single trolley costs about £2,300 per mile of double track, including permanent way, and the conduit system about £4,000 per mile of single track. Cost of rolling stock and permanent way would, of course, be materially reduced for smaller gauges than 4ft. $8\frac{1}{2}$in. The feeders, both main and return, should be underground, at any rate within town limits, after which there is not much objection to their being carried on the same poles as the trolley wire. With the extensive experience gained in this country in underground conductors, a good drawing-in system, with spare ducts for adding to the feeders as traffic increased could be laid in a thoroughly reliable manner, and not cost very much more than special overhead poles. We should then have the overhead trolley system without the great mass of heavy insulated feeder cables on tall poles so disfiguring in American cities. Let us bury our feeder cables and put up no span wires, and then all that is left is a set of light ornamental poles spaced 100ft. apart, with brackets supporting one single-trolley wire per track. Make them of lattice or ornamental scroll work, or make them of more massive ornamental cast iron, to receive in addition arc lamps for the lighting of the streets. But let us be assured that the overhead trolley is not so unsightly as many would have us imagine, and that it can be put up in an ornamental and unobtrusive manner.

In Philadelphia the insulated feeders are in underground conduits, together with bare copper strips as returns ; but I am not aware whether the dynamos are insulated at the power station, or insulated return cables led to the nearest point on the line in the manner I have described.

The third rail system is not generally applicable to any lines, except where built in an exclusive route of its own. The use of storage batteries I have not touched upon. There have been trials in America, but less experience gained than in England and the Continent. If the cost of depreciation and renewal, which is out of all proportion to that of the transmission systems, could be materially reduced, the self-contained battery system would claim attention for town and city traffic. Data on recently worked lines on this system would be welcomed from members who have had experience of such lines.

American cars have no top seats, although the double-decked cars, as they are termed, are coming into use in a few places. We are lovers of fresh air, and, except in the coldest weather, in America I have taken, in common with others of similar mind, the standing room on the driver's or conductor's platforms, on American cars, in preference to the inside. But we in England have somehow a strong inclination to get up higher, and we like to see around us from a position of vantage and freedom ; and we cannot give up our top seats, no matter what other advantages are offered. Protection must, therefore, be afforded such passengers against any breakage of the trolley wire. Mr. Alfred Dickinson has met this in a very neat way, together with more important structural advantages, by putting his trolley wire on one side of the road. The matter could also be met by putting an awning over the top seats, as on the steamcars in Birmingham and elsewhere. With the conduit system, of course, top seats would need no such provision.

(To be continued.)

Colliery Lighting in France.—La Société Alsacienne de Constructions Mécaniques of Belfort has recently carried out an installation at the Bruay Colliery in the North of France. The plant which supplies current for the lighting of the pits, surface offices, and engineers' houses, comprises two high-speed engines of 100 H.P. each and two dynamos.

LIGHTING INSTALLATIONS.*

BY H. A. HENDERSON.

For the purpose of this Paper, installations may be divided into two classes, good and bad ; but I shall divide the latter into two sub-classes—namely, (*a*) installations, which, although they may not be of the best, are still good enough to pass the usual examination and test of the Supply Company's inspector, and (*b*) those which do not fulfil this condition. I have not much to say about Class I., except that this quality of installation depends upon three essentials —namely, good supervision, good labour and good material.

To my mind the most interesting objects for discussion are included in Class II., and so I will at once pass on to these. As we saw that good installations depend upon three essentials so we may say that any one of these being absent produces a result contained in either sub-class *a* or *b*. First, then, let us briefly touch upon supervision. This is a point upon which I cannot lay too much stress, and I fear it is only too often neglected by just the very class of contractors amongst whom one would expect to find it. The reason of this is not difficult to surmise. It is that the busy contractor cannot spare the time to devote to it that he ought, as he has many inquiries and special technical work to attend to, which he is unable to trust to his juniors. The immediate effect is that the work being left perhaps under the control of incompetent men, and most of us know what the average wireman does under these circumstances—the installation falls into Class II., and this notwithstanding the fact that the best material may have been supplied. It is, perhaps, unnecessary for me to mention that under these conditions the weak point is, as a rule, bad joints.

Bad joints in an installation are perhaps the most difficult faults to find out, as one cannot possibly in the course of an inspection pretend to critically examine every one. Generally the outside appearance is good, and, unless the joint be absolutely cut open, its weak points are not discovered. Out of over 500 installations which I have inspected and tested within the last 18 months, only a small percentage were absolutely bad. I have found that the two most dangerous types of contractor to deal with are the plumbing electric bell-fitter and the "freshman" at the technical school. Two instances of installations carried out respectively by a plumber and a student will suffice to show what I mean. In the first, one of some eighteen or twenty lights a superficial examination seemed satisfactory. That is, the *mains* and all easily accessible wires were apparently of good quality. The insulation resistance, however, was below 10 ohms, and a further investigation revealed the fact that ordinary bell-wire, of a quality similar to the sample on the table, had been used and bedded in new plaster without any casing, tubes, or protection whatever. It was necessary for me to actually dig out the wires before I could discover this. Needless to say, being a very low tender, the contractor lost his money and the confidence of his client.

The second example was a case where the best material had been used and everything done upon the most approved scientific lines, but upon turning on the current the lamps only came up dull red. The reason of this was that the number of lamps being even and on two-light electroliers, they were wired in pairs of two in series, "because," as the contractor informed me, "he could not get four wires down the tube of the fitting !"

Such cases as these are, however, I am happy to state, growing fewer day by day. Before I dismiss this portion of my subject I must just add a word or two upon the various systems of wiring premises. In Manchester we are perhaps more favourably situated than in any other town in England, as we have the alternative of wiring either on the three or five wire systems. The latter plan has been adopted with great success in several installations here, notably the Town Hall, Royal Exchange, Free Trade Hall and Reference Library, and the advantage both to the contractor and the consumer is considerable. I am inclined to think, however, that in the majority of provincial towns the most improved system of wiring is not recognised. As an instance I may state from statistics that over 50 per cent. of the installations in Manchester are wired upon the now almost obsolete "Tree System." That is, a pair of mains are run throughout the building and lights tapped on indiscrimately as they are required, without regard either to the carrying capacity of the leads, or the proper protection of the branches by cut-outs. I have come across cases, for instance, where a branch of 18-gauge wire to carry three lights was tapped directly on to a pair of 20's. No doubt the second wireman who was instructed to put on the extra lights was conscientious to a certain extent, but not sufficiently so to pull out the existing tapping, and run his 18's direct to the main.

Such proceedings as this do not conduce to the satisfactory adoption of the electric light by the general public, who—and this is a fact we should never lose sight of—are to a great extent ignorant of technical details, and are in the majority of cases entirely in the hands of their contractors.

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* Abstract of a Paper read before the Northern Society of Electrical Engineers, November 12, 1894.

In my opinion the most satisfactory way of wiring is that which now commonly obtains in London, and has also been adopted by a few provincial contractors, namely, the distribution system, confining oneself as far as possible to 5-ampere sub-circuits, each controlled by a double-pole fuse. The advantage of this to the consumer is considerable, as it allows extra lights to be attached without much extra cost, providing, of course, that the contractor has allowed for this in his mains. Unfortunately, however, it is hard to explain to the prospective consumer that the small additional cost at the outset will probably be of advantage to him later; for a large proportion of the British public are inclined to accept the lowest tender, their object being to put in the light for the present without regard to the future. As to prices at which work is obtained, it would, of course, be invidious on my part to mention any figures; but when one sees, as I have done, variations of as much as 300 per cent. in tenders to specification, one cannot help feeling that there is something wrong somewhere.

Of course, it may be argued that certain contractors can buy material in a cheaper market than others; but I fear that this is not altogether a satisfactory explanation. One is rather led to the opinion that perhaps low quotations are a bait to catch work by contractors who are not already sufficiently established. I think, with regard to cable manufacturers, that perhaps it is somewhat unfair for them to compete with their clients, as friction is sure to be caused by such a proceeding. The manufacturers of fittings perhaps come under a different aspect, as a contractor is frequently asked for a special design or form of fitting, which, if he is himself a manufacturer, he can supply at short notice and comparatively moderate cost; whereas, if he has to go to an outside firm, unless he is in a position to order a quantity, such firm will naturally charge him a high price, and the delay in delivery may be considerable.

As far as regards cables and wires the quality is fixed, and one is obliged to employ the particular form and size which is required.

The employment of efficient labour is of very great importance, and this brings me to the second essential. I may say that I have had a large and varied experience of the so-called wireman, and a very interesting and curious study I have found him. I suppose there are black sheep in every fold, but I am sure that the wireman's fold is particularly well supplied with the article. One finds among them individuals who seem to be given up to almost every form of vice from which they should be free. It is evident that the employment of these specimens of humanity is sure to result in trouble; yet sometimes the unfortunate contractor has no alternative. In the busy season one is often only too glad to get hold of a man who knows the difference between a double pole cut-out and a main switch, and your average wireman lets you know that he recognises this by demanding high wages or assuming an independent attitude.

I will now pass on to the third essential, the use of good material, and I fear that in these days of cheap Continental rubbish this important point is often neglected. There are at the present time Continental firms who may be said to run English contractors; that is to say, they get hold of a contractor who is short of capital and finance him by supplying him with inferior material, mainly fittings, at a low price. Fittings are a very important factor in keeping up the quality of an installation, and one which I fear many supply inspectors neglect. Often the inspector places too much confidence in his insulation test, or in the quality of the insulating material of wires and cables, without stopping to see if lamp-holders or switches are defective, or proper cut-outs put in where they should be. Either of these points, if neglected, is a source of great annoyance, or maybe danger, to the consumer, and allow inferior contractors to obtain jobs at low prices.

Then, again, as I have before mentioned, prospective consumers often make a great mistake in accepting a very low tender on the supposition that it is economical to save a few pounds at first. The remedy for this lies in the employment of a consulting engineer. But I fear that even consulting engineers are not altogether free from partiality. When one sees in a specification, for instance, a certain make of switch mentioned, one cannot get away from the feeling that perhaps there is more in it than the mere fact that the particular make of switch is efficient. However, consulting engineers have a great power in controlling the abuses of the trade, and one which I am sure we should all be glad to see more universally used.

DISCUSSION.

Mr. EIDSFORTH said that the point which struck him most forcibly was the system of testing joints. He used to have a great deal to do in the cable line, and at that time joints were tested under water, and it seemed to him to be a great mistake that this is not the case now.

Mr. CLAREMONT said that the only thing in Mr. Henderson's Paper which has struck him was the paragraph or few words about the consumer having to pay high prices for fittings unless he goes to a manufacturing firm. This should not be the case if the manufacturer is sufficiently fair to allow discount to the trade only.

Mr. H. WOOLER said that what he had to find fault with in the Paper was the remark made about Manchester being in a better position than any other town for the supply of current, having the alternative of wiring either on the three or five wire systems. Mr. Henderson said that owing to having two or three different voltages to select from, they should be able now to supply current cheaper than anywhere else, and he mentioned the Free Trade Hall as a case in point. He very much doubted that.

Mr. C. S. NORTHCOTE would like to correct Mr. Wooler in one or two of his statements. There was nothing in his opinion in the Paper about the saving of current to the consumer, but a suggestion as to the price of installations.

Mr. WOOLER replied that the only point he could make out by using the three-wire or multiple wire system is that you can afford to put in larger cables.

Mr. NORTHCOTE quite agreed with Mr. Henderson's remarks on the sub-circuit system. He knew that very little work had been done up to the last few months on this system. When the electric light first came into use the tree system was mostly employed, but undoubtedly that has been altered in Manchester lately; most buildings are now wired on the multiple system with sub-distribution boards for alternate circuits. With regard to Mr. Claremont's suggestion as to manufacturers maintaining discounts, he thought it was a very great pity that they could not all combine together and get the prices raised, instead of cutting them down so.

Mr. THOMAS referred to the action of cement on indiarubber; it seems to have a very strange effect; for instance, if you put a wire into a bucket of water you get no leakage through it at all, but if you put that same wire upon a damp wall, whether there are any joints in it or not, you get a leakage through it after it has been up possibly only a few hours, and he never had had this explained.

Mr. FAWCUS had noticed considerable action having taken place with casing fixed against enamelled bricks, and there could be nothing in enamelled bricks that can attack the wires; but there seems to be some kind of cement or other used for attaching these enamelled bricks. He had had several cases of wires being completely eaten through.

Mr. BROUGHALL said he would like to mention one other point, and that was that as the weak points in installations are apparently in the joints, he thought the number of joints should be reduced as far as possible, and quite agreed with Mr. Henderson that the only way to do this was to run the wires back to distributing boards. This may cost a little more money in the first instance; but, at the same time, he thought it would be a great saving in the long run.

Mr. ANDREW wished to suggest that, if periodical inspection were made to electrical installations, the trouble might be very much reduced, as it seemed to him that if the contractor had in his mind the possibility of his installations being inspected at any time, he would probably be more careful in putting in good work in the first instance.

Mr. HENDERSON, in replying to the foregoing remarks, said: Mr. Eidsforth has suggested that, in his opinion, joints should be immersed in water for testing purposes. This would, undoubtedly, be a very good thing if it could be done, but for house work it is almost an impossibility. I am afraid that very few joints at present made would stand any test of the kind at all; the obvious thing to do is to vulcanise the joints, and a very simple and expeditious method of vulcanising joints has lately been brought out. It is, undoubtedly, a very important point, as joints certainly have more to do with bringing down the insulation resistance than anything else. Mr. Wooler had made reference to the amount of current used at the Free Trade Hall, but he thought he was right in saying that with regard to the Free Trade Hall there was an actual saving of current through having adopted the five-wire system; probably the reason why the Free Trade Hall seems to consume more current than it should is because it was never properly metered. It was metered in earlier days by two Thomson meters on the outers, which was practically of no use whatever. Now, a five-wire meter has been adopted, but this does not seem to be of any practical use, as it seems to register whether the lamps are being burnt or not. Mr. Thomas had alluded to the action of cement on rubber insulating material. He thought that it is perhaps not altogether the action of cement; you get the same result if you embed the wire in any kind of plaster or concrete, or anything else of the kind; very often it is due to the electrolytic action through exposure to moisture. Mr. Fawcus had asked for instances of corrosion with enamelled bricks. I have a very vivid case before me where we had a meter which got an earth leakage; that is to say, we got 200 volts to earth. The meter was fixed on a pine board, and the board was fixed on enamelled bricks. It had been fixed some six or eight months, with probably an average current of $1\frac{1}{2}$ to 2 amperes leakage to earth; and when he came to inspect it he found the board almost destroyed, and behind the board, when taken down, he found that the glazed surface of the bricks was entirely destroyed and broken up, and just the ordinary brick surface left beneath.

BOOKS RECEIVED.

"Electric Light Installations." By Sir David Salomons, Bart. Price 17s. 6d. Three vols. Seventh edition. (London: Whittaker and Co.)

"American Electric Street Railways." By Killingworth Hedges. (London: E. and F. N. Spon. New York: Spon and Chamberlain. 1894.)

"Lehrbuch der Experimental Physik." Vol. I. General Physics and Acoustics. By Adolph Wüllner. Fifth Edition. 12 marks. (Leipzig: Teubner. London: David Nutt.)

THE INSTITUTION OF ELECTRICAL ENGINEERS.

ANNUAL DINNER.

The sixth annual dinner of the Institution of Electrical Engineers took place at the Freemason's Tavern on Wednesday evening. Mr. Alexander Siemens, the President, was in the chair, and amongst those present were the Rt. Hon. James Bryce, M.P., Sir Saul Samuel, Sir Malcolm Fraser, Sir Robert Rawlinson, Sir John Pender, M.P., Sir Robert Herbert, Sir James Crichton-Browne, and Dr. E. Armstrong.

After dinner the usual loyal toasts were duly honoured, the CHAIRMAN touchingly alluding to the sad mission upon which the Prince and Princess of Wales and the Duke of York recently left our shores for those of a friendly nation.

The CHAIRMAN next proposed "Our Colonial Empire," coupling with the toast the names of Sir Saul Samuel, K.C.M.G., C.B. (Agent-General for New South Wales), and Sir Malcolm Fraser, K.C.M.G. (Agent-General for Western Australia). In doing so he said that in his opinion it was in our colonial empire that the real strength of Great Britain lay.

Sir SAUL SAMUEL, in replying, said he could not separate the event which they were there met to celebrate, the establishment of electrical engineering, and the progress of the colonial empire. The latter was connected with the Mother Country by a system of electricity which was perfectly marvellous, and it could not be questioned that the system tended largely to the maintenance of the unity of the Empire. They might send away a telegram that night to Australia, distant some 12,000 or 13,000 miles, and get a reply on their breakfast tables next morning. He had, in the course of his experience, known of instances where colonial Governments had been somewhat dissatisfied with the action of the Imperial Government; but the matter had been very easily and quickly explained by the aid of the telegraph. But for the prompt replies they were able to get, serious complications and difficulties might have arisen. Sir Saul went on to speak of the rapid growth of the land lines in Australia during his own career there, and mentioned that upon that continent there were now 45,000 miles of telegraph lines.

Sir MALCOLM FRASER also responded, and referred to the great triumphs of applied science within living memory. The science of electricity and its followers had his sincere and most ardent admiration. Electrical engineering was as yet only in an embryonic state, and he looked forward to greater advances still. Steam had had its day, and by the end of the century it would be overcome by its rival, the applied science of electricity.

Mr. W. H. PREECE, C.B., rose to propose the toast of "The Learned and Engineering Societies." He said he was there that evening in an absolutely unique position, being for the first time in his life a guest of the Institution. The philosopher was the man who directed the worker to those fields where eventually the wolf would dwell with the lamb and the leopard lie down with the kid. This field, exposed to view, was found covered with a heaven brightened up with pastures of brilliancy, where they found names like those of Newton, Faraday, Maxwell, Joule shining with great brilliance. They found also names such as those of Watt, of Telford, of Stephenson, and Brunel, and over other countries they found such names as those of Clausius, Helmholtz, and of Siemens; again they found Ampere and Ohm and Volta, and, hovering like Mahomet's coffin suspended in mid air, they found a name once spelled Thomson, but now commencing with a K. The engineer was the working man. This was the day of the practical man. He had fulfilled the prophecy of old, that every valley should be exalted and every mountain and every hill laid low, when the crooked should be made straight, and the rough places plain. The engineer of to-day laughed at rude Boreas. he crossed the Atlantic in five days, and he brought Bombay within twelve days of London; he had harnessed the heat of the sun, he had brought to the use of man the raging ocean, he had caused the lightnings to come to us and say, "Here we are." They could now, with the greatest ease, reproduce the human voice, which spoke in London, in the streets of Paris, and they could in their secret chambers unlock the sound of the voice that was still. The practical man of to-day had alleviated and had even removed disease. He extended life, and succeeded in answering in the most satisfactory way the question, Is life worth living? And who that lived under the influence of electricity who would not say that health, happiness, comfort, and, in many instances wealth, followed the practice of the profession of electrical engineering? These were some of the trophies of the practical man, and it was the finger of the philosopher which pointed out the way he should go. The results to which he had alluded were the results of the happy alliance that existed in the present day between practice and theory. He coupled with the toast the names of Dr. Armstrong, President of the Chemical Society, and Sir Robert Rawlinson, President of the Institution of Civil Engineers.

Sir ROBERT RAWLINSON, in responding, indulged in interesting reminiscences of his experiences during the Crimean war, and of the great triumphs in the removal of disease in the British hospitals by the aid of sanitary science.

Dr. ARMSTRONG also responded. He said he thought the time had come when they should recognise that they were all on one curve, all occupied in doing a great work together, and when it was impossible to say at any moment that that which was theoretical should not be practical. He regarded the presence at a gathering like that of the representatives of learned societies as the outward and visible evidence of the existence of a bond of union between them which it was impossible to sever. Sir Malcolm Fraser had said steam would ere long be deprived of its supremacy. There could be no doubt that that would be the case. But if they were to realise that condition of things it were necessary that there should be far more co-operation between the chemists and the electricians than there was at present. They (the electricians), he thought, were moving in too narrow a sphere, they were too much the slaves of the dynamo; they too largely devoted their attention, those of them who were not engaged in telegraphy, to the study of the dynamo and its uses in producing light, and as a source of power. There were other uses of the electric current to be foreseen which were likely to be of enormous importance. On the chemical side there was an enormous outlook. Electricity was beginning to be employed in many purely chemical industries; instead of using bleaching powder made by the alkali maker, the paper maker and the bleacher were making use nowaday of bleaching liquid made by means of the electric current; and in a multitude of other ways electricity was being made use of. There was no doubt whatever that ere long the whole of the copper would be made by the electrical man; the old-fashioned method was undoubtedly a very bad method when compared with the electrical method. But in order that those developments might take place it was essential that they should widen the scope of their studies. Those of them who had passed the stage of study still had the power of influencing others, and his advice as a chemist and a teacher was that they should advise and encourage all they could to make their studies as wide as possible. In this country they were greatly behind in these matters. Already schools of what might be termed applied electricity were being erected one after another on the Continent, and getting into active work, and they should see to it that England was not left behind in this matter.

Dr. JOHN HOPKINSON, F.R.S., proposed the toast "Our Guests." He said their guests that evening were a most representative lot of men. They had amongst them one who, in the early days of submarine telegraphy, not only found the money so necessary to carry out large enterprises of that character, but also found the faith in ultimate success which went so far to ensure that success, and who had that fire which was so necessary to inflame the energies of electrical engineers. They rejoiced that that man was still with them, and that he still had that faith and that fire. To no one were the electrical engineers of the past more indebted than to Sir John Pender. Then they had also representatives of nearly all our colonies, and representatives of most of the learned and engineering societies. But amongst their guests they had no one who was a more representative man than he with whose name he had to couple the toast, the President of the Board of Trade. He was a man who had succeeded in many walks of life; he had succeeded at Oxford, as a professor, as a mountain climber; he had succeeded greatly as a literary man, and his book on "The American Commonwealth" had done very much to introduce to Englishmen the methods and modes of life of their brethren on the other side of the Atlantic; and, lastly, he had succeeded in Parliament. It was one of the duties of the Board of Trade, as they knew, to curb the aspirations of electrical engineers. The operation, no doubt, was a painful one to the electrical engineer. They would recommend to the President of the Board of Trade that he should confer with Mr. James Bryce, the author of "The American Commonwealth," for he had no doubt Mr. Bryce was fully aware that America was very much in advance of England in these matters. Electric lighting had been largely developed in American towns, and there was no one to interfere with the electrical engineer. There were thousands of miles of electric tramways and thousands of cars running on them. They thought nothing of allowing those cars to run at the rate of 15 or 20 miles an hour. He would suggest that it should be possible that they should have some modicum of the freedom granted to electrical engineers in America. They did hear of people being killed once in a way, but he doubted whether that would be the case here. But even granting that once in a way someone might be killed, he would suggest that the President of the Board of Trade should confer not only with Mr. Bryce, the author of "The American Commonwealth," but also with Mr. Bryce, the mountain climber, and consider with them whether a victim rarely sacrificed on the altar of civilisation would not be amply compensated for by the greater help which thousands would enjoy by the extended use of the electric light, by the greater health which millions would enjoy by being able to get to their work at a distance, and rearing their families in a healthier atmosphere.

The Rt. Hon. JAMES BRYCE, M.P., President of the Board of Trade, in responding, said it might interest them to know that the Board of Trade had now become a very comprehensive department, which included not only what was called commercial business strictly speaking, but a great deal also of scientific work, and it was constantly pushing itself out in new scientific directions. As Dr. Hopkinson had referred to the relations that subsisted between the Board of Trade and that Institution, he would like to say that they very much appreciated the great services which a society like that could render. They looked upon that Institution as a reservoir of knowledge and experience to which they could go with confidence when they desired special information. He might remind them that on two occasions lately it had given them very valuable assistance in duties in which the Board of Trade had to perform upon two committees, first, the committee of 1889, which sat to consider regulations for the management of electric lighting, and the still later committee which sat to consider regulations for the safe management and administration of machinery for conveying electrical power. Upon both these occasions they derived the greatest possible help from members of the Institution who were good enough to sit with them; and they hoped that in their turn they had been able to facilitate the progress of electrical engineering by the deliberations in which they had the assistance of some of the most eminent electricians in the country on the committee which sat from 1890 to 1894 upon the subject of electric standards. The results arrived at by the Committee were adopted by the Chicago International Electrical Congress, and he thought there were some hopes that before long they would see them adopted by the leading Powers of Europe. Dr. Hopkinson had referred to the development of electrical engineering in the United States. He had said with truth that far more had been done there in the electric lighting of cities, but he did not think the electric lighting of private houses had progressed much more rapidly in many parts of America than in London. He had also observed that far more had been done in the way of running electrical tramcars and railroads than in this country. That, no doubt, was true, but it was a subject upon which he hoped they would have some light from electricians when they came to consider, as at the Board of Trade they proposed to do, what could be done to facilitate the creation of light railroads and tramroads. He must, however, congratulate them upon having been far more tender to human life than their American brethren had been. Without entering upon the delicate question which Dr. Hopkinson had raised as to how many lives must be sacrificed in order that public convenience might be increased, he thought they would agree with him that electrical engineering was likely to progress more rapidly, to be more largely extended, and to be regarded with more general popular favour, if they could accompany it with regulations for public safety which would remove prejudice and apprehension in the public mind, and which would prevent the recurrence of such accidents as unfortunately occurred a few years ago in America. He did not think any pains taken for the public safety would be thrown away, even putting the matter in its lowest commercial aspect. Amongst all the work that the Board of Trade had to do, and there were very few things it was not mixed up with, nothing gave it more unqualified satisfaction than the fact that they were able to facilitate the creation of great undertakings such as those with which members of that Institution were associated, and which had the effect of not only increasing the amount of employment for the masses of our people, but also of largely subserving the comforts of the public and the developments of commerce. He would venture to say one word for himself as a guest on that occasion. He always came with a certain feeling of envy into a gathering of scientific men. They who were concerned with politics lived in a region of what was transitory and ephemeral; whilst they (the scientists) were concerned with permanent truths, and every step forward they made became a vantage ground for further advances. They belonged to science, which was in rapid progress, and they always had the excitement and interest of watching for fresh discoveries. If politics was a science at all, which he doubted, at any rate it was a science progressing so slowly as to resemble one of those stagnant streams in the eastern part of England, where, if they looked at the water, they could not tell which way it was flowing. When scientific men met in discussion they were occupied in helping one another in finding truth; they of politics were largely occupied in preventing one another from finding truth. Any attempts which they made to cast light upon a subject, or to bring the Legislature to bear upon it, were, unfortunately, accompanied by a large evolution of heat, they (electricians) had succeeded in giving light and power with as little heat as might be. He confessed he often thought that far more enviable than the lot of those who dealt with passing politics was the lot of those who, like those present, might be called the priests and ministers and dispensers of the unseen and hidden forces of nature, who were able to seize those forces and make them the ministers and agents of men's power and comfort. And yet the world whose messages they carried, whose houses they lit, and which they were going to hurry upon light railroads to every corner of England, knew so little of the powers with which they dealt that it had not even the slightest idea of what was an ohm, a volt, an ampere, and did not appreciate the difficulty which he believed they (the Institution) and the Board of Trade shared of discovering a more convenient term for "the Board of Trade unit." The world admired what they had done, it felt that these great powers which they wielded were safe in their hands, and they might think with some pride that British men of science, illustrated in the last generation by the name of Faraday and in the present by the name of Lord Kelvin, not to mention many other scarcely less illustrious heroes of science had been among the first to advance the mastery of man over nature, and had shown that those forces that had waited so long to be revealed disclosed an ever-brightening prospect for the future.

Sir JOHN PENDER proposed "The Institution of Electrical Engineers." He remembered the time when there was not more than half-a-dozen electrical engineers; at the present time there were nearer 3,000 than 2,000. That spoke of enormous progress in electricity. In the past there were few names—great and distinguished names—Faraday, Thomson, Jenkin, Varley; these all did their part well, and established for electricity not only power, but a reputation which would never die. The establishment of submarine telegraphy was, he believed, one of the greatest achievements of the Victorian age. He believed their dinner that day had been mainly cooked by electricity. He did not want them all to turn their attention to cooking, but he did want them to turn their attention to the simplifying and the cheapening of, and the giving of a more extended area of usefulness to, this great power. He had year after year contributed to electricians very large sums for their inventions, and he should be delighted to continue those contributions in the future if they would only show him that they could do something in the way of cheapening, something in the way of quickening, electricity, quick as it was. In concluding he coupled with the toast the name of the President, Mr. Alexander Siemens.

The PRESIDENT, in replying, alluded to what he termed the fallacious idea which many people held that because they did not know what electricity was, that was an obstacle to the applications of electricity. In that connection he would ask them what was gravity? They did not know. Why should bodies attract each other? They did not know. But they utilised that power in Nature wherever they could; they knew perfectly well how to control it, they could use it as well as if they know why things attracted each other, and in the same way they could use electricity although they did not know exactly what electricity was. It certainly was the case that electricity was only beginning to exert an influence on the everyday life, but the greatest difficulty that electrical engineers had to contend with was the unbelief of the public. They could not get people to believe that because they had proved in their laboratories that, if an ampere is compelled by so many volts to go through so many ohms, it would do it everywhere, whether ohms were represented by short pieces of wire in the laboratory or by long cables. There was one thing to which he wished to call their attention, and that was that they had really given to the English nation a very good example by introducing national units which were based on the metric system. The sooner England adopted the metric system for weights and measures generally the better it would be.

The gathering then dispersed.

PRESENTATION TO SIR JOHN PENDER.

On Friday last Sir John Pender, G.C.M.G., M.P., was entertained at dinner at the Hotel Metropole by the staff representatives of the Eastern Telegraph Company, the Eastern Extension, Australasia and China Telegraph Company, and the associated telegraph companies, on the occasion of their presentation to him of an illuminated address and testimonial commemorating the 25th anniversary of the establishment of submarine telegraphic communication with the Far East.

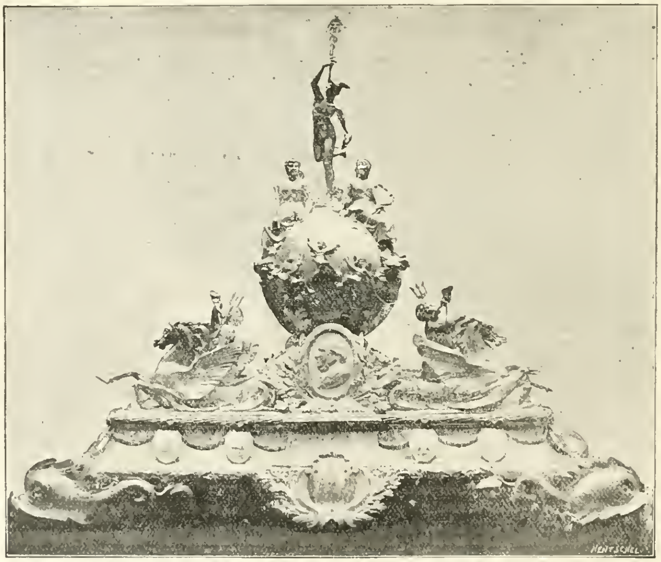
The chair was occupied by Mr. GEORGE DRAPER, the Chairman of the Presentation Committee, who, after the usual loyal toast had been duly honoured, said they were met to do honour to their distinguished guest and chief. Some time prior to the celebration in the summer in commemoration of the 25th anniversary of the establishment of submarine telegraph communication between the United Kingdom and the great centres of commerce in the Far East, a unanimous wish was expressed by the members of the staffs of our Companies that a fitting tribute should be presented to Sir John Pender, who has presided over the affairs of the Companies since their inception, as a token of the sincere esteem in which he is held throughout the service, and as a recognition that it is mainly due to his untiring energy and devotion to the best interests of submarine telegraphy that its influence has been so signally marked and has become so closely identified with the prosperity of the British Empire during the later years of Her Majesty's reign; and in accordance with this unanimous wish they were gathered there to fulfil a duty so willingly undertaken by them all. There were those in that room who could talk about the Atlantic cable in the earliest years—in the fifties, but he (the Chairman) could not recollect that. He did, however, remember a meeting at Sir John Pender's house, in May, 1869, convened by him for the consideration of an extension of the project. An Atlantic cable had been proved to be a success, and it was then to be considered whether a cable could be carried south, *via* Gibraltar, Malta, Egypt, and India, to China and Australia. Sir John's mind was already made up. His thoughts were convictions; the project was one of the best, and it must be carried out. The cable was laid, and now we see the results of the policy adopted by Sir John Pender and others, and the consummate judgment which he displayed on that morning when he said that the thing could be done, must be done, and would be a success when it was done. Sir John Pender seems not to be swayed by the chances and changes that mar and warp the purposes of most men; but what he does is done to a successful issue. In conclusion the Chairman said: We give you, Sir, our best service and our earnest wishes for the future as we drink to the health and welfare of our renowned chief (loud cheers).

The toast having been drunk with enthusiasm, the Chairman called upon the hon. secretary (Mr. F. E. HESSE) to read the address, which was signed by all the members of the Presentation Committee. After reading the address, Mr. HESSE said that the beautiful silver trophy which was now to be presented to Sir John had been subscribed to by practically the whole of the associated staffs, in sums varying from two guineas to sixpence, so that even their youngest members had the privilege in participating in the presentation.

The general appearance of the trophy, which has been manufactured by Messrs. Elkington and Co., is shown in the figure on the next page. The design is nautical, and is symbolical of the particular branch of industry in which the associated companies are engaged. The weight is about 1,500oz., length 4ft. 6in., height 4ft.

Sir JOHN PENDER, who was loudly cheered on rising, said: My Lord and gentlemen, I came here to-night with feelings mixed—with an idea that I was going to meet many men who had been associated with me for so long, and to have right and left of me friends associated with me in my career of submarine telegraphy. But the eloquent address of your Chairman has brought to my memory times gone by, and it has reminded me that I have had a life which I might fairly divide into three parts. The first 25 years of my life were spent in Scotland, the second in business in Manchester, and the third has been identified with submarine telegraphy. While at Manchester I became associated with telegraphs—land lines; and I was there to welcome Cyrus Field when he came over to this country with his project of submarine telegraphy. Great credit is due to him for the part he played in the matter; but, I say it without meaning any disrespect to him or to the American people, they did nothing practical. England had to take up the question, and it was taken up here, but it was more or less a failure in the earlier days. I, however, felt that this was an enterprise that ought to succeed and one which ought to be carried out. The undertaking was too big for the company that was in existence, and we resolved to buy up not only Glass, Elliott, and Co., but also the Gutta Percha Company, and so formed the

Telegraph Construction Company, of which I became Chairman. We found the money to make the cables, and having written to Mr. MacIver to give us the use or the great privilege of a month or two's services of their very best captain for the purpose of commanding the "Great Eastern" to carry out the work, he gave us the services of James Anderson, and that was Sir James Anderson's introduction to submarine telegraphy. You know the part he played in the work, and I have always said that the fact, which Sir James Anderson proved, that a cable could be picked up in mid ocean, gave a character to submarine telegraphy which was an enormous help in carrying it to a successful issue. But you must not believe that all this was done by myself. Lord Tweeddale, who is sitting here, has been a loyal and true man to submarine telegraphy. The encouragement I had from another gentleman here to-night was very great indeed. You know what power Governments wield in these matters. You know that they do not always take a generous, bold and liberal view of progress; but whenever I went to the Colonial Office, of which Sir Robert Herbert was the Permanent Secretary, he encouraged me in every possible way. In receiving this testimonial to-night, I receive it not as a compliment to myself alone, but as a compliment also to those who have so loyally and efficiently worked with me, and I am here to-night to recognise their work. I look upon this ceremony as an evidence of united action on the part of those who have accomplished that which will probably be regarded, when the records of the Victorian age are written, as probably the greatest achievement in the history of the world. I have given you a brief outline of an active life. I say to all of you around this table who have contributed to this magnificent trophy, that while you are complimenting me you are complimenting yourselves also; but you are taking upon yourselves a responsibility which I hope you will carefully fulfil. I have done my part, and other men who are sitting here have done their part, in carrying out this great enterprise; but it is younger blood that will have to carry it forward in the future. We have battles to fight—important battles; but we have such a footing, such a grip of the whole thing, that we shall not be what I believe we are if we allow ourselves to be beaten in anything. I thank you again, gentlemen, and most sincerely, for the great honour you have done me to-night and to those associated with me, and I assure you of my belief that if we continue to work together and in union—for I believe that union is power—we shall thus strengthen the position which we are all so anxious to maintain with honour and dignity (prolonged cheers).



Trophy, presented to Sir John Pender by the Staffs of the Associated Telegraph Companies. (*From a photograph.*)

The Marquis of TWEEDDALE, in proposing "Success to Submarine Telegraphy," said he had been associated with Sir John Pender from the very commencement, and was able, perhaps, better than almost anyone, to speak of the way in which he had conducted the deliberations in connection with submarine telegraphy. Submarine telegraphy had been carried out up to the present time almost exclusively by private enterprise. A taste had been created in the public mind for rapid, regular transmission of intelligence of all kinds, and the public insisted not only on what they had already got, but on a great deal more. They insisted on cables being laid in every direction, and the question arose whether that should be done by private enterprise or with the assistance of the Governments. He thought it would be far better if it were left to private enterprise in the future as it had been in the past. The Governments should confine themselves to looking after terrestrial telegraphy. Whether that would be the case or not, one thing was quite certain, that the end had not been seen of submarine telegraphy, and he expressed the hope that even if it were conducted and developed by Governments it would be done with consideration to those who had established and carried it on so successfully to the present time (applause).

Sir JOHN PENDER acknowledged the toast, and said that the promoters of submarine telegraphy from its inception had not been unknown men, and were not men who had come forward for the purpose of personal aggrandisement. He mentioned the names of a great number of gentlemen who were connected from the first with submarine telegraphs, and remarked that what had been so well begun ought really to be continued in the same way. The Boards of the telegraph companies stood very high, and he was proud to have as associates the men composing these Boards. With regard to the future he held that their position was so strong and so good, and they had managed so well in the past 25 years that even those who were most opposed to them to-day fully admitted that they had done their work well. With regard to lowering the rates, he was in favour of low rates if the telegraphing public would only come forward in sufficient numbers to make them remunerative; but he did not believe in any enterprise being practically useful if those conducting it were working at a loss or paying comparatively insignificant dividends. He concluded by proposing the "Health of the Associated Staffs." He thanked the different staffs for their hearty co-operation and for the ready way in which they had met all that he had brought before them. The staffs had done him great honour in inviting him to be present that evening. He wished to thank all who were present, and desired that those thanks might be conveyed to every member of the staff at home and abroad.

The toast was responded to by Mr. W. T. ANSELL, who said that he had had the privilege of serving under Sir John for many years, and on behalf of his colleagues in the united services he thanked him for his kindly remarks. He sincerely hoped Sir John would live many years to conduct them to further victories. On behalf of the staff he desired to assure him of the continued loyal support of the staff (cheers).

Mr. RICHARD COLLETT and Mr. CH. GERHARDI also responded, and both spoke of the cordiality existing among the numerous members of the staffs of the associated companies, both at home and abroad, and of the interest taken by them in the success of the companies over which Sir John Pender so ably presided.

Sir ROBERT HERBERT proposed the health of the Chairman, Mr. George Draper, who acknowledged the toast, and the proceedings terminated.

THE LONDON COUNTY COUNCIL AND ELECTRIC LIGHTING LOANS.

At the meeting of the London County Council last Tuesday, the Finance Committee reported as follows on the question of loans for electric lighting: "We have again to report upon the question of the periods for the repayment of loans obtained by Vestries and District Boards for electric lighting. It may be well, first of all, to remind the Council of the history of this question and of its present position. In 1891 the Vestry of St. Pancras applied to the Council for loans of £10,000 for the purchase of a site and £60,000 for the construction of electric lighting works, the repayment of the former to be spread over 60 years, and of the latter over 42 years. At that time the Council had power to lend to Vestries for 60 years for the purchase of land, but only for 30 years for the erection of buildings. The Council, being anxious to meet the views of the Vestry, sanctioned the borrowing of the latter sum for 42 years, and as it could not itself lend for that period, resolved to apply to Parliament for powers to advance money for electric lighting purposes for periods not exceeding 50 years. This power was applied for in 1892, and obtained; but it was understood as between the Treasury and the Council that the period to be actually fixed under the provisions of the Act should be determined as freely as if the extended period had not been named by the Act. On July 25, 1893, we recommended the Council to sanction and make a further loan of £15,400 to the Vestry of St. Pancras, repayable in 42 years. The sanction was given, but the Vestry did not take up the loan from the Council. On January 30, 1894, the Council considered a further application by the Vestry for the loan of £30,000 (including the above mentioned £15,400); but on this occasion, after consideration of the whole subject, and of the views expressed by the Treasury, we recommended that the loan should be granted to the extent of £29,700 (on condition that the previous sanction of the Council to the borrowing of £15,400 should not be further acted upon), and that the repayment should be restricted to various periods according to the life of each portion of the works. After discussion in the Council this report was withdrawn. We again reconsidered the whole matter, and brought up a report to the Council on February 12, 1894, recommending that the repayment of the whole should be spread over 25 years. An amendment to substitute 30 for 25 was lost, and our recommendation was ultimately adopted. On June 26, 1894, the Council considered an application by the Vestry of Hampstead for sanction to a loan of £24,400. We recommended that the sanction should be granted subject to the repayment of the whole sum being spread over 25 years, but the Council in this instance substituted 42 for 25 years. After this decision of the Council, we felt bound to adopt in all cases the period of 42 years for initial electric lighting works, and therefore recommended the Council to advance to the St. Pancras Vestry for 42 years the sum of £14,300, the difference between the £29,700 sanctioned on February 12, 1894, for 25 years, and the £15,400 on July 25, 1893, for 42 years. The Council adopted this recommendation, and application was accordingly made to the Treasury for approval of the advance of the Council. The Treasury replied (see letter dated July 28, 1894) practically to the effect that they could not sanction the advance of this loan by the Council for so long a period as 42 years, and we therefore directed our attention to the question whether any new proposal could be made which would be acceptable to the Treasury and which the Council might be willing to adopt. The contention of the Treasury was that no period should be granted which was disproportionate to the life of the works, and in order to arrive at a definite understanding on that point we carefully investigated, with the assistance of the engineer, the question of the durability of each portion of the work in greater detail than had hitherto been done. We were advised that the following division of the work in the St. Pancras case might be taken as being fairly accurate: £3,800 for meters and connections lasting five years; £4,000 for batteries lasting eight years; £2,000 for arc lamps and cooling apparatus lasting 10 years; £13,000 for boilers, covered mains, &c., lasting 15 years; £24,000 for engines and dynamos lasting 20 years; £33,000 for culverts and bare copper mains lasting 40 years; £9,000 for buildings lasting 60 years; £10,500 for land; total, £99,300. We thought that it might fairly be argued that as Parliament extended the maximum period for electric lighting purposes from 30 to 50 years, it was intended that at any rate some portion of the expenditure should be spread over 50 years. On the other hand, it could not be considered right to spread over 50 years expenditure of so short-lived a nature as meters and apparatus of that kind. We therefore came to the conclusion that the Council might be advised to adopt two periods for loans for the initial cost of electric lighting—viz., 50 years for all expenditure on land, buildings, culverts, bare copper mains, and patent royalties, and 20 years for expenditure for all other purposes. The comptroller, by our instructions, communicated with the Treasury, suggesting these terms and stating the considerations which had led us to decide upon them, and the Treasury has, with only a slight modification, agreed to our proposal. We present copies of the correspondence with the Treasury. We think the Council would desire that a definite agreement should now be arrived at between the Treasury and the Council as to the terms for which these loans are to be sanctioned and made, and, as the Treasury has signified its consent to the more favourable proposals of the committee, we recommend the Council to pass the following resolution: 'That the periods of repayment of all loans for the initial cost of electric lighting undertakings be limited as follows: For land, buildings, culverts, bare copper mains, and royalty licenses relating to such purposes, 50 years; for all other purposes, 20 years.'"

Mr. WESTACOTT said that, in his opinion, local authorities in the matter of borrowing for electric lighting purposes would be worse off under the proposal than they were under the original recommendation. Under that arrangement local bodies could borrow for a term of 28 years, and those who agitated at that time to have the term extended had now got into the position that they were worse off than if they had accepted the first suggestion of the Finance Committee.

Mr. CAMPBELL moved that the word "maximum" be inserted, so that the recommendation should be "That the maximum period of payment," &c.

The CHAIRMAN suggested that they had that by the word limited.

Mr. CAMPBELL did not agree with the Chairman, for it was not discretionary under the recommendation as it stood.

Mr. EVAN SPICER (Chairman of the Committee) thought Mr. Westacott was hardly correct in his remarks, for the average would be more than 25 years—in fact, it would be 32 years.

Mr. EMDEN seconded Mr. Campbell's addition to the recommendation, and it was agreed to.

The recommendation as amended was then carried.

CORRESPONDENCE.

RUHMKORFF OR RHUMKORFF?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With regard to the spelling of Ruhmkorff, your "Reviewer" remarks that the termination "rff" points to a Slavonic origin. Ruhmkorff, however, came from Hannover, and spelt his name in that way, though his relations dubbed themselves Rühmkorff. But since the French *u* and the German *ü* are the same thing, he did not, by so spelling it, alter his name, and in German we have every reason for writing it Rühmkorff.—Yours, &c., A GERMAN READER.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

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"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"ELECTROMAGNETIC THEORY" (Vol. I.), by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application. Vol. II. is in preparation.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application to the Publisher.

TENDERS INVITED.—It will be seen by our advertisement columns that the Cowpen District Local Board (Blyth, Northumberland) require tenders for the lighting by electricity or otherwise of the lighting area within their district for a period of seven or ten years respectively, from August 15, 1895. Tenders must be sent to Mr. R. T. Guthrie, the clerk to the Board, by December 20th.

———— The General Secretary of the Exhibition to be held at Bordeaux next year is inviting proposals from electrical engineering firms for the contract for the electric lighting of, and the supply of electrical energy in, the Exhibition grounds, from May 1st to November 1, 1895.

———— The Vestry of St. John, Hampstead, invite tenders for wiring the buildings in the stone yard, Lithos-road, Finchley-road, London, N.W., for the electric light. Tenders must be in by 4 p.m. on Thursday, the 29th inst.

Tenders Accepted.—The contract for the equipment of the Technical Schools of the Portsmouth Corporation, with electrical and physical apparatus, has been awarded to Mr. R. W. Paul, at the price of £477.

———— The Cheltenham Corporation have received the following tenders for the supply of switchboards :—Brush Electrical Engineering Company (Limited), £210. 4s. 6d. ; Siemens Bros. and Co. (Limited), £376. The former tender was accepted.

Sales by Auction.—*Postponement of Sale.*—The sale by auction by Messrs. Wheatley Kirk, Price and Goulty at the Deptford Central Lighting Station, Stowage Wharf, Deptford, S.E., of a surplus quantity of plant and stock for the London Electric Supply Corporation (Limited), originally announced for Wednesday next, the 28th inst., has been postponed until the beginning of December. Particulars appear in another column.

———— Messrs. Fuller, Horsey, Sons and Cassell will sell by auction *on Wednesday next*, at 1 o'clock, at their offices, 11, Billiter-square, E.C., some nearly new modern electric lighting plant, to be disposed of owing to the space being required for other purposes. Particulars are given in our advertisement columns, and all further information can be obtained of the auctioneers, 11, Billiter-square, E.C. ; or of Mr. H. Cuthbert Hall, 46, Queen Victoria-street, E.C.

Liquidations.—On Wednesday, in the Chancery Division, the petition of W. Smallman and others for the winding up of the South Staffordshire Tramways Company came on for hearing before Mr. Justice Vaughan Williams. Mr. Parker, for the petitioners, who asked for a compulsory winding-up order, asked for an adjournment for a week under the following circumstances : The whole of the assets of the Company were in the hands of the receivers and managers appointed in the debenture-holders' action by Mr. Justice Kekewich by an interlocutory order. That action was coming on for trial shortly, and it had been once before Mr. Justice Kekewich previously. The point taken was that the debentures were in the form which was given in the schedule to the Companies Clauses Consolidation Act, and Mr. Justice Kekewich was now rather of opinion that he had no jurisdiction to appoint a manager, but only a receiver of profits of that Company as a going concern. If the judge should take that view, the manager appointed by that interlocutory order would be discharged, and the Company would then have sufficient funds to pay ordinary creditors. The petitioners were trade creditors, and would be paid in the ordinary course of business. The debenture-holders would have a right to the profits in the business only, and that point would be argued before Mr. Justice Kekewich. After some discussion his Lordship adjourned the petition for a week, leaving the parties to agree what further adjournment, if any, would be convenient to all parties.——On the same day Mr. Justice Kekewich, in the action referred to, was asked to make a declaration that the mortgage debentures issued by the Company and its predecessors in title, and now outstanding, constituted a first charge on all the undertaking and property of the Company, and to order an account to be taken of what was due and owing to plaintiffs and all the other holders of the said debentures. Having heard counsel at considerable length, Mr. Justice Kekewich held that plaintiffs had no ground whatever for asking for a manager, and the only thing they were entitled to was the appointment of a receiver to make proper inquiries.

———— The petition for the winding up of J. G. Statter and Co. (Limited) came again before Mr. Justice Vaughan Williams on Wednesday ; but it being stated that negotiations were pending for the sale of the business on favourable terms, his Lordship ordered the matter to stand over for a month.

———— At meetings of the shareholders of the English Electric Manufacturing Company (Limited) held at Leicester on the 22nd ult. and the 7th inst., it was resolved and confirmed that the Company be voluntarily wound up, Mr. Charles F. McInnes, the secretary and manager, being appointed liquidator.

Change of Address.—The Epstein Electric Accumulator Company (Limited) notify that they are removing their works to Milton, Staffordshire, where a 600 I.H.P. power plant is available. The head offices of the Company remain at Gresham House, Old Broad-street, London, E.C. The Company also announce a material reduction in the price of Epstein accumulators.

National Telephone Company.—In our issue of May 4th last a fairly complete description was given of the proposed New Central Telephone Exchange of the National Company at Lime-street, E.C., which was then undergoing structural alteration and equipment. The exchange is now complete, and in full working order, and on Monday last members of the press were invited by the Company to view the station, and an explanation of the working of the apparatus was given by the principal officials to a large gathering. The visitors were shown over the whole of the premises, which are situated above the old Hudson's Bay Company's offices. The switch-room is fitted with apparatus for dealing with about 3,000 subscribers, with an ultimate capacity of about 7,000. In addition to the metropolitan service, the Lime-street exchange provides accommodation for the necessary wires for communicating with Liverpool, Manchester, Birmingham, Leeds, &c., &c. The fine multiple switchboard has been supplied by the Western Electric Company, and combines the very latest improvements in this apparatus. Between £20,000 and £30,000 have been spent by the Company in completing this exchange, and everything has been so arranged as to admit of the ready testing and inspection of the lines. We learn that for another exchange the Company have placed an order with an English company for a switchboard, and this is to be provided with every improvement. The whole of the Company's remaining London exchanges are to be overhauled, and we were informed that the twin-wire system has now been completed over the entire metropolitan service. The credit of the work done at Lime-street belongs wholly to the Company's staff, who have been responsible throughout for the very complete and efficient arrangements now made for coping with the increasing business. Provision has been made for the comfort of the operators, and the electric light is used throughout. The Company have every reason to be proud of the work of their officials, and it was the general opinion of all present on Monday that great credit is due to all concerned. We have heard nothing lately of the proposal to rearrange a portion of the metropolitan subscribers' numbers, and trust the idea has been dropped.

Messrs. Drake and Gorham.—This firm has been entrusted with the fitting up for the electric light of Londonderry House, Park-lane, W., the residence of the Marquis of Londonderry, the current for which will be obtained from the outside supply. The firm have a large number of both town and country house installations in hand at the present time.

Geipel's Steam Trap.—For the high steam pressures now so frequently adopted it has been found that many of the steam traps of the old forms are not well adapted, and that trouble and loss of steam has resulted from their use. Prof. Kennedy, in his Presidential address to the Institution of Mechanical Engineers, stated "that steam traps require more looking after than the whole of the rest of the machinery put together." The reason for this is owing, firstly, to the increased strain on the working parts and joints owing to the high pressure, and, secondly, to the higher temperature of the steam The difficulty with the expansion traps has been due hitherto to the relative smallness of the motion set up in the linear expansion of the metal used, as well as in the positive nature of that motion. The Geipel expansion trap is designed to obviate this defect. The particular form in which the expansion parts are arranged causes a considerable motion to be imparted to the apex for very small changes in the length of these parts ; and there is a certain amount of elasticity in the pipes not to be found in the direct thrust generally adopted. The Geipel steam trap is made by the Shillingford Works Company.

Messrs. Russell and Lennard.—In our trade note last week, announcing the establishment of this firm, we gave the address as 22, Charing-cross-road, W.C. This should have been 22, Charing-cross, S.W.

Trade Catalogue.—Messrs. Dorman and Smith have just completed a new catalogue containing illustrations, particulars, and prices of the very large variety of electrical apparatus actually manufactured by the firm at their Ordsall Station Works, Salford, Manchester. The catalogue is very complete, and, as the firm have entire control of the manufacture of all the goods illustrated, it is unnecessary to point out to the trade the advisability of obtaining a copy of the book, which can be had from Messrs. Dorman and Smith's head offices as above, at their London offices, 11, Grocers' Hall-court, Cheapside, E.C., or from the Glasgow offices, 56, George-street.

Awards.—Messrs. Roothaan, Alewijnse and Co., Nijmegen and Brussels, have been awarded a gold medal for their exhibits of electrical lamps and apparatus at the Antwerp Exhibition, and have received a silver medal for their lamp exhibit at the International Industrial Exhibition at Dresden.

Acton.—At the last meeting of the Local Board it was reported by the Works Committee that Messrs. New and Mayne had written offering to take over the Board's Provisional Order, and to put down the necessary plant and mains for the supply of the electric current. They suggested that a refuse destructor might be erected in connection with the lighting station ; and they appealed to the Board to sell them the monopoly of the electric lighting for 42 years instead of 21, as proposed by the Board. The Committee reported that they considered this request for an extended period a reasonable one, but they could not recommend the Board to dispose of their Order for less than £500. The clerk was ordered to draw up a draft agreement for the transfer of the order to Messrs. New and Mayne.

Ayr.—The Board of Trade having forwarded the Police Commissioners a copy of their regulations respecting electric lighting, it has been sent by them to Mr. Robert Hammond, to examine and report upon it. Some designs of arc lamp pillars were submitted at the last meeting, and the Lighting Committee will decide the matter at their next meeting.

Bedford.—Messrs. Kilpin and Billson have secured the contract to instal the electric light in a portion of the Modern Schoolhouse, the work being carried out under the superintendence of Mr. J. Hardie M'Lean, of Oxford, who has been appointed the consulting engineer.

Bournemouth.—The borough engineer having, in conjunction with Mr. E. Matthew Lacey, proposed a scheme for the Corporation to supply current themselves for the electric lighting of the Winter Gardens at a saving of £150 per annum on the charges of the Bournemouth and District Electric Supply Company (Limited), the Company have now offered to supply the current at a reduction of 25 per cent., which the Lighting Committee recommend the Town Council to accept.

Brentford.—The Clerk reported at the last meeting of the Local Board that he had again been written to by Mr. Sowerby, respecting the electric lighting of the district, and inquiring the terms upon which the Board would grant a concession. The Clerk was instructed to reply that the Board had not sufficient details before them for consideration.

Burton-on-Trent.—Mr. Codrington, C.E., held an inquiry on Wednesday, on behalf of the Local Government Board, into an application by the Town Council for permission to borrow £53,213 for sewage, electric lighting, new stabling, and refuse destructor purposes. There was no opposition to the electrical portion of the scheme, and the result will be made known in due course.

Cardiff.—On Friday, successful preliminary trials of the whole of the circuits of the Corporation electric light installation were made, and the current will shortly be switched on for the permanent lighting of the streets.

Carlisle.—At a special meeting of the Town Council last week, it was decided to apply to the Board of Trade for a Provisional Order, and to oppose the proposed application for an Order of the County of London and Brush Provincial Electric Lighting Company (Limited).

Colwyn Bay.—At the last meeting of the Local Board, Mr. J. Roberts said he had heard that a private company was applying for powers to light Colwyn Bay by electricity. He thought the Board should follow the example of Llandudno, and have the power to make terms with a company, and he proposed that they, therefore, apply for a Provisional Order. This was seconded and carried.

Coventry.—At Tuesday's meeting of the City Council, the General Works Committee presented a report on the delays which had arisen in the equipment of the tramways for electric traction, and recommended that notice be given to the proprietors of the tramways requiring the tramways to be equipped within three months. The report was approved.

Dundee.—The Gas Committee of the Town Council on Monday decided to extend their electric light mains to Seagate.

Ealing.—At the meeting of the Local Board last week the surveyor reported that 3,580 8-c.p. lamps had been applied for out of the 5,000 which it was at first computed would be required by private consumers; and he would be much mistaken if by March next application had not been made for the full number.

Edinburgh.—Lord Provost M'Donald, presiding at Tuesday's meeting of the Town Council, briefly reviewed the improvement schemes which the Municipality had undertaken or would shortly undertake. He estimated the total expenditure at £1,773,533, of which £100,000 was for electric lighting, and £200,000 for extension of tramways and alteration to mechanical power for haulage. With respect to the former he said that the scheme for lighting the city with electricity would soon be completed, and he trusted the citizens would take kindly to the new light and become good customers of the town. In his opinion the introduction of electric light would not affect in any degree the consumption of gas, provided, of course, the Gas Commissioners charged a popular price for it. The Council afterwards remitted to the Lord Provost's Committee to consider and report as to which mode of tramway traction the Council should ultimately adopt in view of a change, wholly or partially, to mechanical power.

Factory Lighting.—The whole of the new and extensive mineral water factory of Mr. J. A. Reid, of Helenburgh, is lighted by electricity, there being installed four arc and 36 incandescents, equal to 4,000 c.p.

Great Yarmouth.—The Borough Surveyor reported that the applications for the current now numbered 20, with an aggregate of about 1,000 lamps. None of the plant for the private lighting had yet been delivered, and complaints were beginning to be heard as to the delay.

Hampstead. The Vestry at their meeting last week resolved to accept the offer of the Prudential Assurance Company to lend them the sum of £24,400 for electric lighting purposes for 42 years at 3½ per cent.

Maitland (New South Wales).—An important point has been raised as to the liability of local authorities to repay amounts borrowed for purposes outside the Acts under which such local authorities are constituted. It would appear that the Commercial Bank of Australasia loaned to the Lambton Municipal District the sum of £7,000 to enable the Municipality to purchase and erect electric lighting plant and machinery, the whole of which was given as security for the amount lent. The bank claimed to appoint a receiver under the Municipalities Act, as the sum lent was not repaid, but objection has been taken by Sir Julian Salomons that the Municipal Council had no power to borrow money for electric lighting works, that the advertisement of its intention to borrow was not in compliance with the Municipalities Act, and that the bank knew the Council had no powers to borrow for the purposes for which the money was lent. Judgment had not been given at the latest date of our exchanges.

Paddington.—The Local Government Board have agreed to the Board of Guardians sealing the contract, without advertising for tenders, with Messrs. Spagnoletti and Crookes, for the electric light wiring of the male wards and administrative block, at £145 and £115. 10s. respectively.

Radcliffe.—The Local Board have decided to charge 8d. per unit for the electric current.

St. George's (Bristol).—The Chairman remarked at the last meeting of the Local Board that a private company was seeking to obtain powers to light the parish by electricity, and he submitted to them whether they ought not to obtain such powers, and then they would be in a position to use them if required. After some discussion, it was agreed to leave the matter to be dealt with by the new body shortly to be elected.

Stockport.—The Stockport Guardians have decided that the new workhouse to be erected at Hazel-grove to accommodate 1,500 inmates shall be lighted by electricity.

Wandsworth (London).—The Wandsworth District Board of Works have decided to, if necessary, retain counsel to appear before the Board of Trade in support of their objection to the street transformer chambers proposed by the County of London and Brush Provincial Electric Lighting Company, and the clerk was directed to inform the Company that the Board were of opinion that all questions in connection with the proposed works should be settled before the work is commenced.

Warminster.—At the last meeting of the Local Board, the Clerk stated that he had written to the Local Government Board, applying for sanction to borrow a loan of £250 for the extension of the electric light in the town. They had formally acknowledged the receipt of the letter, but said nothing about the inquiry being held.

Windsor.—The Town Council have resolved to apply for a Provisional Order for their own district and for that of the Eton Local Board.

COMPANIES' MEETINGS AND REPORTS.

Western and Brazilian Telegraph Company (Limited).

The twenty-eighth ordinary general meeting of this Company was held at Winchester House, Old Broad-street, on the 16th inst., Mr. W. S. Andrews in the chair.

The SECRETARY (Mr. R. M. Cunningham) read the notice convening the meeting and the minutes of the last meeting, and the report and accounts were taken as read.

The CHAIRMAN: Gentlemen, we have again on this occasion to refer to a boom in the traffic—not, unfortunately, accompanied by a similar boom in the receipts. The receipts for the half-year ended June, 1894, were £77,603, while for the corresponding period of 1893 they were £79,373, being a decrease of £1,770. But, gentlemen, as I have had to remark on previous occasions, although there is a diminution in the receipts, there is a large increase in the work done. The unfavourable influence by which our receipts have been lessened continued last half-year, and I am sorry to say that it increased in severity. At our previous meeting we reported to you that exchange had gone down to 10¼; that was in the half-year ended December, and it was at that time the lowest that had been recorded, but in the half-year we are now considering we actually only got out of the whole period two months of that exchange of 10¼, for the exchange continued, unfortunately, to go lower. Now for the six months ended June, 1893, the exchange averaged 12⅛, for the six months ended December, 1893, 10¾, and for the six months ended June. 1894, 9½. This and the other causes which we mentioned at our meeting last May will explain the falling off in the receipts. The aggregate loss on exchange of this Company and of the Platino Company combined reached no less a sum during this half-year than £36,321. Now you will readily understand that this diminution in receipts must have been far greater, but for the large increase which I have already alluded to in the traffic. The number of words transmitted has again been surprising. It has occurred mainly, as before, in the internal message work, but it has also extended to the international work. The additional number of words transmitted compared with June, 1893, reaches the large figure of 623,295 words—almost a large business in itself. It constitutes an increase upon the gross traffic of the corresponding period of upwards of 42 per cent. Now, gentlemen, if this business had been done at the par of exchange—that is to say, under normal conditions—we should have been enabled to recommend the declaration of a dividend, not of 1 per cent. for the half-year, but of 3½ per cent. for the half-year. You will therefore see that all this trouble and bother for us arises from this one question of exchange, in connection with which, I am pleased to say, there is now an improvement. It is an eminently satisfactory feature that our loop or duplicated lines, and our duplex and staff arrangements, have enabled us to get through this greatly augmented business not only to our own satisfaction, but, which is far more important, to the satisfaction of our customers. Turning to the expenses account, under Abstract "A" (expenses at stations) there is an increase of £1,218. There are seven items of increase and six of decrease. I will not trouble you with them, because £1,442 of this item is for salaries and wages abroad—that is to say, for salaries and wages for transacting this 42 per cent. of increased business, and I venture to think that that is rather a creditable record. There is, of course, consequently a diminution in the other items under Abstract "A," but I need not trouble you with them. Under Abstract "B" (ships) there is a saving of £4,069, and, satisfactory as this is, we shall be able, we believe, to effect a still further economy during the current half-year. Under Abstract "C" there is a slight increase of miscellaneous items, but in salaries and wages there is a decrease of £52. Now, the final result of all these figures is that on expenses account there is a reduction of £3,684. Including £1,045, the amount brought forward from 1893, there is a balance of £38,908. From this has to be deducted £11,672 for debenture interest, £5,000 for debenture redemption, and £2,000 placed to reserve, leaving us £20,236 to deal with. We recommend you to pay 1 per cent. for the half-year, or at the rate of 2 per cent. per annum, carrying forward £5,630 to the current half-year. We have explained in the report why we carry forward such a considerable sum as that for the next half-year; namely, to provide against contingencies. You will see from the report that we have taken no credit for the business recently opened out by means of the Pacific and European land lines with Valparaiso and other important places on the west coast of South Africa. This traffic, as a fact, has increased largely since the opening of the lines, and it is still increasing, and seems to promise to become a valuable and permanent source of additional revenue. I may say that the amount of traffic transmitted by the Company last half-year has been the largest ever forwarded since we have been a Company, and, as you are aware with respect to this traffic, the growth has been continuous, and for some time past has been proceeding by leaps and bounds. No other words would describe it accurately. It is also a source of great gratification to the Directors, and, no doubt, to the shareholders, that the doubling of a great part of the Company's system, the application of the duplex apparatus, and the complete staff arrangements of the Company have done so much to encourage the business; and looking at the fact that the United States of Brazil are again enjoying tranquility, and that this means the growth of their wealth trade, and commerce, the outlook is more encouraging than has been the case for some time past. If we have managed to complete thus far these lines and arrangements, and persevered in preparing a powerful and complete system of telegraph during times of trouble and difficulty in order to be prepared for the inevitable growth of a great country like the United States of Brazil, the accentuation of the country's progress and prosperity should fortell a greater future for this institution. We were just engaged in a negotiation which would have resulted, as we are entitled to believe, in the accomplishment of the reorganisation of our debenture debt, and would have set free a large amount of annual revenue, when we received information that it was understood some plan was afloat in Brazil for the purchase of the lines of the Company, and we had to discontinue our efforts respecting the debentures. And then, gentlemen, just about the same time—for it never rains but it pours—the Chairman of the Brazilian Submarine Company, at the general meeting of that Company, announced to the shareholders that there ought to be a closer arrangement between the Companies, that in his opinion the sooner such an arrangement was come to the better, and that he understood that the Chairman and the Managing Director of this Company were in favour of some such arrangement. Well, gentlemen, it is due to Sir John Pender to say that for some years we had let it be known to the Brazilian Submarine Company that we were of that opinion—it is nothing new. Any arrangement, however, being subject to the rights of the Brazilian Government to purchase: we could make no arrangement which was not so contingent, as otherwise it would have been travelling outside the concession, which we could not do. Of course, it has taken some time for the new Chairman of the Brazilian Submarine Company to get into the saddle and to see his way through a very complicated business; but his views appear to have ripened and taken a pretty distinct and decided turn. At the present time, however, and under present conditions, we are manifestly not in a position to negotiate with the Brazilian Submarine Company. I have thought that Sir John Pender's remarks called for recognition on our part, and have, therefore, made these observations. Well, now, gentlemen, is it undoubtedly the fact that the Brazilian Government have the power to acquire this Company's lines under the concession? With reference to that I will read to you what that document says: "At any period after the first ten years, reckoned from the day on which the lines shall begin working throughout their whole extent, and until the term of the concession expires, the Government may redeem them with their respective stations and dependencies. "The price of such redemption shall be fixed by arbitrators, who shall take into consideration not only the value of the works in the state in which they then are, without regard to the original cost, but also of the net yield of the lines on an average of the five previous years. And in no case shall the price of redemption be less than the actual cost to the Company of laying down and working the cables." That is pretty clear. There can, besides, be no question that in addition to the desire of most Governments to acquire the sole control of the internal and some, indeed, of the international telegraphs of the country as essential to the good government of the country and the welfare of the people, the Brazilian Government have special reasons for contemplating this acquisition in our case, and they have given the general reason and two or three reasons besides. I will now read a part of what we understand to be the official report of the Telegraph Direction, as approved by the Commission and the Government to be laid before the Chambers:—"The telegraphic service, being a public one, like the postal service, should remain in the hand of the Government, especially when it extends over the greater portion of the territory. At the beginning all nations, not daring to venture into such an expensive work, left its exploitation to private initiative. In view of the development and success of the private undertakings the Governments commenced to bring them under the control of their official administrations, and went further—buying up the existing companies. The same happened as regards the telephone service, although it was not so important. France got the monopoly of the telegraphic as well as the telephonic service. England has spent 12 millions for the same purpose. Later on a tendency was shown to redeem the international cables, and so the Submarine Company was purchased, and the exploitation of their cables transferred to the Post Office. There is already an agreement between England and Belgium to make the cables between the two countries Government property. In the same way the five private cables between France and England have been redeemed. Regarding Brazil the case is much more important. Within the limits of the union a foreign company's cables, the Western and Brazilian Telegraph Company's, connect all the capitals of the most important States from the extreme north to the extreme south of Brazil. When the concession was granted to the Western Company, Brazil was not in a position to undertake the work, and probable profits were not encouraging. Although the Western Company had nearly all the traffic, as land lines were not developed, still, up to 1882, they were not able to pay dividends. Therefore the concession was very reasonably and advantageously granted; but to-day, there being no risk of loss owing to the success of the undertaking, the time is opportune to purchase the Company, as their traffic is increasing in such a way that the longer we wait the more we shall have to pay. Their traffic, in 1889 was 1,869,000 words, rose to 2,680,000 in 1893, and to 3,551,000 in 1893. Are we to wait until privilege expires in 1933? This service cannot be left indefinitely in the hands of foreigners. The necessity of purchase becomes more and more imperious. (This is supported by many important reasons). It was only recently that the land lines were cut in the interior by rebels, obliging the Government to hand all their work to a foreign company, which means to say to entrust all their plans, orders, and combinations to an unknown staff of foreigners. That is not very complimentary to us. Although it happens that we could rely upon the greatest loyalty on the part of the Company (that is rather better) still, the danger exists, and would be much greater in case of external war. The Brazilian administration has at its disposal every requisite for telegraphic service. It only requires to be augmented. There is no reason for allowing a foreign Company to continue to compete. The great increase in the telegraphic service during the past four years points clearly to the purchase of the Company as an economic measure. Upon this point we have the Company's statistics." The report then deals fully with the capital, revenue, and expenses, and then goes on to mention—"Were it not for fiscalisation and suspension of service during the revolt, which greatly hampered the development of the Company's traffic, the revenue would have been larger." Now this is a little obscure. "They agree upon a basis of two millions sterling, and, if revenue collected in gold as intended, gross receipts would be at least 10 per cent., but as London Directorate and administration here would disappear, together with stations and other expenses, the revenue would be much greater, especially if salaries were based upon Government department scale. The rapidly increasing traffic assures large dividends in the future." Well, that does not seem altogether the selection of an unfavourable moment *qua* Brazil for the purchase. Now I will return to our own statement. The Telegraph Department might have said even more than this, because England, France, and Germany not only possess the entire control of the internal telegraphs of the country and have purchased international cables, but they have since increased the number of the latter by laying additional cables, with the object of still more furthering and assisting the development of national and international telegraphic communication in the interests of trade and commerce. Now Brazil at present only seems to contemplate acquiring the undivided control of her internal communications. The Western Company connects together nearly all the chief ports and centres of Brazil by its coast cables, and consequently competes with the Government in the performance of the internal message service of the country. No doubt, the Government is fully alive to the fact that the continued existence of this state of circumstances, looking at all the other countries of the world pretty well, is practically an anachronism, and might even, under given conditions, become objectionable. It is most gratifying to the Board that the Government has seen reason to feel that they could rely upon "the greatest loyalty on the part of the Company," and this is a valuable testimonial to the staff in Brazil, as well as to the Manager. We owe much to Mr. Reidy our representative in Rio, and to Mr. McNeil, his assistant, and the staff for their prudence and discretion. People do not always exhibit these two excellent qualities in times of crisis and excitement. Still, *qua* Brazil, this is a foreign Company, and although its complete arrangements have proved at a great crisis to be all that could be desired or expected, it is perhaps, all the more natural that the Government should be educated, so to say, by the facts which, owing to accident in great part, have come uppermost, and should desire to become possessed of a telegraph system of proved excellence, for they have had to depend on it for months. *Qua* ourselves, however, and the way in which we look at this measure coming forward, we cannot, of course, but see that it comes forward just as the clouds begin to break and the sunshine becomes visible. We seem now at a turning point, which will probably result in a very great expansion of the commerce of Brazil. We cannot help that, however. As the Government can, of course, effect considerable economies, and will be enabled to fix their own tariffs and collections, there is no doubt that the purchase does in fact, as a mere matter of business calculation, give to the Government the certainty, if they please, of large financial advantage. There is no question about that. Now, gentlemen, let me define the position. As we understand it, there is an official report approved by the Government recommending the purchase of this Company's undertaking. This report is to be submitted to the Chambers for their consideration, and if the Chambers agree with the plan, but not otherwise, a resolution will be passed probably authorising the Government to negotiate and to purchase. You see, therefore, that at present we are merely in the preliminary stages of a project. Usually the difficulties begin when the actual negotiations begin. It is easy enough to accept the principle of purchase, but not so simple to arrive at conclusions satisfactory to the parties, especially in a complicated case like ours, where there are many contingent facts that will have to be taken into consideration and dealt with. However, on our parts every effort will be made to arrive at a favourable settlement satisfactory to the proprietors. Looking at all the facts, what I may call, without exaggeration, the perfection of the system, and the consequent growth of the traffic, with the rising prosperity of Brazil, nothing but terms satisfactory to the shareholders, including all equitable provisions and compensations, ought to be proposed or could be accepted. Meanwhile, let me deprecate any discussion because it can do no good that I can see in any way, and it is pretty much of an axiom not to discuss matters publicly which are under negotiation. In this case, besides, the environments are uncertain, the terms are unknown and, consequently, unsettled, and their discussion even has not yet been authorised by the Chambers of Brazil, so if we were to talk about terms and so on we should be rather in the dark. You may depend upon this—that we shall do our utmost in your interests, and if patience, conciliation, and thorough consideration of all points are calculated to be of service they will be applied on your behalf. Gentlemen, if when the time arises this important measure should go through, there is one unpleasant result that it will bring with it, and that is the severance of the pleasant relations which have always subsisted between this Board and yourselves and the general body of the shareholders. We are not unmindful of the fact—and I have said this before—that but for your discretion and good common sense, we should have been unable to build up this valuable property which your confidence, patience, and self-denial have made possible and we have been so fortunate as to be able to accomplish. I now beg to propose the resolution, which will be seconded by one of my colleagues, and then I shall be happy to reply to any observation which the shareholders may—shall I say, think it prudent to make? The resolution is—

"*That the report and accounts to June 30, 1894, now submitted, be and the same are hereby approved and adopted, and that a dividend for the half-year (free of income-tax) at the rate of £2 per cent. per annum, be, and is hereby declared, payable on the 16th inst.*"

Mr. C. W. EARLE : I beg to second the resolution.

Mr. FRY said that there was one point upon which he desired a little explanation. He quite agreed that in view of the very important negotiations that must take place between the Company and the Brazilian Government, it was right and proper that the shareholders should have every trust and confidence in the action of the Directors. The point upon which he desired to ask for information was in paragraph 8 of the report, which was as follows :—"The Directors have to notify that the conversion of Ordinary shares into Preferred Ordinary and Deferred Ordinary shares will be suspended on and after January 1, 1895, until further notice." Now, the Articles of Association were very clear in giving those powers to the shareholders, and he should like to ask under what powers in the Articles of Association the Board had rescinded that clause.

The CHAIRMAN : We have not rescinded it, but have suspended it. I think, however, that you will in a moment recognise the practical impossibility of going on making these divisions. You would have different sets of preferred shares with different amounts of claims for interest : in fact, I do not know how they would be classified on the Stock Exchange. The whole thing arises from the shares being cumulative. One Preferred share might have six months of cumulative interest, while another Preferred share might have been exchanged later, and have less interest due on it and so on.

Mr. FRY remarked that the Preferred shares so far had always received their dividend. The Articles of Association gave the shareholders the right to convert, and he considered that the Directors had no power to rescind that right.

The SOLICITOR : The resolution giving the power of conversion is permissible. It says the Directors "may."

The CHAIRMAN then put the motion, and it was carried unanimously. Gentlemen, there is nothing else to detain us to-day. We have got through our business, and I am much obliged to you for your attendance.

Mr. ENNIS proposed a vote of thanks to the Chairman. They ought to recognise the very important and clear statement which had been made to them by the Chairman respecting a subject which they had all been anxious to hear about.

A SHAREHOLDER seconded the motion, which was carried unanimously.

The CHAIRMAN : We are all of us very much obliged to you, gentlemen.

The proceedings then terminated.

County of London and Brush Provincial Electric Lighting Company (Limited).

The annual general meeting of this Company was held on Monday at the Cannon-street Hotel, under the presidency of the Right Hon. D. R. Plunket, Q.C., M.P.

The SECRETARY (Mr. B. Broadhurst) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN : It is now my duty, gentlemen, to propose :—

"*That the report of the Directors and statement of accounts to June 30, 1894, now presented to the shareholders, be received, and that the same be hereby adopted.*"

I am glad to think that in submitting this resolution to you it will not be necessary for me to detain you for more than a few minutes. I think, speaking on behalf of my brother Directors and myself, I may fairly congratulate you on the position in which we already find ourselves, and also that we may encourage you to take a hopeful view of the prospects you have before you in the near future. You know it is only six months since that the reconstruction and capitalisation of the Company enabled us to go to work, but already our progress within the County of London is, I think, very satisfactory, and our experience outside the County of London, in the more distant districts in which we are operating, has been fortunate even beyond our most sanguine expectations. As to the County of London, the contracts which, as you know, were spoken of in the prospectus under which last spring we made our first issue of capital as having been entered into between this Company, the Brush Company, and the Electric Construction Company respectively, are in course of being carried out, so that we may hope before this time next year we shall have a plant capacity for serving about 90,000 glow lamps. We have also been fortunate enough to secure two admirable sites for the purpose of erecting our stations thereon. One of these, for the north side of London, is situate on the Regent's Canal basin, and the other, for the south side, is on the banks of the Thames, near our Wandsworth district. We shall thus at both these places secure the economy of water carriage for our coals, and an abundant supply of water for all other purposes. At the same time we have entered into contracts which we believe to be both fair and favourable for the execution of the necessary street work, and it is our intention not only to lay down sufficient conductors for all our immediate purposes, but also to lay a certain considerable additional number of pipes into which cables may hereafter be drawn, when, as we expect, the necessity of such additional supply of cables arises. In point of fact we believe, from the number of applications we have already received, and from our observation of what has happened in somewhat analogous cases elsewhere, that we shall obtain a very large and increasing number of orders both in those districts of the metropolis which we at present occupy, and in others also which we may hope hereafter to acquire. We are, therefore, laying our foundations broad and strong in order that we may be able better to build on them hereafter, I believe, a great and flourishing business, which will give satisfaction both to our shareholders and our customers. Turning to our operations outside the County of London, our position is no less satisfactory and encouraging. At Bournemouth—where, as you know, we last spring acquired the interests of the Brush Company in the Bournemouth and District Company —our progress has been so rapid that we have had to enlarge our station and to purchase an additional plant capacity of 9,000 8-c.p. lamps. We also had to lay considerable additions to our mains. These improvements and additions have been made at a considerable cost, the total outlay at Bournemouth being now about £65,000. We have connected up, between January and October 1st, some 3,000 lights to the system, and there are a good many orders still remaining to be dealt with. Our zealous manager, Mr. Lawson, has estimated for me that by the end of this year the additions to our light connections will amount to about 5,000, thus making the number of lamps for this year about 19,500, as against 14,500 for the year 1893. At the same time we have been able to make a number of changes both in the plant and the staff at Bournemouth, which have resulted in considerable economies as well as increased efficiency; so that the station and distribution charges, which last year amounted to 6d. per unit, will for this year be something less than 5d. per unit, and it is calculated that our revenue will amount this year to something like £7,000, as against £5,000 for the year 1893. So much for Bournemouth. At Dover also our prospects are extremely hopeful, I think you will agree with me, for the generating station there, which was commenced in the spring, has been pushed forward so rapidly that it is hoped we shall be able to supply our customers with current before the end of the month of December. We have entered into a contract with the Corporation of Dover for lighting the streets and the sea front, and already 500 lamps have been wired in the town hall. At the same time we have offered our services to the military authorities, and I am glad to say that we have succeeded in getting the order for the lighting of the gun tower on the pier. There are also further orders under negotiation. At Windermere we have entered upon a very interesting and what we believe will turn out a very profitable enterprise, for we have secured the use of the rush of water where the river Leven flows out of the lake, and it is our intention to apply this great and economic source of generating power to the purpose of supplying the electric light to such of the towns in the neighbourhood who may be dis posed to avail themselves of our services. These are the only stations which are especially mentioned in our reports.

Mr. ALFRED THOMPSON : There is Wandsworth.

The CHAIRMAN : I have referred to that, as you will remember, when I stated that the contracts were being carried out, so that we hope by this time next year to supply our current there, and that we have succeeded in getting a very good site for a generating station there. I think our friends in that district may rely upon our being able to carry out the hopes I have put forward. You must not suppose, because we have not referred to other places, that those which I have mentioned are the only ones in which we are interesting ourselves. We have made application, and shall continue to make application, for Provisional Orders at other places which we think suitable for successful business ; and, on the other hand, various applications have been made to us for pecuniary assistance by local bodies interested in the matter of electric lighting. Some of these we have been obliged to refuse, because the expectations held out were not encouraging enough. In the case of others the question is still under consideration ; and, of course, it depends very much upon the terms upon which local Provisional Electric Lighting Orders can be obtained. I think, however, you will agree with me that it is better not on an occasion of this kind to go into a discussion of negotiations which are still pending ; and, on the whole, I think it will be enough if I say it is the feeling of the Board, and I believe it is the opinion of our shareholders, that our progress up to the present time has been remarkably rapid, and that our position is one with which we may be satisfied. It is only a short time since we commenced operations, as I have said, and, for the rest, our feeling is in the old saying, that "it is better to be sure than sorry." This County of London Electric Lighting Company is, in a certain sense, the younger sister of the City of London Electric Lighting Company, and not only is it so in the sense that they were brought into the world under the same auspices ; but we have the great advantage that your excellent Deputy-Chairman (Mr. Braithwaite) and Mr. Reynolds are members of the Board of both these corporations. It is our intention to follow and to emulate the sound management which has produced such successful results in the case of the City of London Electric Lighting Company, and it is our hope that we may ultimately equal, if we do not exceed that success in the still wider field in which our Company is destined to operate. Under these circumstanes I hope there will be no difficulty in adopting the resolution I have submitted, and in giving us your confidence and favourable consideration ; at all events, until next spring, when we shall have to present to you—for this is in the nature really of a preliminary meeting—probably a longer and, I confidently hope, a not less satisfactory account of our stewardship. I now have the honour to move this resolution.

Mr. ALFRED THOMPSON seconded the motion. He only desired to make one remark, which was that at Wandsworth, where he was living, the gas company were anticipating this Company's operations, for they had issued a notice announcing a reduction in the price of their gas from Christmas of 2d. per thousand cubic feet.

The CHAIRMAN : That shows that they have considerable confidence in the success of our future operations. He then put the resolution to the meeting in the usual way, and, having declared it carried unanimously, remarked that that was all the business that had to be brought before the meeting on the present occasion.

Mr. ARTHUR AYRES proposed a vote of thanks to the Chairman and Directors for the satisfactory statement they had submitted to the shareholders, and he fully trusted that their expectations might be realised in the future.

A SHAREHOLDER seconded the motion, which was carried by acclamation.

The CHAIRMAN briefly acknowledged the compliment on behalf of the Directors and himself, and the proceedings then terminated.

General Electric Power and Traction Company (Limited).

An extraordinary general meeting of this Company was held at Cannon-street Hotel, on Wednesday, for the purpose of considering and, if thought fit, passing the subjoined resolution :—

"That the Company be wound up voluntarily under the provisions of the Companies' Acts."

The Right Hon. Lord Egerton of Tatton presided.

The SECRETARY (Mr. William Bulloch) read the notice convening the meeting, and the minutes of the last meeting.

The CHAIRMAN said they had heard the minutes of the last meeting read, and he was present at that meeting as Chairman, acting on behalf of his friend the late Earl of Albemarle, who was absent through indisposition. Since then he was sorry to inform them that the Earl of Albemarle had died. Their late Chairman, prior to his serious illness, had taken a great interest in, and had devoted his time entirely to, the business of the Company. He himself had been requested to act as Chairman, both during Lord Albemarle's illness and since his death. Mr. Parker resigned his seat at the Board in the beginning of this year. With reference to the special object for which the meeting had been convened, they would remember that in the last annual report it was stated that some reorganisation was necessary in view of the large losses of capital shown by previous balance-sheets. He then stated that the Directors were giving the matter their further consideration with the view, if possible, of putting the Company on a better and more satisfactory basis. Since then the expenses had been cut down and the affairs of the Company had been simplified wherever it had been possible. In the course of this policy they had carried out the transfer of the manufacturing business referred to at the last general meeting to the Acme and Immisch Electric Works (Limited) on the terms then mentioned. The matter was carried out in accordance with the resolution passed at the last meeting ; and in continuation of the same policy, which was then sanctioned by the shareholders, the Directors had also transferred the launch business on the Thames to a new company. It was found necessary at the beginning of the year to have fresh capital in order to make the launch business an effective one last summer ; and it was not thought desirable, even if it had been possible, for the Company to spend capital on that business. By the transfer of the launch business to a separate Company the raising of the fresh capital required was facilitated. Although the season had not been a very favourable one, yet he believed that the working of the new Company, the Immisch Launch Company, had been satisfactory during the short time it had been in existence. Both the manufacturing business and the launch business were carried on at great disadvantage by this Company owing to the financial state of its affairs. Consequent on the losses sustained by this Company, its credit was not sufficient to give confidence in carrying out its business, and its position could not but be prejudicial to both these businesses. With reference to the other assets of the Company, the Directors did not at the present time see their way to make any recommendation of an immediate nature which would be advantageous to the shareholders, and they thought that the remaining assets could best be realised under a voluntary liquidation. The liquidators would have more power perhaps than the Directors had now, and they considered it would not be to the advantage of the shareholders, although the expenses of the Company had lately been brought within very moderate limits, to continue the Company as at present. They thought they had no other course to recommend them than to pass the resolution, which he then proposed, for winding up the Company voluntarily under the provisions of the Companies' Acts. Of course, if the resolution were adopted, it would be necessary to confirm it at a subsequent meeting, at which another resolution would be proposed for the appointment of liquidators. They were anxious to keep the expenses as low as possible, and, with this object, it had been suggested that the Company's auditor, Mr. Wilding, and the Company's secretary, who were perfectly familiar with all its affairs, should be nominated, and he thought that an arrangement should be made with them to remunerate them by a fixed sum irrespective of the time the liquidation might take. The assets of the Company consisted of the copper works, which, if the price of copper had remained what it was when the works were first started, would have been very remunerative. Owing, however, to the fall in the price of copper, it had been impossible to start the works. They believed the liquidators would have a better chance of dealing with this asset than the Company could do in its present condition.

Mr. IMMISCH seconded the motion.

Mr. B. NICHOLSON said he failed to see how the fall in the price of copper would affect the Company as a manufacturer. If copper fell the goods they manufactured would fall, but the interests of the Company would not be seriously affected unless they held, say, 1,000 tons of copper, in the value of which there had been a great fall.

The CHAIRMAN replied that he was only acting as Chairman, and could not pretend to know all about such details.

In the discussion which followed, Mr. Dunn, the Rev. J. Page Hopps, and other speakers took part, and the past management was animadverted on for the heavy losses which had been sustained. Mr. HOPPS intimated his intention of proposing an amendment for appointing a committee of investigation unless further information were given to the meeting.

Mr. IMMISCH, in answer to questions, stated that the Company was started originally with the idea that electric traction was coming to the fore. Their deceased Chairman and his friends, and he himself as head of the firm of Immisch and Co., were all enthusiastic about electric traction. So much was that the case that his firm sold their lucrative and prosperous concern for shares in this Company. He had been on the Board ever since the Company started and he certainly could say that the Directors had done their utmost to try and make traction a success, but they had failed from circumstances beyond their control. They did not receive a single penny for their business. The Directors had taken no fees for the last three years ; but still there were certain expenses which were necessary in keeping up a Company, and what they had left that was good was not sufficient to support the expenditure which would be necessary. It was for this reason that the Directors had come to the conclusion that the wisest course would be that which was recommended by the resolution.

Mr. GARCKE pointed out that the loss which had been sustained had really not been so much as appeared. The capital that was lost was represented by the shares paid to Immisch and Co. for their property, which was paid for in shares.

Mr. GARCKE, in further reply, at the close of the discussion, said he thought it was very natural that the questions which had been asked should have been put. Although sitting at the table, he was not a Director of the Company. He only came in to advise the Directors as representing a very large section of the shareholders. He came in two years ago, when the whole of the loss practically had been made. It was incurred a long while ago—very largely at the inception of the Company—by reason of the over-capitalisation. Mr. Immisch had explained that he transferred his business entirely for Ordinary shares, on which no dividend had been paid. Unfortunately the figures put in the books as representing the property was very much in excess of its value. Some misapprehension existed as to the transfer of the two businesses to which the Chairman had referred. Until last year the two businesses were departments of this Company's working. The Company, suffering under a heavy loss of capital, was very prejudiced in the electrical world, and had very little credit. They found it very difficult to carry on these businesses with advantage, and they therefore felt it would be better if they were transferred to new companies, by which a little additional capital might be obtained for the development both of the manufacturing business and the launch business, They had received in consideration of the transfer fully paid up Ordinary shares in the new companies—a very usual proceeding—and the new companies had the power to issue Preference shares. Although this Company had received from the two new companies Ordinary shares for the businesses transferred to them, the position of the Preference shareholders in this Company was in no way relegated to that of Ordinary shareholders. If they had gone on themselves they would have had to raise debentures, whereas by the establishment of the new companies a little additional capital had been obtained by way of Preference shares ; in other words, they had allowed other companies to raise money to develop this Company's business. The position and rights of the shareholders in this Company had not in the least degree been altered. Instead of owning plant, machinery, and launches they held shares. A question had been asked why a call was made two months ago, but it was made many month ago, and he believed that the shareholder who put this question was in arrears with his call, which he only paid up two months ago. Another question asked was, what had been done with the call ? In the last balance-sheet it was shown that the position of the Company was not one which could be described as very affluent ; they had no money in hand but a large amount of liabilities, and what the Directors had done in the past two years had been to liquidate as far as they could and to straighten out all the complicated transactions the Company had become involved in Practically, for the past two years, the Directors had been doing the work of liquidators, but a point had now been reached when the work could best be done by actual liquidators, With reference to the copper works, the Company entered on an enterprise for developing a copper-depositing patent, and for establishing works for carrying out a process which they still believed in. Some time elapsed before the works could be completed, and in the interval there was a very serious fall in the price of copper. The Directors considered the matter, and came to the conclusion that it would be very unadvisable to spend a large sum in developing this process and, moreover, the Company was not in a position to do it. The copper business could best be developed by another separate Company, and what the liquidators would probably do would be to form a syndicate to take over this business. With regard to the Acme and Immisch works, that was a new Company, and the business which this Company had sold to it was not a re-transfer to the original owners. Mr. Immisch was to be a Director of the new Company, and he had allowed his name to be used for the purpose of preserving the *clientèle.* In the new Company this Company would receive shares fully paid up, representing seven-twelfths of the total capital, and the Acme Company received fully-paid shares to the extent of five-twelfths. He thought that the position was clear with reference to the original vendors. It was true Mr. Immisch received a large amount for his business, but the payment was entirely in shares. The capital of the new launch company was £8,900, which was fixed by an independent valuer, and it had been paid to this Company in ordinary fully-paid shares, and no other Ordinary shares had been issued to anyone. However much the shareholders had suffered—and he sincerely sympathised with them—he felt strongly that they were not justified, without knowing more of the circumstances, in alleging that the Directors were not doing their best in the interests of the shareholders. He felt that the Board had done their best to retrieve the misfortunes of the past. The question of appointing liquidators would be dealt with at the next meeting.

The resolution was then adopted *nem. con.*, and a vote of thanks to the Chairman concluded the business.

NEW COMPANIES, STATUTORY RETURNS, &c.

NALDER AND HARRISON CONSTRUCTION SYNDICATE (LIMITED).—This company was registered on November 17th with a capital of £15,000 in £1 shares, to enter into and carry into effect an agreement made between N. F. Nalder and H. T. Harrison of the one part, and F. R. Boardman (acting as the trustee for the Company), of the other part, for the acquisition by the Company of certain patents, patent rights, inventions, concessions, &c., particulars of which do not transpire, and to carry on, establish, undertake, and engage in any business or transaction.

POWDERED PLASTIC PAINT COMPANY (LIMITED).—This Company was registered, on November 15th, with a capital of £5,000, in £1 shares, to acquire a new and improved process for the manufacture of powdered plastic paint, and to manufacture and deal in powdered plastic paint, varnishes, enamels, colouring and preservative liquids, &c.

SNOWDON MOUNTAIN TRAMROAD AND HOTELS COMPANY (LIMITED).—Among the objects of this Company, which was registered on November 16th, with a capital of £70,000, in £10 shares, to construct a tramroad to the summit of Snowdon, and to erect an hotel at the summit. is the acquisition, establishment, and maintenance of telegraphs, telephones electric light and power works, &c.

VEGETABLE SILICA PATENTS INSULATING SYNDICATE (LIMITED).—This company was registered on November 17th with a capital of £5,000 in £1 shares, to enter into an agreement made between Mannsell C. Bannister and this Syndicate to acquire, develop, and generally deal with certain letters patent and other rights ; and to manufacture, sell. and deal in materials for insulating purposes or otherwise.

ALBERT HOSTER (LIMITED).—Several requests for the filing of the necessary returns have been addressed to this Company without reply, and the last, dated October 31st, states that the Company's name will be struck off the Register of Joint Stock Companies unless cause be shown to the contrary.

ALLAN EVERITT AND SONS (LIMITED).—The annual return of this company, made up to November 2nd, has been filed. The capital is £300 000, divided into 10,000 Preference and 20,000 Ordinary shares of £10 each. All the Preference and 12,000 Ordinary shares have been allotted, and of these 3,300 Preference have been issued as fully paid, while 4,000 Ordinary shares have been issued with £8 per share considered as paid. Consequent upon a call of £10 per share on the Preference, and £8 per share on the remaining Ordinary shares, the sum of £131,000 has been received.

WESTINGHOUSE ELECTRIC COMPANY (LIMITED).—The annual return of this Company, made up to September 20th, was recently filed, when, out of a nominal capital of £600,000, divided into 30,000 Preference and 30,000 Ordinary shares of £10 each, 18,955 Preference and 20,000 Ordinary shares were taken up ; 15,800 Preference and all the Ordinary shares were issued as fully paid. The full amount has been called on 1835 Preference. and a call of 10s. per share has been made on the remaining 1,320, resulting in the total payment of £1,010.

WIMSHURST, HOLLICK AND CO. (LIMITED).—The statutory return of this Company, made up to November 5th, has been filed. Out of a capital of £40,000, divided into 4,000 Ordinary and 4,000 Preference shares of £5 each. all the Ordinary have been taken up, and issued as fully paid ; 628 Preference shares have been subscribed for and allotted, and the full amount per share has been called, resulting in the payment of £3,140.

WINDERMERE AND DISTRICT ELECTRICITY SUPPLY CO. (LIMITED).—The statutory return of this Company, made up to October 17th, was recently filed. 307 shares have been taken up out of a nominal capital of £50,000 in £5 shares ; and the 7 shares have had £1 per share called and paid, while as yet no calls have been made on the remaining 300 shares.

CITY NOTES.

ALLGEMEINE ELEKTRICITATS GESELLSCHAFT (BERLIN).—The Directors' report for the financial year 1893-94 shows a profit of £160,299 as against £130,745 in 1892-93. It is proposed to declare a dividend of 9 per cent. as against only 8¼ per cent. in the preceding year.

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ended November 18th were £972, as against £882 in the corresponding period of 1893, being an increase of £90. The total receipts for the half-year amount to £17,691, as against £16,473 for the corresponding period of 1893, an increase of £1,218.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—During the temporary interruption of this Company's Falmouth-Bilbao cable, arrangements have been made by which telegrams for Bilbao, Madrid, and other places in Spain can be promptly forwarded by the Eastern Telegraph Company's route.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY (LIMITED).—The numbers are given elsewhere of the drawing of 362 Five per Cent. Mortgage Debentures in this Company, payable at par on January 1st next, at the banking house of Messrs. Barclay, Bevan and Co., 54, Lombard-street, London, E.C.

HALIFAX AND BERMUDAS CABLE COMPANY (LIMITED).—Notice is given that application is to be made to Parliament in the ensuing session for an Act to, among other things, make further provision with reference to the investment of the annual subsidy or yearly sum payable by Her Majesty's Treasury to the Company, or to the trustees, for the holders of mortgage debentures issued by the Company, and to authorise the investment and reinvestment of this annual subsidy, or any available portion thereof, or other moneys received or to be received by the Company or the said trustees. Mr. N. H. Smith, of Nicholas House, Nicholas-lane, London, E.C., is solicitor.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended the 18th inst. amounted to £881. The amount for the corresponding week last year was £553.

ROYAL ELECTRIC COMPANY OF MONTREAL.—Messrs. Coates, Sons, and Co., of 99, Gresham-street, London, E.C., will receive up to 4 p.m. this day (Friday) subscriptions for £120,000 Four and a-Half per Cent. Debentures in the above Company, at par, to be redeemed to the extent of £6,000 per annum by annual drawings at 105. The prospectus states that "the Company has important franchises and most valuable contracts with the Imperial Corporation for lighting the whole city by electricity at remunerative rates for the period closing January 1, 1904. The authorised capital of the Company is $1,500,000, and the paid-up $1,000,000, and quarterly dividends at the rate of 8 per cent. per annum have for some time past been regularly paid."

VICTORIA (B.C.) ELECTRIC RAILWAY AND LIGHTING COMPANY.—The numbers have been published of the Five per Cent. First Mortgage Debenture Bonds of this Company, amounting to £1,000, which have been drawn for repayment on and after January 2, 1895, at the rate of £105 per cent., in accordance with the provisions of the trust deed.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended November 16th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,181.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LIMITED).—An extraordinary general meeting of the shareholders of this Company is to be held at the offices, Eccleston place, Belgravia, S.W., on Wednesday next, at 11 o'clock, when resolutions will be proposed arranging for the issue of a portion of the newly created share capital at a premium of £1 per share, and other business in connection with the same matter.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Nov. 14.		Price Wednesday, Nov. 21.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 21.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£1,012,880	Stock	9 0	Anglo-American	36	37	38	39	6 2 7	Jan., Apr., July, Oct.	38½	35½
£2,993,560	Stock	18 0	Do. Preferred	70	71	72	73	2 14 10	,, ,,	73	70½
£2,993,560	Stock	6/0	Do. Deferred	6¼	6¾	6½	7	.	..	6⅝	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 17 1	January and July	..	..
130,000	£10	4/0	Brazilian Submarine	11¼	11¾	11	11½	6 13 1	Mar., June, Oct., Dec.	11⅝	11
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	110	114	110	114	4 8 11	June and December	..	—
10,000,000	$100	$1¾	Commercial Cable Capital Stock	135	145	135	145	4 17 9	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12½	13½	12½	13½	5 18 6	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	,, ,,	..	..
12,931	5	1/8	Direct Spanish (£1 paid)	4¼	4¾	4¼	4¾	4 4 3	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¼	9¾	9¼	9¾	5 2 7	,, ,,	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	4 3 4	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8	8½	8¼	8¾	6 2 10	Jan., Apr., July, Oct.	8⅜	..
400,000	10	2/6	Eastern	15¾	15⅞	15¾	16	4 1 3	,, ,,	15 15/16	16⅛
70,000	10	6%	Do. 6 per Cent. Preference	16½	17	16½	17	3 10 7	,, ,,	16¼	16½
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock xd	117	120	117	120	3 6 8	May and November	119	118½
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	110	106	110	4 11 11	February & August	..	..
250,000	10	2/6	Eastern Extension	15⅞	16⅛	15⅞	16½	4 6 10	Jan., Apr., July, Oct.	16⅛	15 15/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	116	120	116	120	3 6 8	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	106	103	107	4 [illegible] 7	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	106	103	107	4 4 7	,, ,,	105½	105
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	104	107	104	107	3 15 6	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	107%	110%	107%	110%	3 12 9	May and November	109½	..
180,227	10	1/3	Globe Telegraph and Trust	8¾	8⅞	8¾	9	4 15 9	Jan., Apr., July, Oct.	9	8 13/16
180,042	10	6%	Do. 6 per Cent. Preference	15½	16	15¾	16¼	3 13 11	,, ,,	16⅛	15⅞
150,000	10	5 0	Great Northern	20½	21½	20½	21½	3 11 1	Jan., April, and July	21 1/16	21
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	106	—
17,000	25	12 6	Indo-European	46	48	46	48	5 4 2	May and November	..	..
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	104	107	102	106	5 13 0	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	101	107	104	107	3 15 8	.	105	..
11,839	8	4/0	Reuter's	3	5	3	5	..	April and October	3¼	3
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	103	108	103	108	5 11 7	,, ,,	..	..
15,609	10	6/0	West African Telegraph	3	6	3	5	..	January and July	..	..
£249,900	100	5%	* Do. 6 per Cent. Debentures (red.)	100	103	100	103	4 17 10	March & September	102¾	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	2	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	101	106	100	105	7 12 5	June and December	101	..
88,321	10	9d.	West India and Panama	1	1½	1	1½	..		1½	1 1/16
34,563	10	6%	Do. 6 per Cent. 1st Preference	11	11½	11	11½	5 4 4	May and November	11⅝	11⅛
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 11 1	June and December	..	..
64,242	15	7/6	Western and Brazilian	10	10½	10	10½	..	May and November	10½	10½
33,129	7½	7/6	Do. 6 per Cent. Cumulative Preferred	6¼	6¾	6½	7	..	..	6¾	6⅝
33,129	7½	4/6	Do. 6 per Cent. Deferred	4¼	4¾	4½	4¾	..	..	4⅝	4¼
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	103	106	101	105	5 15 11	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	103	106	101	105	5 15 11	,, ,,	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	112	118	112	118	5 18 8	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 16 6	March & September	..	..
			TELEPHONES.								
44,000	6	10/0	Chili Telephone (fully paid)	2	3	2	3	..	..	..	..
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	..
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	7/16	9/16	7/16	9/16	..	Yearly	..	..
484,507	6	3/4	National	4⅞	5⅛	4⅞	5⅛	4 17 7	June and December	5 1/16	4 15/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	16	15	16	3 15 0	,, ,,	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	15½	15	16	3 15 0	,, ,,	14 15/16	—
119,234	5	3/4	Do. 5% Non-Cumulative 3rd Pref.	5½	5¾	5⅝	5⅞	4 5 1	..	6⅜	5⅝
1,000,000	Stock	4½%	* Do. Debenture Stock, 4½% (red.)	110	113	110	113	4 1 1	January and July	..	..
58,000	6	1/0	United River Plate	2	3	2	3		,, ,,	..	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	88	94	88	94	5 6 5	,, ,,	91	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	12	13	12½	13½	..	..	13¼	12¾
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	14¾	16¼	14¾	16¼	3 18 8	.	15⅛	14⅞
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	131	133	131	133	3 15 2	June and December	133	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	4½	6½	4½	5½	3 12 9	—	..	..
£57,400	£100	6%	Do. 6 per Cent. Debentures, 1900	..		..		..	—	..	..
8,322	£5	..	House-to-House Electric	..		..		..	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		—	—	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		—	January and July	..	—
45,000	£5	2/6	Liverpool Electric Supply (fully paid)	6⅝	6¾	7 1/16	7 3/16	—	..	..	—
111,000	6	..	London Electric Supply	..				..	..	..	..
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	9¼	9¾	9¼	9¾	2 11 3	..	9¾	9 5/16
£150,000	Stock	4½%	* Do. 4½% Debs. (Bonds of £10, £20, and £10)	113½	114½	111½	115½	3 19 6	June and December	..	..
6,452	£10	..	Notting Hill Electric	6½	7½	6½	7½	—	..	7 1/16	7
19,980	£5	2/0	St. James and Pall Mall	7½	8	7½	8	.	..	7¼	7 3/16
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9¼	8½	9	3 17 9	—	..	
59,900	6	2/0	Westminster Electric Supply (fully paid)	7	7½	7	7½	3 0 0	—	7 1/16	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2¼	2⅜	2¼	2½	6 0 1	..	2½	2⅜
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2¼	2½	4 16 0	..	2 7/16	2¼
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	110	113	110	113	4 0 2	March & September	112½	110½
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2½	3	2¾	3¼	—	January and July	..	..
12,139	5	..	Edison and Swan United	—		—		—	..	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	..	—	..
120,000	2	..	Electric Construction	⅜	⅝	⅜	⅝	..	—	..	..
12,845	2	2 9¾	Do. 7 per Cent Cumulative Pref.	1¼	2	1¼	2	..	—	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1⅜	1⅝	1⅜	1⅝	..	—	—	..
20,000	5	.	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	..	1 9/16	1 7/16
60,000	10	10/0	India Rubber, Gutta Percha, &c., Works	25	26	25	26	4 16 1	February & August	25⅝	25 1/16
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 0	March & September	..	—
15,995	£10	6/4	International Okonite Ordinary	..		..		—	.	..	—
16,000	£10	..	Do. 8 per Cent. Preference	—		—		—	December and June	..	—
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	⅛	—	⅛	..	..	..	.
37,350	12	12/0	Telegraph Construction and Maintenance	41	43	41	43	4 3 9	March and July	41	42½
£160,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	—		—		..	..	..	—
41,098	£5	..	Do. Preference (fully paid)	—		..		..	—	..	—
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	8	9	8	9	5 11 1	..	..	..
£30,000	10	..	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1%	City and South London Railway	37	39	39	41	2 8 0	May and November	40¾	40½
7,000	10	5%	Do. 5% Perpetual Preference	13½	14	13½	14	3 11 5	..	14¼	13⅞
£67,130	Stock	4%	Do. 4% Perpetual Debenture	120	122	120	122	3 5 7	May and November	..	..
37,500	£10	1%	Liverpool Overhead Railway	7¾	8 1/16	7 13/16	8 1/16	1 4 10	..	..	..
6,295	10	6%	Do. 5% Preference	13	13¼	13	13¼	3 16 0	..	—	..
£125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July	..	—

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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NOTES.

The Board of Trade Inquiry into the recent accident in Cannon-street, by which a horse was killed and several persons slightly injured by electrical shock and fragments of street paving, came to an end on Friday last, after having extended over three days. According to the evidence this much-advertised mishap came about in this way. The City Company was anxious to bring the Watling-street sub-station into operation on the day in question, in order to temporarily relieve another sub-station; the result was that the sub-station was switched on to Bankside before the cables had been properly tested. In running the ducts originally their relative positions had been changed at one place *en route*, and the consequence of this crossing of the pipes was a subsequent cross-connecting of the cables, notwithstanding an elaborate system of labels; so that the cable end at Bankside labelled "Milk-street" in reality went to "Watling-street," and *vice versâ*. There was therefore a *true* and an *apparent* Watling-street cable at Bankside; the latter was connected up to the station switchboard, whilst the former was left with its inner conductor touching the lead cover of a third cable. Neither the Watling-street nor Milk-street cable, we may add, was of the lead-covered type. On receipt of a telephone message the man in charge at the Watling-street sub-station switched the Bankside main on to the transformers, already made alive by a connecting main from another sub-station. The Bankside-Watling-street cable was thus under a pressure of 2,000 volts with its inner to earth, and also as it unluckily happened its outer nearly so. The 2,000 volts soon proved more than the abraded cable could stand, and inner and outer became short-circuited through the earth, charging it and ultimately blowing off two junction-box covers.

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The death of the unfortunate quadruped and the shocks to various bipeds are thus clearly accounted for, but not so the explosions. The City Company evidently have no doubt that an explosive gas mixture present in their ducts did the mischief. Some people talk of an explosive mixture of hydrogen and oxygen, generated by the short circuit taking place in a damp place and fired by the flame or spark. Others, again, think a sudden short circuit developing in a closed space would cause a sufficiently violent expansion of the air to account for everything.

◆

In view of these diverse hypotheses the Board of Trade Electrical Adviser's report will be awaited with considerable interest, although we have only to read the evidence given at the Inquiry, and to assume that the pipe joints of both gas and electric company were not quite so immaculate as made out, to have a strong suspicion that coal-gas was the culprit. If that be so, the question of the means to be taken to mitigate this dangerous nuisance becomes one of the highest importance. The present leaning of the City Company is towards ventilation. Now, to create a *suction* in the ducts will, doubtless, get rid of their contents; but it is also a pressing invitation to stray coal-gas to come in. The American plan of forcing hot dry air through the conduits seems in every way preferable. It would also have the added advantage of obliging the City Company to plug up the short lengths of duct leading into the basements of consumers' houses, and thus prevent the ends of these from becoming on occasions impromptu gas jets, as was the case on Ludgate-hill.

◆

The moral of the story, since no story is complete without one, seems to be that the ancient saw that more haste often means less speed applies to electric light undertakings. Had there been no need to hurry on the switching in of the Watling-street sub-station, and had fuses of reasonable carrying capacity been provided, the City Company would to-day be many pounds in pocket and the daily Press several sensational columns short.

◆

The communication on "Experiments in Cable Signalling," which we publish this week, by Mr. Patrick B. Delany, will attract the attention of all interested in the working of cables. He fully establishes the merits of automatic transmission; this has, however, been already recognised by many cable companies, who have by the adoption of a mechanical system of sending materially increased the speed of working upon their cables. The data given as to the speed of transmission for practical working obtained over the lines of the Anglo-American and the Direct United States Cable Companies are very satisfactory, and Mr. Delany is to be congratulated upon the results. The article would have had more interest to the telegraph operator if a fac-simile of the signals at these high speeds had been given, such as was published by Mr. Arthur Dearlove in his recent article in our columns on the 1894 Anglo-American cable.

◆

The proposal to work through a long cable joined up with a landline does not seem to all telegraph engineers to be in the right direction, either when the landline is at the sending or at the receiving end of the cable. It is to be remembered that signals cannot be transmitted through even a land-line without a certain amount of "distortion," and, therefore, the signals entering the cable start with a less perfect formation than when they are originated at the cable station itself. This view appears to be supported by the fact that at Heart's Content only 178 letters per minute were received from London, whereas 243 letters could be received there when sent from Valentia. Moreover, the annual cost in this country of a long land-line is by no means insignificant, and it would certainly be cheaper for a company owning more than one cable to work a single land-line with a high-speed Wheatstone, rather than to provide a land-line for each cable. The "man at the other end," whom all experimenters and operators well know, appears to interfere even with the results obtainable by automatic transmission. This is particularly noticeable in the figures given over the '80 cable, where the difference between what may be called the "experimental speed," and the "actual" speed was as much as 10 per cent.

◆

Mr. Delany is, no doubt, right in saying that all long cables will be worked by the "automatic" system, but it would be interesting to know why he considers that "the dangerous drawbacks of bad coasts, shore ends, &c.," will be abolished by connecting the end of a cable to a land-line. He seems to have accomplished two things at which submarine telegraph men have long aimed; namely, the use of Morse sounders on a long cable, and the abolition, where such abolition is found to be useful, of the cable station.

◆

A very interesting engineering study is afforded by the various phases in the use of what is known as "scavenging" in the history of the gas engine. The latest phase in the development of this part of the action of a gas engine is the joint invention of Mr. Crossley and Mr. Atkinson, two very able inventors, who have done much to improve this class of motor. An account of the invention is given in our columns this week, in a Paper by Mr. Atkinson on "The Modern Development of the Gas Engine." In the earliest engines, which were built on the principle that if gas will blow up a floor it will blow up a piston, the refinements of a scavenging charge were far from the inventors' minds. Even the celebrated "Otto" cycle, the invention of Beau de Rochas, makes no provision for removing the products of combustion from the large clearance space, or compression chamber, behind the piston. The curious and erroneous "stratification" theory, which was adopted in the earlier years of gas engine practice, gave a certain encouragement to inventors to leave these waste gases in the cylinder; for it was supposed that as the piston advanced they stuck close behind it, like a rubber pad, and acted as a soft cushion for the explosive force. This idea was, in fact, perpetuated in the scavenging arrangement introduced by Mr. Dugald Clerk, who, as far as we know, was the first to attempt to sweep out the waste gases by a charge of air. In Mr. Clerk's engine the in-rush of air and gas at one end of the cylinder was required to sweep out the waste gases at the other end; but the various gases would not "stratify" as theory required, and, as a result, some of the unburnt coal gas went straight out through the exhaust.

In the "Griffin" engine the stratification idea was abandoned, and the residual waste gases were got rid of by the heroic measure of sacrificing two complete strokes to the process. Between the exhaust stroke and the fuel-charging stroke the engine drew in and then rejected a whole cylinderful of air. The time spent in this operation, and the energy wasted in engine friction, made this scavenging method initially and continuously expensive; so that it was not at all generally adopted. For a long time inventors were content to turn out engines working on the ordinary "Otto" cycle, and no attempt was made to prevent the waste gases of one explosion mixing with the explosive charge for the next. Improvements in the valves, the abolition of the end slide, and other modifications, ultimately led to much more economical practice becoming possible; and it was soon seen that the space filled by these waste gases could now be very advantageously filled with explosive mixture. The dilution and the padding were no longer necessary. A return to the scavenging practice was again made, and this time with marked results in the improvement of the economy and output of the engine. The old "Otto" cycle has been retained; but during the exhaust stroke the inertia of the moving mass of gas in a long exhaust pipe is caused to jerk the last trace of the products of combustion out of the cylinder. It thus seems that scavenging has now "come to stay," and it will be interesting to see what will be its next modification. We should especially wish to see the 65ft. exhaust pipe abolished.

◆

In a recent Paper on "The Law of Hysteresis and the Theory of Ferric Inductances," read by Mr. Steinmetz before the American Institute of Electrical Engineers, the author discusses the formula which he has constructed to fit the loss of energy by magnetic hysteresis. The same formula has been found by Riccardo Arno to agree with the loss of energy in a dielectric, and the exponent 1·6 thus acquires new value and becomes something better than a rough approximation for an engineer. Mr. Steinmetz, in the earlier part of his Paper, calls this formula empirical, and remarks that "the explanation of this exponent is still unknown." Were it not for this remark, the latter part of the Paper might be taken to be an explanation, for after a considerable amount of algebra he propounds the following statement:—

> "The equivalent conductance due to magnetic hysteresis is proportional to the coefficient of hysteresis, η, and to the length of the magnetic circuit L, and inversely proportional to the 0·4th power of the E.M.F., E. to the 0·6th power of the frequency, N, and of the cross-section of the magnetic circuit, S, and to the 1·6th power of the number of turns, n."

We have no doubt that these fractional exponents, when plotted, give a curve which runs smoothly through the experimental observations, better than any other one-figure exponent. This may be quite sufficient for the practical man; but the formula still remains empirical, and though useful, is not scientific. Newton observed "nunquam Natura per saltum." This might be taken to imply that so far from objecting to fractional indices, Nature really protests against jumping from stepping-stones of squares to cubes and higher powers, and prefers to wade with dignity and fluxion through the stream. Even where the laborious method of least squares recommends the adoption of a formula of this kind it is not satisfactory. Nature, to change the metaphor, has a good many rational formulæ in her pocket-book, and we must consult these and pick out one which, without whittling, but merely filling in suitable constants, will fit our observations. Having done this, it will be interesting to study the physical meaning of the various terms and constants.

Epping Forest Electric Railway.—Notice is given in the *London Gazette* that the promoters of this enterprise have decided to abandon it.

Exhibitions.—Karlsruhe is to be the scene of an exhibition opening in September next, and devoted to small industries and domestic economy.

Tests for Lightning Conductors.—The Government of India has decided to adopt Mr. E. O. Walker's apparatus for testing lightning conductors.

Electric Traction in Berlin.—The Berlin magistrates have resolved that the conversion of the existing horse-car lines into electric lines is much to be desired.

New Journal.—A new weekly German journal, appropriately edited by Dr. H. Lux, and devoted to the lighting industry, began its career at Berlin this month. The publisher is S. Fischer.

Electricity in Mining.—An Austrian firm is laying down an electric power transmission plant at the gold mines of Messrs. Stantien and Becker at Nagy-almas and at Verespatak, in Hungary.

Technical Education.—The London County Council, at its last meeting, passed the necessary formal resolutions allocating £57,000 for the year 1894 5 for the purposes of technical instruction.

The New Heilmann Electric Locomotives.—The construction of the new Heilmann electric locomotives is being pushed forward, and they may be expected to come into operation by next spring.

Interurban Telephonic Communication in Spain.—Telephonic communication is being established between Bilbao and Vittoria. A line has just been completed and put in operation between Madrid and Barcelona.

Lord Armstrong.—We have received an advance copy of a well-executed portrait of Lord Armstrong, which is to form the supplement to the Christmas number of the *Tyneside*. This number of the magazine will, we understand, be issued early next month.

The Light Railway Conference.—Sir J. Hibbert, M.P., Lord Thring, Lord E. Fitzmaurice, and Mr. H. Hobhouse, M.P., have been chosen to represent the County Councils Association at the conference to be held at the Board of Trade Office on the 6th of next month on the subject of the construction of light railways.

Electric Lighting in London.—In the coming Session of Parliament application will be made by the Charing Cross and Strand Electricity Supply Corporation for an extension of area, and the County of London and Brush Provincial Company will seek power to light the districts of St. Mary Newington, St. Olave, and Battersea.

State Telegraphy Silver Wedding.—A proposal is under consideration to celebrate in some becoming way the Silver Wedding of the State and the Electric Telegraph. That union was effected on February 5, 1870, and the parties will, therefore, have reached the twenty-fifth year of a prosperous and profitable wedded life on February 5th next year.

Professorial Changes.—Dr. Walter Nernst, Professor of Mathematical Physics at Gottingen, is to succeed Prof. Boltzmann at Münich. Dr. Nernst has made a name for himself mainly in connection with thermo-chemistry and electrochemistry researches. Dr. Nernst is only 30 years of age, having been born at Graudenz in 1864.

Worcester.—At the first meeting of the newly-formed Electricity Committee, on the 26th inst., Mr. Davenport reported that the applications for current continued to come in very satisfactorily, over 1,000 lamps having been connected to the mains since the opening of the works six weeks since. The total number connected now exceeds 5,300.

Differential Railway Rates.—We hear that the City and South London Railway Company, which for some time had charged 3d. for a single journey before 10 a.m., and 2d. after that hour, and which subsequently abandoned the differential charges in favour of a uniform 2d. fare, has within the last week raised the morning fare to 3½d. before 10 o'clock, the ordinary fare remaining at 2d.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
Zanzibar-Mombasa	Sept. 4.	Nov. 28.
St. Vincent-San Thiago	Nov. 19.	Nov. 23.
Hongkong-Amoy	Nov. 16.	Nov. 28.
Bilbao-Falmouth	Nov. 15.	—
Amoy-Gutzlaff	Nov. 10.	—
Ceara-Maranham	Nov. 25.	—
Latakia-Cyprus	Nov. 27.	—

Water-Power Utilisation in Spain.—A central station has just been completed and put in operation at Saragossa. The water-power of the Casa Blanca Falls is utilised. A central station is about to be established at Camfredon, a small town near Barcelona, as also one at Orense, in Galicia. Water-power, situated at a distance of about 10 miles, is to be utilised. The public lighting will comprise 160 arc lamps.

A Caselli Commemoration Medal.—At Florence, says *L'Elettricità*, an influential committee has been constituted for the purpose of coining a medal in honour of Giovanni Caselli, of Siena, the inventor of the pantelegraph. This instrument, intended to transmit writing and designs to a distance, was first exhibited at the Italian Exhibition at Florence in 1861. A copy of the medal will be deposited in the National Museum at Florence.

Obituary.—At the meeting of the Institution of Electrical Engineers on Thursday last week, the President announced the death of an old member of the Institution in Col. Armstrong, who, he said, had had a great deal to do with the development of the submarine defences of the country. Col. Armstrong was also the first electrical adviser to the Board of Trade. The President moved that an expression of sorrow at the occurrence be recorded in the Transactions of the Institution.

English and American Lamp Bases.—One of the American glow lamp manufacturing companies has recently issued a little card showing illustrations of the ten different kinds of lamp bases in use in that country. Fortunately we in Great Britain are not troubled with such a variety, and the "B. C." and the "Edison" sockets suit our purposes in ordinary work, the "B. L." is occasionally used where there is vibration, and of course a few small Edison or B. C. caps are wanted for initiation candles.

Association of Technical Institutions.—We have received a copy of the Report of the Council of the Association of Technical Institutions. The Association has held three meetings during the past year. At the present time there are thirty technical colleges and institutions on the books of the Association. One of the efforts of this body has been to draw up an efficient scheme of secondary and evening class education. The annual meeting is to be held at the Draper's Hall, E.C., on January 18th next.

Projector Advertisements.—It is stated that, as a result of negotiations between the St. Martin's Vestry and Her Majesty's Office of Works, the latter has decided to take action to secure the suppression of the nuisance and desecration caused by the advertisements thrown on Nelson's Column and the neighbouring public buildings. As the Office of Works has at present no power to authorise the abatement of the impertinence, it is proposed that a Bill for that special purpose shall be brought into Parliament. It is to be hoped that the Bill will also give power to the private property owners to protect themselves against this nuisance.

The Berlin and Vienna Telephone.—The telephone between Vienna and Berlin (500 miles) was finished last week, and the first experimental conversation which was carried on between the two cities on Friday was said to be successful. It is expected that there will be a very large amount of patronage for the line, especially in the way of communications between the two Bourses—so large that it is anticipated that a second and, perhaps, a third line will very soon be required. During business hours the present line will be exclusively at the disposal of the Bourses in the two cities.

A Historic Dynamo Sold.—The dynamo which furnished current to the first electric lights ever used for tower illumination was recently sold by the Wabash (Ind.) City Council to the Rose Electric Light Company of St. Louis. It was a Brush machine, and was connected with the Court House tower in Wabash in March, 1880. The trial run was witnessed by hundreds of visitors from all over the country. The outfit continued to run until 1886, when the four 2,000-c.p. lights were taken down, and, with the dynamo, stored away in the City Hall. The dynamo and lamps cost $18,000, and were sold for $30.

Guard Wires—It is a pleasure, says the *Street Railway Review* of Chicago, to "note the increasing tendency among city authorities to prohibit the use of the guard wire over trolley wires. Electric railway men have been opposed to them from the start; but city officers, actuated by ignorance and by the telephone companies, thought they knew better, and insisted on them. Time has proved that the electric railway men were right and that there are more accidents with guard wires than without them." Guard wires may not, perhaps, increase the risk of accident; but, judging by the accounts from Barmen and Dortmund, published in our present issue, they do not appear to appreciably decrease the chance of mishap.

Automatic Signals for Level Crossings—The report of Major-General Hutchinson on the accident which occurred on the South-Eastern Railway at Chartham, near Canterbury, on October 9th, when a waggon containing 21 hoppers was run into by a goods train, and seven persons killed, has just been issued. The report states that no blame can be attached to the driver of the train, and if, when nearing the railway Finch, the driver of the waggon, had stopped, even the slightest delay would have been sufficient to let him hear the approaching train and get out of the way. The Inspector recommends the adoption of an electrical appliance attached to the rails, by which a bell would be rung at such crossings on the approach of a train. Whilst inspecting officers can demand this to be done on new lines the Board of Trade has no statutory powers to compel it on existing railways.

Electrical Pumping Plant at Cambois Colliery.—An electrical pumping plant, consisting of a Corliss engine driving a dynamo giving an output of fifty kilowatts, has just been erected at Cambois Colliery, owned by the Cowpen Coal Company. The pumping in the mine at Cambois was originally done by the hauling engine driving the endless wire rope, the rope passing over the pulleys of these pumps underground and driving them, the pumps being 8in. diameter and 18in. stroke. The current for the electrical plant was taken underground, and distributed to seven pumps, each being driven by an electric motor capable of developing 8 H.P., and driving through worm gearing on a crank disc, to which the connecting rod of the existing pumps is coupled. The old plant, it is said, had a coal consumption of 30 tons per week, whilst that of the new plant had only nine tons in the same time, besides requiring less attendance by two men and two boys.

Association of Municipal Corporations and the Telephone.—At a meeting of the Council of the Association of Municipal Corporations held at the Westminster Palace Hotel on Thursday week (Sir Albert Rollit, M.P., in the chair), the following resolution was passed: "That in the opinion of the Council no powers should be given to any telephone company which will enable them to interfere with streets, or with the rights of individuals in property, unless statutory conditions and obligations are at the same time imposed on the company for the protection of the public; particularly with regard to maximum charges, maximum dividends, and obligations to supply. That the subject should be treated as an Imperial, and not as a Local one; and, therefore, it should be urged on Parliament that so much of the draft agreement between the Postmaster-General and the telephone companies as relates to vesting in the companies the wayleave powers of the Postmaster-General under the Telegraph Acts should not be carried out. That this resolution be referred to the special Committee on this subject with authority for them to arrange for a deputation to the Postmaster-General."

Magnetic Blow-out Fuses.—An interesting experiment was recently made at the Kent-avenue Station of the Brooklyn City Railroad Company to test the efficacy of the magnetic blow-out principle in the fuse carriers which form part of the General Electric Company's generator equipment. Previous to the test there had been, on the part of the Railroad Company, no little scepticism as to the value of the magnetic blow-out principle, and the test was made with the view primarily of proving the correctness of the claims of the manufacturing company that the apparatus would cope with almost any demand made upon it. Six water rheostats of large capacity were connected in the circuit in series in order to regulate the load, and the conductors were brought directly from two of the four 1,500-kilowatt multipolar generators. The fuse blew at 4,400 amperes at 550 volts, equivalent to 3,243 H.P. The result of the test was a complete demonstration of the efficacy of the magnetic blow-out on a very powerful and destructive arc. It was clear from the applause of the fuse afterwards that the action of the magnetic blow-out must have been instantaneous, and perhaps the most remarkable feature is the small amount of metal blown.

Photometric Symbols.—In its issue of November 17th the *Electrical World* discusses M. Hospitalier's proposals with regard to photometric symbols, to which we alluded on p. 29 of our issue of November 9th, and says, "We are willing to advocate these symbols and introduce them into our columns, unless in the discussion which we hope will follow sufficiently good reasons are given to change our present opinion. . . . One fortunate feature in his proposals is that these letters do not include either B or H, and it therefore cannot be argued that they may be confused with the now obsolete symbols for these well known magnetic units, for which the last Congress has recommended the French script letters, which recommendation is being generally accepted, except by *some English writers* and journals who still resist the introduction of international uniformity, as they have and do in the case of their wretched system of weights and measures, which we Americans have unfortunately inherited from them. We trust that those of our readers who are interested in these symbols will discuss the matter now, or for ever after hold their peace." "Some English writers" is good.

Submarine Telegraphy to the East.—To celebrate the 25th anniversary of the establishment of submarine telegraphy to the Far East, a dinner was given last Friday at the Holborn Restaurant to the staffs of the Eastern, Eastern Extension, and associated telegraph companies. Mr. J. Denison Pender, the Managing Director, presided, and the company numbered nearly 200. In proposing "Success to the Associated Companies," Mr. George Draper (secretary of the Eastern Telegraph Company) traced the development of submarine telegraphy to its present success under Sir John Pender, the chairman of the companies, whose "best wishes" he brought to the staffs both at home and abroad. The Chairman acknowledged the toast, and afterwards proposed "The Health of the Associated Staffs." He said that the associated companies had stations dotted all over the globe, and the traffic of the whole world passed through their hands. He regarded submarine telegraphy and the railway system as the two greatest enterprises of the nineteenth century, and, while the railways aimed at speed and safety, submarine telegraphy aimed at speed and accuracy. At the outset, those who took up submarine telegraphy were allowed to go on with their work, and, unaided, to fight their own battles; but now that their enterprise was successful, there were those who desired to take away what the existing companies possessed. They must not be content to rest, but must go on in the future as they had done in the past. Mr. Saunders (chief electrician), Capt. Greey and Mr. Beck replied. Mr. F. E. Hesse (secretary of the Eastern Extension Company) afterwards proposed the health of the Chairman, which was cordially received.

MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 65.)

The Flywheel.—The fundamental principles of the flywheel are laid down mathematically in the early part, and the moment of inertia of any given flywheel may be calculated by means of the Table there given. There only remain to calculate the amount of fluctuating energy which the flywheel must receive between the higher and the lower limits of speed, and to settle those limits of speed. Calling ΔE this fluctuating energy, in foot pounds, when the engine is working at its worst condition under which it is required to run steadily, and N_0, N_1, and N_2, the normal, minimum and maximum velocities, reckoned in revolutions per minute, during the period of one revolution, we will proceed to discuss the relation between these quantities. From equation (22) we have,

$$\Delta E = \frac{\pi^2 I}{1800} \left(N_2^2 - N_1^2 \right),$$

and

$$I = \frac{1800 \,.\, \Delta E}{\pi^2 (N_2^2 - N_1^2)}; \quad . \quad . \quad . \quad . \quad . \quad (87)$$

whence, in order that the difference between N_1 and N_2 may be small, I must be large. Let p be the percentage variation of speed, then,

$$p = 100 \left(\frac{N_2 - N_1}{N_0} \right),$$

and

$$\frac{N_2 + N_1}{2} = N_0;$$

therefore,

$$I = \frac{90000 \, \Delta E}{\pi^2 N_0^2 \,.\, p} \quad . \quad . \quad . \quad . \quad . \quad . \quad (88)$$

Engine flywheel rims are usually of cast iron, having a density of 450lb. per cubic foot, and are rectangular in section. If D is the outer and d the inner diameter, and w the width of the rim, in feet, then the mass of the rim is,

$$M = \frac{450 \, w \,.\, \pi \, (D^2 - d^2)}{4 \,.\, g} = 11{\cdot}05 \, w \, (D^2 - d^2)$$

in gravitation units. Neglecting the arms, as is usually done, the moment of inertia of the flywheel is,

$$I = M \,.\, \frac{D^2 + d^2}{8} = 1{\cdot}38 \, (D^4 - d^4) \, w;$$

whence, for cast-iron flywheels,

$$(D^4 - d^4) \, w = 6250 \,.\, \frac{\Delta E}{p \,.\, N_0^2}, \quad . \quad . \quad . \quad . \quad (89)$$

from which the dimensions of the flywheel rim may be conveniently proportioned. The outer diameter must be chosen with a view to convenience of size and lightness. The larger the flywheel the lighter will be the rim for the same steadying power. It must, however, be remembered that a cast-iron rim should never be run at a greater velocity at the extreme edge than 100ft. per second, while 80ft. per second is the usual limit in practice. At higher speeds the stress on the metal is liable to cause fracture of the rim. Where the flywheel is also used as a pulley, the diameter is determined by the velocity at which the belt or ropes will be run. Belts are not usually run at higher velocities than 3,000ft. per minute, and are often run at lower speeds than this, while ropes are most economical if run at 5,000. The tendency of modern practice is to abandon cast-iron wheels, especially those in which the arms and rim are cast together; and to substitute a material and a structure that will stand a much higher peripheral speed. This becomes especially necessary in engines for electric traction power stations, where the crank is called upon to develop several times its normal torque for several revolutions at a time, whenever a heavy load comes on. Hitherto, great fluctuation of speed has resulted; but the tendency to adopt large and heavy flywheels of cast or wrought steel, running at enormously high speeds—it is said that a speed of 660ft. per second has been successfully tried—will probably make this class of engine run much more steadily. Into the question of the strength of flywheels we cannot here enter, and flywheel accumulators for traction stations are discussed later.

The percentage fluctuation of speed which will be permitted must be settled by considerations of the class of work which the engine will have to do. It must in every case be such that the flywheel will be more sensitive than the engine governor. This is necessary in order that the governor may not oscillate with the fluctuation of speed during each revolution of the engine; a behaviour on the part of the governor which would be satisfactory enough if it did not lag behind that fluctuation in giving steam to the engine, but which, in practice, causes unsteadiness, owing to the existence of such a lag. In electric light engines the percentage fluctuation should not exceed 1 per cent., while in many cases it is less than ¼ per cent. Arc lights show distinctly any fluctuation exceeding 2 per cent.; while glow lamps are much more sensitive to variation of speed. This refers to the fluctuation during any one revolution at steady load, and not to the range of speed between full and light load, which is a matter for the governor and not the flywheel. In traction stations a less regular movement of the crank shaft may be permitted, and the fluctuation often exceeds 2 or 3 per cent. in small stations.

When the engine is coupled direct to the spindle of the dynamo, the rotating parts of the machine will act, in some measure, as a flywheel. If these parts are of solid metal, as in the so-called flywheel alternators, there is no injury done by reducing the size of the engine flywheel in proportion to the moment of inertia due to the machine; but if the parts are exposed copper coils they will be liable to severe strains and to become detached if any very great dependence on their inertia is made. Where intermediate gearing is used, the moment of inertia of the machine must *never* be taken into account in designing the flywheel.

In order to determine ΔE, it will be necessary to ascertain the variation of thrust on the piston rod throughout each stroke. This thrust, at any instant, is equal to the effective pressure of the steam on the whole piston *minus* the inertia of the reciprocating parts. Calling F this thrust in pounds, p_e the effective pressure per square inch, A the piston area in square inches, w the weight of the piston, piston rod, cross-head and connecting rod, in pounds, and a the acceleration of the piston in feet per second. Then

$$F = p_e \,.\, A - \frac{w \,.\, a}{g}.$$

The values of a are + during the first half of the stroke and − during the last half. Thus, the reciprocating parts reduce the thrust in the former and increase it in the latter half; causing a more equable distribution of power throughout the stroke.

Taking the motion of the piston as a simple harmonic motion, to which it very closely approximates, we have, by equation (9),

$$a = \left(\frac{\pi N_0}{30} \right)^2 . \, r \cos \phi,$$

where r is the radius in feet, and ϕ is the inclination of the crank. The maximum value of this is

$$a\,(\max) = r \left(\frac{\pi N_0}{30} \right)^2;$$

whence the maximum inertia resistance of the piston and reciprocating parts is

$$f_{\max} = \frac{w \,.\, r}{g} \,.\, \left(\frac{\pi N_0}{30} \right)^2 . \quad . \quad . \quad . \quad . \quad (90)$$

In Fig. 33 the curves f and b represent the front and back indicator diagrams of the steam engine which is to be fitted with a flywheel. The diagrams should be taken at the conditions of maximum fluctuation. The intercepts of the ordinates, &c., give the effective pressures along the stroke at various equally distant points. These are plotted below in curve (c), the base being, as before, the stroke of the piston. From this must be deducted the reaction of the moving parts, as given in the above equations. If the ordinates, &c., represent pressures per square inch, the quantity f_{max} must be divided by the piston area before deducting this reaction. The deduction is made as follows:—The quantity f_{max} per square inch of piston area is set up vertically at the origin or left side of the base line, and vertically downwards at the extreme right end. A straight line joining these points gives the curve of inertia reactions, as shown in Figs. 33 and 34. Taking the algebraic difference between curve (c) and this curve of inertia, we obtain curve (d), the curve of effective thrust on the piston rod. The ordinates of this curve (d) multiplied by the sines of the crank angle to which they respectively correspond would give the ordinates of crank-effort. But the base line of the curve (d) is not one in which equal parts represent equal crank angles, so that it will be necessary not only to multiply the ordinates of (d) by the sines of the angles, but also to set off these new ordinates on a new base of which equal parts shall represent equal motions of the crank. To do this graphically, and without the labour of multiplying by the sines of the several angles, the author has devised the following modification of the usual method:—On the base of the curve (d), Fig. 34, construct a semicircle, and divide its circumference into any number of equal parts. In the figure there are eight parts. From these points draw radii to the centre of the circle, and verticals, such as $P a$, to the curve d, cutting the base at x. Take the points on the circle in succession and proceed as will be illustrated by taking the point P. We draw through the point x, where the vertical intersects the base, a line, $x y$, parallel to the radius $P m$, and drop $a y$ normal to this line from the corresponding point on the curve d. The length of the parallel which this normal marks off, from the point x, gives the value of the crank effort when the crank is at the angle ϕ. It will be seen that the operation has merely consisted in graphically multiplying the ordinate $a x$ of the curve d by the sine of ϕ, giving $x y$ as the required crank effort. The operation is repeated for each of the points on the semicircle, and the successive values plotted on a new base at equal distances apart. The new curve which is thus formed is shown in Fig. 35, the ordinates are the values of the crank effort, and the abscissæ are the amounts of crank angle, reckoned from the position at which the crank is on a dead centre. The curve is, therefore, a curve of work; it represents, if its ordinates are taken on the proper scale, the varying work done on the crank pin during one half revolution. It is unnecessary to determine the value of the scale to which this curve has been drawn, and the operation of doing so would be tedious. We only require to know in what proportion the fluctuation of energy stands to the work done per stroke; and this can be ascertained by means of this curve. Drawing the mean ordinate line, we find a portion of the curve passes above it. The ratio of the area of this portion, above the mean line, to the total area of the curve is equal to the ratio of the fluctuating energy to the work done by the engine in each stroke. If we know the horse-power and speed of the engine, the calculation of this latter is, of course, very simple. The areas may be obtained by a planimeter, or by counting the squares on the squared paper on which the curve should be drawn.

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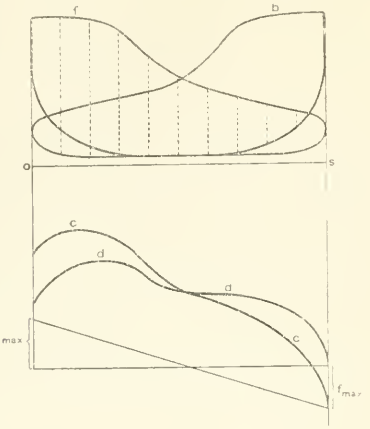

FIG. 33.

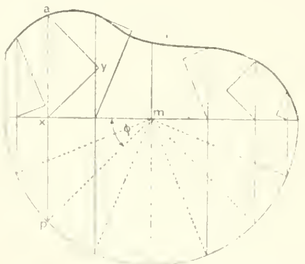

FIG. 34.

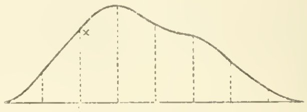

FIG. 35.

(To be continued.)

THE LOCALISATION OF FAULTS IN HIGH TENSION NETWORKS.

BY F. C. RAPHAEL.

A.—DURING WORKING.

(1) *From the Station.*—The subject of localising faults in *low* tension networks during working was very fully discussed in Germany, by Dr. Frölich and Dr. Kallmann, in Papers read before the Elektrotechnischer Verein last year (*Elektrotechnische Zeitschrift*, 1893, pp. 18, 155 and 239). A translation of Dr. Frolich's Paper and an abstract of Dr. Kallmann's were also published in *The Electrician* (Vol. XXX., pp. 412, 440 and 474; Vol. XXXI., pp. 103 and 268).

One method of continuous control, described by Dr. Kallmann, is adaptable to high-tension circuits with practically no alteration. Test-wires are laid from the central station to the armouring of the cables or the metal junction-boxes at various points of the network, and each of these wires is connected in the station through a relay (which closes the local circuit of an indicator and bell) to the "standard earth" of the station. If, on an earth occurring, more than one indicator drops, a voltmeter is used to find out between which test-wire and the "standard earth" the greatest pressure exists. On the Berlin low-tension three-wire network it is found expedient to wind the relays so that they will not act with a less pressure than 1·8 volts. In the case of a high-tension network this minimum pressure should be greater; its best value should be determined for each system by experiment or experience.

Also, when used for a high-tension network, the relays, voltmeter connections, &c., should be insulated as for high pressures, and high pressure fuses should be used to avoid mishaps. The apparatus should, of course, be on a board by itself, and not too near to the main switchboard.

When these wires for testing the earth potential at various points are not laid, there are two other methods which can be used in some cases to determine the position of an earth from tests in the station during working. They must, however, be conducted with great care ; and it is desirable to have the switchboard permanently so arranged that the tests may be made conveniently and with no danger to the operator.

The method to be preferred is that described in Dr. Frölich's Paper as Method 8 C (*The Electrician*, Vol. XXX., p. 475), and to use it there must be at least one feeder and test wire on each side of the fault.

The way to apply this method is to disconnect at the switchboard two adjacent feeders leading to the faulty cable, and also their corresponding test wires, and to connect them as in Fig. 1. P_3 and P_4 are the test wires, H_3 and H_4 the feeders, g a galvanometer, and a b a resistance slide with sliding contact c. The balance position of c is when the same current flows through g, whether the battery switch is open or closed. The resistance of the slide must be great compared with the resistance of the feeders, else their resistance must be allowed for in calculating the position of the fault if the test is intended to be accurate. If the position of balance, or approximate balance, is at the end of the scale (say, *e.g.*, the right-hand end), the next two adjacent feeders (H_4, H_5) in the direction indicated by the contact pointer and the corresponding test wires should be connected up in place of the former ones, and so on until the two feeders bounding the faulty length be found. Then an accurate localisation test may be made without disconnecting the transformers from this section of cable, unless there are a great number very unevenly distributed along the section. On obtaining balance with the correct two feeders the distance of the fault from the left hand feeding point is of course $\frac{a}{a+b}\,l$, where l is the length of the section between the two feeding points.

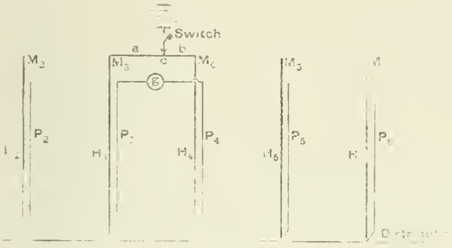

FIG. 1.

If the position of the fault, as indicated by these tests, is at a feeding point—*i.e.*, if, for instance, on testing between H_3 and H_4 the balance position of the slider is at the extreme right-hand side, and on testing between H_4 and H_5 it is at the extreme left-hand side—the fault may be in the feeder (in the above case, the feeder H_4). Then the galvanometer should be put across the slide-wire terminals M_4 and M_5 instead of between P_4 and P_5. On balance being obtained, the equivalent length of the circuit H_4, 45, H_5 must be taken for l in the expression $\frac{a}{a+b}\,l$. That is, if, for instance, H_4 be 400 yards long, H_5 500 yards, and the length of the distributing main 100 yards ; and if the sizes of cable be respectively 19/16, 19/16, and 37/16, l must be taken as 950 yards. If $\frac{a}{a+b}$ is then 0·340, say, the distance of the fault from M_4 would be $0{\cdot}340 \times 950$ yards $= 323$ yards.

The second method is to disconnect from the dynamo all the feeders to the faulty cable except one, to measure the relative potential difference between each feeder and earth, and thus localise the fault by the ordinary fall-of-potential method. This, however, entails more calculation and thinking than the preceding method. It can, however, be used in some cases where the former one cannot, as there may be enough feeders or test-wires for this test, but not for the other. In order to have a sufficiently high potential for this test, it may often be necessary to put a battery between the station end of the feeder left connected to the dynamo, and earth. The voltmeter used, if not electrostatic, must have a high resistance compared with that of the fault.

(2) *By Tests Outside the Station.*—Bridge tests made between two (or three) junction boxes, such as can be made with ease and accuracy on low-tension networks, would be too dangerous to carry out on high-tension circuits during working.

A method that has been from time to time mentioned and tried, is to use a large triangular-shaped coil of many turns, connected to a telephone. With this the operator walks along the street, one side of the triangle being held parallel to the cable, and he listens in the telephone for the fault to alter the character of the hum. When used thus, during the ordinary working, it cannot be relied on to find the fault, and it is often even misleading.

The only useful localising test that can be made outside, in addition to those which can be made from the station, is to measure the relative potential difference between points of the faulty cable and earth. This enables one to localise the fault by the fall of potential method even if the cable is only connected to the station at one point. In making this test it is advantageous to free in the station the ends of all the feeders except one, and all the test wires leading to the faulty cable.

B.—FAULTY CABLES DISCONNECTED FROM MACHINE.

If it is necessary to disconnect the cable, exactly the same localisation test as above—Fig. 1, Frolich's Method 8 C, should be made from the station, and the fault can be localised accurately. This may be checked by a test in the street by Frolich's Method 8 A (*The Electrician*, Vol. XXX, p. 475, or *Elektrotech. Zei.*, 1893, p. 51), but a careful test from the station should by itself be absolutely accurate.

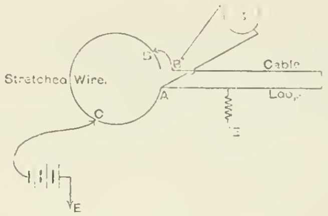

FIG. 2.

In the case where the distribution cables run straight to the station without the feeders and test-wires necessary for Frolich's Method 8 C, it is best to short-circuit them at the far end (if a loop is not already formed otherwise), and to localise the fault by Murray's loop method—using a resistance slide, or stretched wire in preference to a resistance box.

When Murray's or similar methods are used to locate faults, it is of advantage to use a stretched wire (or resistance slide) bridge with the contact point B (Fig. 2) movable as well as the contact point C.

The reading on the scale A B is then made the same as the length of the section under test (or the equivalent length as described above if the loop is made up of several conductors of different sections). Then, when balance is obtained, the index C will point at once to the distance, or equivalent distance, of the fault from the station or feeding point as the case may be. If two or three scales—*e.g.*, 0 to 250, 0 to 500, and 0 to 1,000—be marked on the instrument, the length of the wire or slide between A and B need never be too short.

A circular wire or slide is also usually more convenient than a straight one. The contact resistance $B\,B^1$ should be arranged to come, not in the cable arm, but in the arm B C, where it is easy to make it negligible or to allow for it in marking off the scale.

THE FIRES AT THE BARMEN AND DORTMUND TELEPHONE EXCHANGES.*

On July 16th, about 4 p.m., a fire broke out in the post and telegraph office of Barmen, which destroyed the northern portion of the roof, together with the terminal poles of 700 telephone wires. The fire was put out by 5 p.m., but not before the top floor had been burnt out, 8 out of the 14 lightning conductors demolished, the zinc roof melted, the greater part of the telephone wires torn, and £1,500 worth of damage done.

The fire appears to have originated as follows. On July 16th, between 3 and 4 p.m., operations had been commenced at the telephone connection with the Luftkurhaus near the Töllethurm, during which this line was brought into contact with the working mains and the rails of the electric mountain tramway, the guard wires notwithstanding. The two-track railway crosses the telephone line and the earth conductor of the latter in the Kohlenstrasse, near the terminus of the railway (*see* Fig. 1). At this point two guard wires are placed vertically above the two railway mains. The earth connections of the Luftkurhaus was brought half way down the hill on account of the occasional dryness at the top. In connecting the Luftkurhaus and the pole just across the railway the earth wire had been torn by the trees and was just being taken over to the Töllethurm instead, when it broke at the pole and fell first on to the guard wires and then on to the railway mains and the rails, remaining finally with its free end on the ground. At this time the conductor of a tram coming up the hill, on seeing the wire hanging across the guard wires, stopped the tram, dismounted, and drew the wire out of reach of the railway mains, touching it through his coat for insulation. He then tied it to a tree with the aid of the workman at the pole. Both men state having seen sparks where the telephone and railway connections touched. About the same time the fire broke out at the exchange in Barmen, though how precisely it originated cannot be determined, owing to the destruction of the terminal poles.

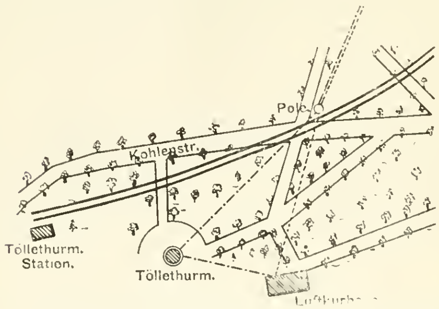

Fig. 1.—―――― Working mains of the electric mountain railway. ▬•▬•▬•▬ Connection with the Luftkurhaus. ············ Lengthened earth connection.

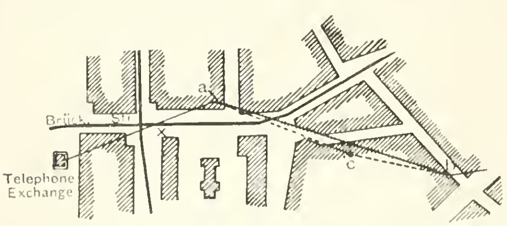

Fig. 2.- ―――― Working main of the electric street railway. ―――― Existing telephone line. ┼┼┼┼┼┼┼┼ Line to be taken down. New telephone line.

A somewhat similar accident happened at Dortmund (Westphalia) on the following day, about 11 a.m.

In order to avoid a new building erected in the line of the municipal telephone wires, new poles had to be erected at *c* (Fig. 2) between the poles *a* and *b*. In hauling over the wires to the new poles one of them broke at *a*. The portion leading towards *b* was held by the workman in charge at *a*, whilst the portion towards the telegraph office fell into the street and on to the electric street railway at *x*, the mains of which were protected at the point by guard bars. A postman just passing states having seen a small flame at the instant of contact, so that connection with the mains must have taken place in spite of the safety arrangement. When, shortly afterwards, a tramcar passed the spot, the contact spring pushed the wire along the guard-bar, a vivid flame arising at the same time. The strong current entered the telephone system through the contact spring, and was transmitted to the telephone exchange. It there first set fire to the woodwork surrounding the lightning conductors, and then to the roof. All the female telephone assistants received strong shocks in their ears from the telephones employed, a circumstance which led the Director at once to the conclusion that a connection must have been made with the street railway. The energetic efforts of the officials and the fire brigade, which arrived in about 10 minutes, succeeded in confining the fire to the roof, and the damage to £500. Four lightning conductors, for 50 wires each, their lead-pipe cables, and their connections with the switches were destroyed, but the apparatus in the exchange rooms was uninjured.

NOTES ON ELECTRIC TRAMWAYS IN THE UNITED STATES AND CANADA.*

(*Concluded from page 110.*)

BY H. D. WILKINSON.

With regard to electric traction in the centre and outskirts of our own metropolis, while impossible in our already too crowded main thoroughfares, I am still of opinion that lines could be laid advantageously in our wider and less frequented thoroughfares, which would relieve the congestion of the narrower streets, and at the same time afford wide and attractive views, which would draw people by such a route by preference.

For instance, let us say that one of our Westminster lights has been seeing a client in the City and is returning to Westminster—or perhaps it would be more dignified to say that a City client has an appointment with a Westminster luminary. He is, of course, pressed for time, and sooner than go by 'bus up crowded Fleet-street and the Strand, with an exasperating wait or change at Charing Cross, he will take a ticket at the Mansion House or Blackfriars and get himself put down at Westminster Bridge by the District Railway. But if someone informed him that electric cars ran every two minutes from Blackfriars to Westminster Bridge *via* the Victoria Embankment, and would land him there in ten minutes, I am very much mistaken if he would not take that route. At any rate, if nothing short of a cab would suit our City man on such a visit, I suspect that the route named would be much sought after and appreciated by the ordinary travelling public; and this noble thoroughfare would be made a scene of life and energy, and be an attraction to many who cannot spare the time to walk along it. I respectfully commend this to the notice of the London County Council as a scheme that might well be combined with that of the river frontage electric lighting, and be a work of great public utility.

I only mention this in passing as an instance; but we have only to look around our outlying districts and see plenty of paying routes to our breathing spaces, open commons, parks, &c., where neither horses nor the railroad are practicable, where the ascents with heavy loads cannot be tackled by horse-flesh, and railroads would mean cuttings and tunnels on the level; but the electric car can easily climb hills and take heavy loads of people to where they can get Nature's best tonics—long stretches of view and pure air. The termini of such lines could be situated with the greatest advantage at or near the suburban railway stations.

The points I have hitherto brought forward have been almost entirely confined to experience in the States, where, in fact, most experience has been gained; but in so far, at least, as administrative, industrial, and public opinion in this country may be influenced by what has been done on the New Continent, there is much to be said on the progress made by our compatriots in the Dominion of Canada. As in the States, the life is vigorous and expansive, but none the less in true accord with British instincts. The cities of Montreal and Toronto are well provided with electric tramways, and the citizens avail themselves of this means of transport in living out some distance in the suburbs. The streets of the City of Toronto are as well laid out and kept as those in our own metropolis, the roadways being asphalted, and the footways well flagged. The overhead trolley is everywhere in use, and æsthetically does not intrude upon the general appearance of the city. In Montreal I went over the new power station of the Montreal Street Railway Company, then being fitted up with engines and boilers of 3,600 H.P. The engines and dynamos were of Canadian manufacture, and the boilers were from England. This station was designed to meet the needs of the entire tramway

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*Abstract of official report. Translated from the *Elektrotechnische Zeitschrift.*

* Supplementary Paper read before the Institution of Electrical Engineers, November 8th. [We regret that the clearness of this Paper should suffer from the lack of the diagrams illustrating it, but we have been quite unable to obtain copies for reproduction.—Ed. *E.*]

system of the city after converting all the remaining horse cars into electric. The change meant an electric supply to something like 150 motor cars, with nearly as many trailers. The rails in these two cities are of the grooved girder type, imported from Great Britain, 72lb. to the yard, and laid, as in this country, directly on the concrete foundation of the roadway with tie rods, but not sleepers.

While scarcely coming under the head of ordinary road tramways, the electric line from Queenstown to Chippewa, Ontario, is of special interest. The line follows the western side of the Niagara Strait near enough to the edge of the cliff to obtain magnificent views of the Falls and rapids, and was built by the Niagara Falls Park and River Railway Company on Government ground, rented at £2,000 per annum, with the object of developing tourist and excursion traffic. It was only opened in May, 1893, and in that summer 10,000 to 15,000 people travelled on the line per day, at fares ranging from 2½d. to 3s. The latter is the return fare covering 23 miles. The takings during July and August were £500 per day. Land in the vicinity fetched £40 an acre when the line was first constructed. After six months' working it fetched £100 per acre, and no doubt will continue to rise, as the Company intend laying out a few good hotels, and the facility of locomotion promises the starting of good residential property on the heights, which have hitherto been unapproachable except at rates particularly gratifying to cabmen. The line is of the most substantial character, laid as a steam railroad, with 56lb. rails, on sleepers, and ballasted. There were last year 24 motor cars, 10 of which were "observation cars," and 18 trailers. The observation cars weigh 20 tons loaded, and carry over 100 people easily. They are specially constructed with two rows of seats, fitted lengthways in the car, one above the other, and facing one way, so that everyone can get the view. The usual thing is to run one motor car and one trailer with over 150 people aboard.

It was anticipated that there would be a fair amount of traffic in winter as soon as the ice bridge was formed below the Falls, as this is a great attraction. There was a foot of snow on the ground when I went over the line; but the travelling was most agreeable, as the cars were kept up to a comfortable temperature by electric heaters under the seats, supplied with current tapped off the circuit. Six of these heaters in a car, three on each side in multiple series, consumed 2 amperes at 500 volts, and would, therefore, cost less than 3d. an hour. The cars were well lighted by glow lamps, and the route was lighted by clusters of these lamps placed at the top of every alternate pole.

I am much indebted to Mr. W. T. Jennings, C.E., of Toronto, who designed the line and power plant, for his courtesy in showing me over the line and affording me information for this Paper. The power is derived mainly from the Falls, a head of 57ft. clear fall being utilised, which now supplies three wheels of 1,000 H.P. each, one being in reserve. To meet the heavy loads when climbing the Queenstown heights, up a grade of 1 in 20, it was found more economical to put a small additional power house down at that terminus, with dynamos driven by steam power, than run two 37/15 or one 37/12 insulated feeders from the water-power station, a distance of nine miles, which would have cost at least £2,600.

This fact is significant of economies to be effected in transmission, and seems, as far as long lines and heavy traffic are concerned, to point to a practical conclusion as regards the maximum power per station in street tramway power plant similar to that enunciated by Mr. Crompton with reference to electric lighting stations; namely, that there is a limit to the amount of power it is economical to supply from one point only. The cost of insulated feeders comes in as a considerable item in first cost on lengths above five miles, and the loss of voltage and energy in transmission of the current is a continuous one. I think it worth while to consider high-tension transmisson by underground feeders and the use of motor-transformers, or the direct use on ordinary lines of what the Americans call "boosters," or motor-generators; or, again, the three-wire system, or the establishment of power stations situated, not as they are now, namely, in the centre, from which lines radiate outwards, but at the most distant points, and feeding towards a centre. The stations are situated in this manner in the city of Cleveland, Ohio, and, through the courtesy of Mr. Wason, I am pleased to be able to you show a day load-curve. The largest curve, which reaches 3,400 amperes at seven o'clock in the morning, is from the original station, and you will see the curves below of two new stations feeding into the same network, and which together add another 2,400 amperes at the same hour. The curve was that for the day previous to my visit, when the ground was covered with frozen snow and the temperature was 9 degrees of frost. Of the total current, about 600 amperes is used to drive motors in shops and factories.

I have specially made mention of the Canadian line at the Falls on account of four points which are deserving of notice and reflection. The first I have already touched upon, namely, the cultivation of tourist and excursion traffic along a route where attractive views and fresh air can be obtained. The second point is that the termini are in close proximity to two main lines of railway—namely, the Michigan Central and the Grand Trunk—which not only increases the tourist traffic, but creates a traffic of its own independent of scenery but with the scenery thrown in. The third point is that the line passes near an agricultural and fruit-growing district, and special freight cars have been added for conveyance of these crops to the railways at rates lower than could formerly be obtained, and at the same time profitable to the tramway company. And, fourthly, the line forms part of a through connection between the two large cities of Toronto, on the North, and Buffalo, on the South, by steamboat connection at the termini of the line.

The line has already been described to you by Mr. W. H. Preece, C.B., in his Paper at the beginning of last session, in a more fascinating way than I can hope to bring it before you. When Mr. Preece first enlivened us by his presence at the Chicago Exposition, everyone who was bound to admit to him that he had not seen that line at the Falls felt somehow at once to have lost half his stature. Mr. Preece, like all Englishmen, when he takes his seat in a tram-car or railway carriage, likes to go ahead, and I do not think anyone could have put a more worrying inquiry to Mr. Preece than to ask him if he was going back to his hotel in Twenty-second Street by the elevated or so-called rapid transit, line. I suppose our suburban railways in the metropolis, which I hold are second to none in the world for speed and safety, somewhat spoil an Englishman for any more tardy lines.

While it is evident that the combination of fortuitous conditions in the Canadian Falls line is very exceptional, yet I am of opinion that, by keeping these and other favourable conditions in view, there are many districts in our own country where electric tram lines could be put down at once with advantage.

I have drawn attention in my Paper to some points in power station plant, more particularly with reference to fly-wheel strains under the exceptionally sudden changes of load in street tramway work, which are sometimes the cause of serious mishaps. The ordinary fluctuations in load are caused by the starting or stopping by chance of a number of cars at the same instant, the variations being at times from over full load to quarter load; and the more excessive fluctuations are due to short circuits, or the sudden release of load by automatic circuit breakers. In one large station of 4,800 H.P. I was informed that the average was 20 short circuits per day. Most of these were temporary, and caused either by high winds shifting some of the overhead gear or falling telegraph or telephone wires, but in exceptional cases caused by the trolley wire itself breaking and falling on to the rails or ground. An overload or short circuit, when driving by belt, puts a sudden brake on the periphery of the fly-wheel and a shearing strain on the spokes.

The belt, of course, slips, but at times it parts or is thrown off, and in the course of its career sometimes damages the governor and leaves the engine uncontrolled, under which circumstances it is rare if there is time to shut down before something goes; and, as they tersely put it on the other side, it is best to get behind a pillar and await developments. The bending strains set up in the rim by centrifugal force in a racing engine appear to have been the cause of more fractures of the wheel than than the shearing strains. The reason for wheels with one to two thousand foot-tons of stored energy is, presumably, to secure regulation of speed in engines having a small number of steam admissions per unit of time; but I think it will be admitted that the governor has more chance of producing an immediate effect upon the speed when there are a large number of admissions per unit of time, and there is the additional advantage in the use of much smaller and solid fly-wheels of approximately one-tenth the stored energy, and thereforewell able to "stand the racket" with safety.

Regarding the use of belts, I think engineers in the States are coming to see that it is worth while to put a little more material in the generators and do without these weak links in the chain of transmission. At any rate, I noticed many of the newer plants were direct-driven, with marine-type engines.

I admit that there is something very stately and imposing in a long row of trip-gear engines with large flywheels and belts. I enter very keenly into the enjoyment of such a sight, and am also much impressed by the number of yards super. in stone and brick outside the building, and feet super. of floor inside; but when we have to consider capital cost of works, and adaptability of plant to get down in good shape to its work under trying conditions with safety, we may wisely let such considerations take a secondary place.

Our corporations would do well to study the needs of the people in and around their townships; and I am confident that the good sense and judgment they, as business men, always display in schemes for the benefit of their townspeople, would lead them to select paying routes for light railways not paralleling the ordinary railways, and which would not only meet the needs of the daily transference of the population, but take in and out light market freights, and, by affording healthy travel, tend to foster the energies of their townspeople. The success of the Isle of Man Electric Tramway is an indication that such needs of the population do exist, and when catered for and fostered, result in benefit to themselves, the promoters, and, indirectly, to the country at large. As I have before pointed out, such lines create traffic of themselves, and raise the value of land and property in the vicinity. I venture to predict that if facilities for reasonably quick and cheap travel between the suburban districts of our large towns and outlying villages were afforded the masses, they would gladly avail themselves of them. Such facilities would afford them enjoyment of open space, pure air, and opportunities of observing life in different grooves to their own, on the one hand, and cheap carriage for market produce on the other, which could only have a beneficial effect, and would most probably bring about an alleviation of agricultural discontent, and a mitigation of the crises resulting from the labour problems of the day. Speeds can be accelerated somewhat in the open country.

The recent proposal made by the Board of Trade to the Chambers of Commerce and other bodies interested, to discuss the question of light railways, is an action of much importance to the country at large, apart from the consideration of systems of travel, and one that I am sure is fully appreciated by this Institution. The questions of land, permanent way, signals, staff, level crossings, and fencing in where it is not practicable for such lines to take the high road, are to be brought forward. The Board of Trade has ever shown the most ready spirit to favour electrical enterprises in the best interests of the public, with due regard to the protection of property, as exemplified in electric lighting orders and in the drawing up of the present practical code of regulations for electric railways; and I have no doubt that the question of operating light railways in suburban, inter-urban, and country districts by electricity will be thoroughly brought forward by the engineering and electrical trades section of the London Chamber of Commerce, in response to the esteemed invitation issued by Sir Courtenay Boyle.

We can count on our fingers the number of electrically worked roads in the United Kingdom, and they can only claim a short mileage; but I beg to assure our American cousins that this is not because we are afraid of running into the sea. There are more people to the square mile in our large towns and cities than in more roomy America, and our streets are not mapped out on squared paper before a town is built. Hence the special character that must necessarily pervade our designs in electric roads.

After all, mileage is not the only gauge of advancement. What will do for one American city, generally speaking, does for a second, a third, and a thousand. It is refreshing to notice the individual character in institutions, public works, and speech, that obtains in the different townships of our country, in contrast to the sameness of cities in the States. At the same time this means more investigation into the needs of the people and design of road, calling for greater achievements, although not on so large a scale. Taking the cities of Liverpool and London, for instance, we have our elevated electric road, our subterranean electric road, and a second now building, which are engineering works of the highest order, and exceedingly well adapted to the necessities of our traffic. I call these achievements to be proud of.

In conclusion, I may be permitted to say that, while judging such information as I could bring to bear upon the question as it affects us in this country to be of interest to our engineers, as it certainly has been given me with infinite open-handedness and cordiality by my American friends, I do not cease to recognise the great labours and genius of our great engineers and electricians who have frequently addressed you in this room, and from the Presidential chair in both this Institution and the Institution of Civil Engineers, and whose indomitable perseverance and energy have led the van in laying the earliest electric rails in the United Kingdom.

ELECTRICAL STEEP-GRADE TRACTION IN EUROPE.[*]

BY C. S. DU RICHE PRELLER

INTRODUCTION.

The rapid growth of electrical traction in Europe, wherever local conditions and reasonable official regulations are conducive to its adoption, is evidenced by the fact that within the last few years it has also been extensively applied, and is in course of further application, on steep-grade, or mountain railways properly speaking that is, on lines which have not only occasional steep-grade sections, such as occur, for instance, on many electrical tramways, but continuous gradients varying from 5 to 25 and upwards of 60 per cent. (1 in 20, 1 in 4, and 1 in 1·6 respectively), and which connect either the base and summit of a given declivity, or different districts separated by a mountain range.

It will, therefore, not be inopportune if I place before the Institution a short synopsis of what has been already done in Europe in that branch of electrical engineering, together with certain conclusions and proposals founded on my own experience.

Leaving aside for the present, as being more suitable for separate treatment, the question of heavy—viz., 50 to 100 ton—electrical locomotives for trunk railways, the working of steep grades by electricity may be considered under two heads—

1. By cable traction; and,
2. By motor cars or locomotives with fixed conductors.

CABLE TRACTION.

Up to a recent period, steep-grade cable railways in various parts of the globe, but notably in Switzerland and in the Alps generally, where they alone exceed 20 in number, have been constructed for being worked either by component of gravity with water ballast, in conjunction, on some lines, with a second or compensation cable, or in some cases by fixed hydraulic, gas, or steam motors.

The principal disadvantage common to all lines worked by component of gravity consists in the excessive additional dead load due to the water ballast, which entails not only a great deal of additional brake power *per se*, but a variety of complicated safety brakes, involving very careful manipulation; while the three systems of fixed motors are either uneconomical, or unwieldly and obsolete.

The superior advantages of cable traction by electrical motors, as compared with all the other systems referred to, have been attested by three lines in Switzerland, all of which have been constructed within the last four or five years—to wit, the Burgenstock, on the Lake of Lucerne; the Monte Salvatore, on the Lake of Lugano; and the Stanserhorn, near the Lake of Lucerne, which last named was opened for traffic only last year. It is not the purpose of this Paper to give a detailed description of these lines; suffice it to point out their salient, and more especially their electrical, features.

(*a.*) *Burgenstock.*—The summit level of this line is 2,884ft. above the sea, the total rise being 1,443ft. in a little over 1,000 yards, the minimum grade 32, and the maximum 58 per cent. Electric motive power for working the cable and cars is obtained by high-tension (1,600-volt) transmission from a hydro-electric power station 2·5 miles distant, the output of the two series-coupled direct-current Thury dynamos, given by a high-pressure turbine, being 40 kilowatts, or 60 H.P. Two corresponding series-coupled motors at the summit of the cable railway drive the cable-winding drum through belt, countershaft, and bevel gearing; the total reduction being 700 to 5 revolutions, or 140 to 1, corresponding to the regulation car speed of about three miles per hour. The car speed is regulated from the motor station, and not by the driver, except in case of emergency.

(*b.*) *Monte Salvatore.*—This line has a summit level of 2,900ft., the rise being 2,000ft. in a length of 1·2 mile, the initial grade at the base 17, and the maximum at the summit 60 per cent. The motor station is situated midway up the incline, and the power is derived by a 2,000-volt transmission from a large hydro-electric 1,500-H.P. power station five miles distant; the output of the Oerlikon (Brown) direct-current generator, driven by a high-pressure turbine, being 60 kilowatts. The corresponding motor on the line drives the cars and cable in precisely the same way as on the preceding line, except that the Salvatore incline is worked in two sections.

(*c.*) *Stanserhorn.*—This line ascends an altitude of no less than 6,200ft. above sea level, and has a total rise of 4,570ft. in a length of 2·5 miles, worked in three sections, having maximum gradients of 30, 60, and 62 per cent. respectively. The requisite power per car is 40 H.P., and a motor station is placed at the summit of each section. The three Thury motors actuate the winding drums as before described, and are fed from the same power station as the Burgenstock line, but by a separate high-tension (2,000-volt) transmission 2·5 miles in length. The total efficiency on this, as on the other lines, is about 60 per cent.

(*d.*) *Conclusions.*—The three lines, of which I have given a necessarily very incomplete *résumé*, mark a conspicuous advance in cable traction. As compared with haulage by the other systems referred to, they show a saving in car weight of no less than 50 per cent., the full car load, with 36 passengers, being in the former case 12 to 15 tons, and on the electrically-worked lines only 6 to 7 tons. Again, the average cost of construction of the Swiss cable railways worked on the older systems is no less than £41,000 per mile, whilst that of the electrical lines is only £24,000 per mile, or 40 per cent. less. Similarly, the working expenses on the older lines vary, with one or two exceptions, between 60 and 80 per cent., whereas the electrical lines are worked at 45 per cent. of the receipts. These three lines also show a remarkable development due to electrical traction *per se*, inasmuch as, apart from the unprecedented grades, up to 62 per cent., or 1 in 1·6, the length of the incline has been gradually increased from 1,000 to 2,200 and 4,500 yards, which, having regard to the mechanical work performed on the grades, is equivalent to 14, 20, and 44 miles respectively on the straight and level. And, lastly, the superior safety and smoothness of electrical working, attested by the Burgenstock and Salvatore lines, has made it possible to dispense on the Stanserhorn incline with the rack used as a safety factor on its two predecessors; so than on Stanserhorn electrical traction has achieved the feat of scaling Alpine altitudes which, it was hitherto believed, could only be reached by rack railways worked with special steam locomotives, such as those used on the neighbouring mountain Pilatus, at more than double the cost per train mile.

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[*] Paper read on November 22nd before the Institution of Electrical Engineers.

TRACTION BY MOTOR CARS OR LOCOMOTIVES WITH FIXED CONDUCTORS.

The first steep-grade railway worked by electrical traction with fixed conductors in Europe was the Florence and Fiesole line, opened in 1891. It was in succession followed by the Murren mountain railway, in Switzerland, opposite the Jungfrau; by the Mont Salève line, in Savoy (near Geneva); by the Genoa, and then by the Zurich steep-grade road railways; and quite recently by a similar line at Barmen, in Rhenish Prussia.

Of these lines, those of Florence, Murren, Genoa, and Zurich have continuous grades of 8, 5, 7, and 6 per cent. respectively, and are worked as simple adhesion lines, with overhead contact wires, and return circuit by the electrically bonded rails; while the Salève and Barmen lines, having continuous inclines of 25 and 18 per cent., or 1 in 4 and 1 in 6 respectively, are worked with the aid of a rack, and the former has an outside conductor rail in the shape of an inverted ordinary flange rail, while the latter has overhead contact. The Murren line is the only one worked with electrical locomotives; all the others are worked by single motor cars.

(*a.*) At *Florence*, the power station, situated at the foot of the incline, comprises three Tosi boilers, three Oerlikon vertical compound 90-H.P. engines, and three belt-driven Edison bipolar dynamos with a total effective power of 245 H.P., equal to 93 per cent. efficiency. The 12 motor cars are each fitted with two 20-H.P. spring-suspended and series-coupled Sprague-Edison motors, the original ones having double-reduction, the more recent ones single-reduction spur gearing. The contact is by trolley wheel and pole, and the total efficiency of the system is 66 per cent.

(*b.*) On the *Murren* railway, whose altitude is 5,300ft. above sea level, power is generated by a high-pressure turbine, which drives a direct-coupled Oerlikon (Brown) bipolar dynamo of 120 H.P. The power station is situated about midway of the line, the power being derived from the torrent of the celebrated Staubbach Fall. The four locomotives weigh 7·5 tons each, and carry two 30-H.P. single-reduction spur-geared motors; the tractive force of each locomotive being about one-third of its weight, and the total efficiency of the system 68 per cent.

(*c.*) The power station of the *Mont Salève* line (summit level, 3,700ft. above the sea) is situated about a mile from the line, and comprises two low-pressure turbines and two separately-excited Thury multipolar dynamos mounted on the vertical turbine shafts, and giving, at the low turbine speed, 500 H.P., or only a quarter of their combined normal output of 2,000 H.P. The 12 motor cars are each fitted with two 30-H.P. four-pole Thury motors, with double spur gear reduction, and current is taken from the outside conductor rail by metallic slide-contact shoes. Owing chiefly to the unnecessarily heavy gearing, the total efficiency is only about 52 per cent.

(*d.*) At *Genoa*, the power station is about 1·3 mile distant from the line, and contains at present two boilers, two compound condensing Tosi 160 14-H.P. engines, and two belt-driven 110-kilowatt Siemens inner-pole dynamos. The present line, which is the nucleus of a projected suburban system, is worked by six cars, each fitted with two 16-H.P. Siemens motors; the reduction being 10 to 1, by chain and toothed wheel. Current is taken from the overhead wire by two Siemens and Halske's rectangular metallic contact frames.

(*e.*) The *Zurich* power station is placed at the upper end of the line, and comprises two boilers, two 100-H.P. Oerlikon vertical engines and dynamos, together with an accumulator battery of 300 Tudor cells for compensating the variations of load of the steam engine. The 12 motor cars are each fitted with two 12-H.P. Oerlikon motors. The total efficiency of the line is 65 per cent.

(*f.*) At *Barmen*, the power station is situated at the foot of the incline, and contains two 225-H.P. compound condensing engines driving direct two Siemens inner-pole ring dynamos, whose output is 155 kilowatts each. The line is worked by 10 motor cars, each provided with two 36-H.P. Siemens motors, which, by single spur gearing, actuate the rack pinions mounted direct on the car axles. The total efficiency is, like that of the other lines, from 60 to 65 per cent.

(*g.*) *Conclusions.* It is seen that the primary generating power is steam on the Florence, Genoa, Zurich, and Barmen, and hydraulic on the Murren and Mont Salève lines; the dynamos being direct-driven in four, and indirect in the other two cases. Notwithstanding the high cost of fuel in Italy and Switzerland (as much as 30s. per ton), and the steep grades on the Florence, Genoa, and Zurich lines, the running expenses do not exceed 4·5d. per car mile; while the total working expenses, including administration and renewals, are within 7·5d. per car mile, or about 50 per cent. of the receipts. On the Murren and Saleve lines, the cost of hydraulic power per annum is, of course, restricted only to wages and repairs. In the former case, the working expenses do not exceed 40 per cent. of the receipts; while in the latter they are as much as 80 per cent., this high rate being due chiefly to inadequate fares. A specially noteworthy feature is the steady speed of eight to 10 miles per hour with which motor cars run up the steep adhesion inclines of 6, 7, and 8 per cent. at Zurich, Genoa, and Florence; while on the descent a speed of even 15 miles per hour has proved perfectly safe, in conjunction with the powerful and instantaneous action of the electric safety brake constituted by the motors acting as dynamos on the descent, although, for all ordinary purposes, even the mechanical brake alone suffices to stop the car within its own length.

As regards the comparative working cost of steep-grade adhesion or rack railways by steam and by electricity, I can affirm from my own experience, as well as from every other case which I have had occasion to investigate, that, irrespective of the immensely greater elasticity of the service, and, consequently, the far more rapid development of the traffic, electrical working ensures an economy of at least 50 per cent. as compared with steam.

GENERAL CONCLUSIONS.

With regard to electrical traction on flat, as well as steep-grade, lines generally, I am led to the following conclusions:—

Direct and Indirect Driving of Generators.—Although direct driving, whether by steam engines or by turbines, is the ideal standard, and therefore always preferable, it cannot, for tractive purposes, be laid down as a dictum *à priori.* On lines having steep, and more especially alternately rising and falling grades coinciding with sharp curves, an intermittent traffic, and frequent stoppages, the variations of load are so great and so rapid—often from zero to maximum in the space of one minute—that vertical high-speed engines suitable for direct driving generally work very uneconomically. This is, *e.g.*, the case at Florence, and in an even greater degree at Marseilles, where the high-speed direct-driving engines had actually to be replaced by horizontal low-speed Corliss engines, with belt driving. In the case of hydraulic power, high-pressure turbines always admit of economical direct driving, whereas low-pressure turbines involve for direct driving proportionately larger dynamos, giving only part of their normal output, so that here, too, indirect driving by gearing or belt is generally more economical. The same applies where gas engines are used.

Steam, Hydraulic, and Gas Generating Power.—The first cost of an hydro-electric installation often exceeds that of steam plant, more especially in the case of a variable volume and small head of water, involving the use of low-pressure turbines. High-pressure turbine installations are always preferable and more economical. Where cheap hydraulic power is not available within a distance of about four miles from the line, and fuel is dear, gas manufactured on the spot is much more economical than steam power.

Conductivity of Rails.—Where the rails serve as return circuit, the ordinary fish-plates should have the same sectional area as the rails, so that, together with stout fastenings, they make a joint as stiff as the rail itself. In this way, and especially when laid on metallic sleepers, the permanent way gives 80 per cent. of the required conductivity at the joints; so that only 20 per cent. has to be made up by copper bonding, *plus* an adequate margin of, say, 10 per cent. Solidity, compactness, and careful maintenance of permanent way, as is usually found on electrical lines, as well as on railways generally in Europe, go far to make up for the elaborate copper bonding which the often defective condition of permanent way necessitates on American lines. It is for the same reason that electrolytic action on gas and water pipes, which is so common a phenomenon in the States, is practically unknown in Europe.

Conductor Rail.—Where a conductor rail is used, it should preferably be placed outside, instead of inside the ordinary rails, because the outside conductor obviates all complications, and the contingency of short circuit at points and crossings. On specially steep grades, involving the use of a central rack, the rack rail or bar itself, having continuous contact with the pinion wheels, constitutes an excellent conductor, provided it be effectually insulated from the sleepers by porcelain bells serving as supports.

Overhead Trolley Wheel and Slide Contact.—Contact by a trolley wheel whose spindle is rigidly held by the trolley pole is suitable for lines on which straight sections and flat curves predominate; but for lines with numerous and sharp curves, the rectangular single or double slide-contact frame, as used by Messrs. Siemens and Halske on their overhead lines, is far preferable. It is lighter and more pleasing in appearance than either the rigid trolley, the flexible South Staffordshire trolley, or the slide-contact bars used on the Isle of Man line. It obviates, moreover, many of the objectionable cross and diagonal wires, and hence the infinite variety and complexity of fastenings which the use of the rigid trolley wheel involves, and many of which, however neat as mechanical contrivances *per se*, are not exactly ornamental objects when suspended at an height of only 20ft. above the roadway. The only defect to which the Siemens slide contact is subject consists in the upper, slightly arched, and, of course, renewable contact side of the frame being liable to become grooved, whereby the easy play to right and left of the contact wire is impaired; but this defect can be easily remedied by employing material of adequate resistance. Another and very simple form of slide contact is that used on an electric road railway from the Lake of Lucerne to the foot of Stanserhorn, and consisting in a crescent-shaped grooved contact piece of bronze, which is loosely hinged to the trolley pole, and thus, in conjunction with the lateral play of the pole, adjusts itself to the sinuosities of the line.

Underground Contact and Accumulator Cars.—It is generally recognised that the overhead trolley system, which in reality is only a makeshift, is unsuited for the central parts of the large towns, and *a fortiori* of the metropolis of this country; and the same applies equally to the other largest capitals of Europe—to wit, Paris, Berlin, and Vienna. In these cases the conduit system or accumulator cars are therefore at present the only practicable solution of the problem. In Europe the conduit system, whether it be that of Buda-Pesth, or with a central slot, may be estimated to cost complete £10,000 per mile and upwards, according to local conditions, though this is not too costly, having regard to the enormous traffic in large towns; but its efficient working presupposes, among other things, very perfect drainage of the trench. As regards accumulator cars, they would really constitute an ideal form of electrical tramway traction, if the present car-weight of 12 to 15 tons, and the power and traction expenses of 8d. to 10d. per car mile, could be reduced to half. As a case in point may be quoted the unwieldy accumulator cars which run on the Madeleine and St. Denis Tramway in Paris, and give fairly satisfactory results; but which, owing to their heavy weight, are not infrequently deficient in torque on the long 1 in 20 grades, when the motors become saturated. The overhead system, on the other hand, is very well adapted for suburban tramways, and eminently so for light railways and road railways in the country. The cost of such road railways, if constructed on the metre or 3ft. 3in. gauge, can well be kept within £6,000 per mile, including electrical equipment; and the already quoted road railway from the Lake of Lucerne to the foot of Stanserhorn, which only cost £4,500 per mile, as well as another similar line near Bâle, have demonstrated what a cheap and convenient motor car service can do in essentially agricultural districts.

Gearless and Geared Motors.—Gearless motors are eminently suitable for high speeds, while for low speeds they require to be of inconveniently large size. For geared motors single reduction is, of course, always preferable, although on exceptionally steep grades, where the motors have to develop their maximum power at minimum car speed, double reduction may in some cases be unavoidable. In any case, spur gearing is always preferable to worm gearing or chain motion, both of which involve too much friction and consequent loss of power.

Parallel and Series Coupling of Motors.—This much-debated question cannot be decided *à priori*, but depends on individual cases. For level or easy-grade lines, parallel coupling is more suitable; whereas on steep grades, where starting requires always the maximum torque, series coupling is generally called for.

Variations of Load.—On lines with steep or rising and falling grades, these variations cannot be mitigated, much less equalised, simply by increasing the number of cars or trains on the line, since the variations are caused not only by the varying traffic, but by the varying grades and curves, and by the varying degrees of adhesion, more especially in starting. Where separately-excited dynamos are used, a partial means of compensating the variations of load is, as is well known, that of varying the excitation by the main current passing through the exciter. But the most effectual remedy is the addition of an accumulator battery, which absorbs any excess of supply from the generator over demand on the line, and, *vice versâ*, makes up for any deficiency of supply, so that the steam engine and generator can always run at full and constant load. Accumulator batteries have fully vindicated their claim as an important auxiliary and as a means of economical working of traction installations at Zurich, and subsequently in the Isle of Man, and well repay the additional first cost of plant.

Continuous and Alternate Current.—Hitherto continuous current has been exclusively used for electrical traction. But, having regard to the high degree of efficiency and perfection and the ease of starting recently attained in alternate-current motors, thanks notably to the persevering efforts of such constructors as Messrs. Brown, Boveri and Co., it may be confidently predicted that, as in lighting installations and in power transmissions for industrial purposes, so also in electrical traction alternate is destined to supplant continuous current. Alternate current, whether single or multiphase, will not only admit of electrical traction being applied over much longer distances than is economically possible with continuous current, but it will ensure a saving of something like 30 per cent. in the weight of dynamos and motors, irrespective of the saving in copper of feed and contact wires, and will thus considerably simplify and cheapen electrical installation and equipment for tractive purposes. But, whether by alternate or by direct current, on flat as on steep-grade lines, on so-called light railways as on tramroads in town and country, we may be well assured that electrical traction in its various forms has, both in this United Kingdom and throughout Europe, a brilliant and triumphant future.

THE MODERN DEVELOPMENT OF THE GAS ENGINE.*

An interesting Paper on the above subject was read on Saturday week before the members of the Manchester Association of Engineers, by Mr. James Atkinson. The Paper, which was illustrated by numerous diagrams, first dealt with three epochs of the "Otto" gas engines, of which three diagrams were given, showing the great reduction in the gas consumption which had been effected during the last 14 years. The "differential" and "cycle" gas engine, invented by the author, were next described, after which the reasons for the recent greatly improved consumption in the Crossley "Otto" engine were explained and shown to be mainly due to the scavenging arrangement for getting rid of the burnt gases entirely, which was a recent invention of Mr. Crossley and the author. The means for getting rid of the burnt gases left in the cylinder at the end of the exhaust stroke were described in detail. By an alteration in the position at which the exhaust valve in an ordinary "Otto" engine would be closed and the admission valve would be opened, the improved engine was so arranged that for a quarter of a revolution the air valve and the exhaust valve were both open at the same time. The improved engine was fitted with a long exhaust pipe, an average length of about 65ft. being found the most suitable. When the exhaust valve was opened, there was some 30lb. to 40lb. pressure in the cylinder. The energy stored up in this cylinder full of hot gases was utilised in putting in motion a long column of exhaust gases in the exhaust pipe. When, therefore, the piston commenced to slow down, after the middle of the exhaust stroke, the column of gases being in motion caused a reduction of pressure in the cylinder, the reduction being accentuated whilst the crank was passing from one position to another, during which time there was a partial vacuum in the cylinder. Both the admission valve and the exhaust valve being open at the same time, a strong current of air was drawn through the end of the cylinder, sweeping out the burnt products and replacing them with pure air. It was, however, necessary to so shape the end of the cylinder that the burnt gases were completely swept out. As soon as the burnt gases were replaced with pure air, the gas valve was also opened, and an explosive mixture was drawn in during the suction stroke, the cylinder being thus filled entirely with pure air and combustible gases. The effect of this was shown by means of a diagram, which represented a mean pressure of 98·75lb., and bringing the consumption of gas per brake horse-power per hour down to 16·487 cubic feet. This was an enormous reduction, being the greatest ever made by any single improvement in the gas engine, and the consumption was not more than half the amount required formerly. Incidentally, there were other advantages in the improved engine. It was known that an ordinary type Otto engine, working for long periods at its maximum power, would not give as much power when thoroughly hot as shortly after it was started. In the improved Otto engine, however, owing probably mainly to such a considerable volume of cold air being drawn through the combustion chamber, this engine continued to work as satisfactorily for any length of time as it did on starting. In some instances an engine had been allowed to run on a brake the whole day, and at the termination a brake test had been made which proved that the engine was giving as much power as at starting, and with as low a consumption of gas. When engines were worked with weak gases, such as Dowson gas, trouble had sometimes been experienced when the gas was perhaps not so rich as it ought to have been, owing either to unsuitable fuel being used, or the gas generator not being properly managed. The mixture being too uninflammable gave poor diagrams, and often caused ignitions in the exhaust or air pipes. With the improved engine, however, a greater quantity of gas per revolution could be got into the cylinder and satisfactorily burnt, giving higher mean pressures, and practically complete immunity from the troubles referred to. Ignition was also made more certain and regular from there being no waste gases mixed with the explosive mixture. At the first glance it would be supposed that the improved engine required to be more strongly constructed than an ordinary Otto engine, but this was not the case. When gas engines were working unsatisfactorily—as, for instance, with the ignition tube rather too cold—they occasionally missed igniting a charge. Sometimes this might go on for several revolutions, until finally a cold charge of pure gas and air was ignited, and an abnormally large diagram was given. As several charges had been drawn through without being ignited, the cylinder was cold, and the weight of gas and air enclosed was greater than if the engine were working normally, the consequence being that under such circumstances it was possible to get a certain maximum strain which was the same for any engine, and this maximum strain was not affected by the improvements. It was, therefore, necessary to make all gas engines strong enough to stand this possibly heavy strain, so that, though a higher initial pressure was obtained in the improved engine, it was not necessary to strengthen any of the parts beyond what would in any case be required, the maximum possible strain being proportional to the compression pressure. The improved engine did not expand the charge beyond the original volume before compression, and in this direction still further improvement might be obtained, though this was hardly probable. A rough trial had been made with an engine, closing the admission valve earlier, so as not to fill up the cylinder at the end of the suction stroke. From experiments made, there did not, however, appear to be any economy in reducing this charge, though it must be admitted that the trial was not made as completely as it might have been. They must bear in mind that, by increasing the expansion in this or any other way, a larger cylinder and engine per unit of power was required. Consequently, the mechanical efficiency could not be as good, and from a commercial standpoint cost of engine per unit of power was an important element. All things considered, and bearing in mind the excellent results obtained, it was very doubtful whether any material all-round gain could be made in this way.

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* Abstract from the *Engineer*.

In the discussion following the reading of the Paper, Mr. Jenkins, after remarking that the costliness of gas retarded the introduction of gas-engines, which might be very usefully adopted for a great many purposes, said he would like to know whether the increase of compression pressure from 40 to 79 had any detrimental effect upon the mechanical efficiency of the gas-engines when working at reduced pressures. Mr. Fulton, commenting upon the introduction of the long exhaust pipe, said that if this had necessarily to be made straight it would be impracticable in some situations where this could not be done. He thought that with this pipe the increased friction in the pumped-out air when getting away would tend to throw still more load upon the piston in expelling the air, and as to the method of getting rid of residual products it might possibly happen that some of those products would on the incharging stroke be drawn back from the exhaust pipe into the cylinder. Mr. Saxon observed that, in his opinion, the brake efficiency of a gas engine would not equal that of the steam engine. It was a very peculiar feature in Messrs. Atkinson and Crossley's gas engine that the exhaust opened so early and closed so late, and the getting rid of burnt gases was certainly effected in a praiseworthy manner. Mr. Craven, in giving some interesting particulars of the working of a 20-horse gas engine, made by Crossley, and developing 30 H.P., which he had put down in his works, said this engine drove a 15-ton overhead rope-driven travelling crane, and about 40 machine tools of various kinds. The gas consumed in the engine was 500ft. per hour, and at 2s. 6d. per 1,000 cubic feet the cost equalled ½d. per horse-power per hour. Mr. E. Constantine observed that, though testing by the brake was, no doubt, the right way, they must also consider the indicated horse-power. An Otto engine, consuming 14½ cubic feet of gas per indicated horse-power, cost about 0·4d. per indicated horse-power per hour, taking the charge for gas at 2s. 6d. per 1,000 cubic feet; whilst a steam engine, using 40lb. of steam per horse-power, evaporating 8lb. of water per 1lb. of coal, would cost 0·4d., at 15s. per ton of coal. A large cotton mill engine averaged 0·138d., whilst a triple expansion engine, consuming 14lb. of steam per indicated horse-power, and evaporating 9lb. of water per 1lb. of coal, cost 0·125d. per indicated horse-power per hour. The President (Mr. Thomas Daniels) recommended the adoption of gas engines for separate bays in a locomotive or machine works. Mr. Atkinson, replying upon the discussion, said that, with regard to the increase in compression from 40lb. to 79lb., he might observe that in the former case it was difficult to keep the slides of the engine right, and this necessitated a limit being placed to the compression pressures. When the slide was done away with, and the ignition tubes introduced, no difficulty was experienced in getting the higher pressures. The exhaust pipes in the present engine could be made with any reasonable number of bends, but no elbows must be introduced.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, November 30th.

London Chamber of Commerce.

3 p.m. Meeting of the Electrical Trade Section at Botolph House, Eastcheap.

Royal Society.

4 p.m. Anniversary Meeting.

Electro-Harmonic Society.

8 p.m. Ladies' Night. Concert at the Banquet Room, St. James's Hall Restaurant, Regent Street.

Institution of Civil Engineers.

8 p.m. Students' Meeting. The following Paper will be read: "Sub-Aqueous Excavation at Newry," by Charles H. Olley.

MONDAY, December 3rd.

Royal Institution.

5 p.m. General Monthly Meeting.

Society of Engineers.

7:30 p.m. Ordinary Meeting at the Town Hall, Westminster. The following Paper will be read: "The Principles and Practice of Hydro-Extraction," by H. B. Ransom.

Society of Arts.

8 p.m. Cantor Lecture: "Modern Developments in Explosives," by Prof. Vivian B. Lewes.

TUESDAY, December 4th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. Monthly Ballot for Members. The following Paper will be further discussed: "The Machinery of War-Ships," by Albert J. Durston. After which the following Paper will be read, time permitting: "Colliery Surface-Works," by Edward B. Wain.

WEDNESDAY, December 5th.

Society of Arts.

8 p.m. Ordinary Meeting. The following Paper will be read:—"Fire Protection," by Edwin O. Sachs.

FRIDAY, December 7th.

Institution of Junior Engineers.

8 p.m. Meeting at the Westminster Palace Hotel. The following Paper will be read and discussed: "Water Works and Appliances," by William Mallock.

⁂ Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

The Bochum-Herne (Westphalia) Electric Tramway.—The official tests of this line took place on October 20th, the Post Office, the railway Directors, the provincial authorities, the town of Bochum, and the Verein Deutsch Electrotechniker being represented. It is a line of the ordinary type, overhead conductors, divided into sections, and 7km. long, return being by the rails, which are thoroughly bonded and cross-connected, so as to avoid evil effects from a faulty junction. The way is raised 15cm. above the road, which is very wide, causing other conveyances to keep off the tramway as a general rule, and permits the speed on the open road to be made as high as 30km. per hour, about 17 miles. The cars run at this speed very smoothly and easily. The motors are geared down by chain gearing, which works almost silently. The technical questions to be settled, which alone concern us, were the disturbance of the telephones and the danger to the telephone subscribers from accidental contact of their wires with the line. It was found that even when no car was on the line a noise was heard in the telephone, which increased when a car started, and every stop was distinctly audible, becoming worse and worse as the cars got further from the station, due to the fact that the telephone line and the tramway run parallel to one another. When many cars were running conversation between Bochum and Herne became very difficult. The difficulty of protecting the wires from contact is great, especially when both are on the same side of the road; a falling pole might easily do the mischief. There was a general concensus of opinion that the telephone wires would have to be moved.

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THE PHYSICAL SOCIETY.

The Physical Society of London has during the last few years shown signs of activity uncommon in well-established scientific institutions. These, when once well started, generally develop by degrees, and sometimes gradually degenerate. The Physical Society, after many years of quiet, useful and unassuming work, recently began to set its house in order, to reorganise its methods, to establish a Journal which will contain not only its own proceedings but a series of abstracts of recent physical work, and finally to change its place of meeting from South Kensington to Piccadilly. After three meetings in its new quarters it is evident that the facilities afforded by the Royal College of Science for easy access by the Metropolitan Railway and for experimental demonstrations, are more than counterbalanced by the central position of Burlington House, and the prestige which the Society now acquires by association with the other learned societies which have quarters allotted to them in this building. The Physical Society is indebted to the Chemical Society for the use of its admirable rooms, and, though it never was in any sense a South Kensington affair, it now enjoys an independence which must prove to be of great value to its work.

The meetings of the Physical Society of London are remarkable in many respects. The range which is covered by the Papers is very wide and touches mathematics on one side, chemistry on another, and electrical engineering, and every other practical application of physical science in turns. The monotonous droning out of a long Paper is almost unknown, and two, if not three or four, different subjects are considered at each meeting. The suppression of the commercial element is accomplished apparently unconsciously, under the influence, it seems, of the true scientific spirit which is always present. In so far as electrical matters are dealt with, the Physical Society is to the Institution of Electrical Engineers as the Chemical Society is to the Society of Chemical Industry. The same speaker, with the same invention to describe, seems to set about it in a totally different manner before the two audiences, and a crucial test is to be found in the occasional display by a manufacturer of a new instrument or two, without the reading of any Paper. Such shows on a large scale are made once a month at the Institution of Civil Engineers with great success, but there they form no part of the proceedings of the meeting. Even when the object of a Paper before the Physical Society is to describe a new, and perhaps patented instrument, the author of the communication is wont to treat it more from the point of view of a physicist than of a tradesman; and rival manufacturers who come to see, frequently take no part at all in the discussion.

When a member advances to the blackboard and says, "Let P be a body of perfect conductivity and of any shape," carefully drawing it and shading it, "immersed in an infinite isotropic dielectric of inductive capacity K, and r and s two infinitely small charges," also carefully drawn, "moving with the velocities r and r_1, then—" then we know things are going to be a little dull. But nobody could want a more lively meeting than that of last Friday. Had Mr. Womack's Paper not come on first, it is safe to say that it would not have come on at all. Prof. S. P. Thompson's Paper, rather misentitled "Mirrors of Magnetism," described some remarkable investigations of virtual magnetic images, not so practically useless, perhaps, as he thought was the case. Leading his audience off into optical analogies, he started a discussion of unusual animation in which no two speakers agreed either with each other or, in some cases, with themselves—the design of alternators, the principles of magnetic and of electrostatic screening, and half-a-dozen side issues were introduced—a discussion which even a combined phonograph and kinetoscope would be incompetent to report. The theoretical behaviour of imaginary bodies endowed with perfect properties under ideal conditions having been adequately considered, Prof. Ayrton called attention to the absurd want of logic frequently exhibited in question-begging demonstrations of Ohm's law, and showed an admirable arrangement of galvanometer, resistance, and a zero-electrostatic voltmeter for rigorously proving this theorem. A side show of no little interest was a historical collection of instruments ranged along the table, exhibiting the development by Prof. Ayrton and Mr. Mather of their electrostatic voltmeter, which has resulted in an instrument with a single needle pivotted on an axle, with fairly short period and dead-beatness, and giving a deflection of about 2¾ inches for 100 volts. An afternoon might well have been spent on the discussion of the main subject of the Paper, of the pertinence of a hydraulic model which was introduced, of the details of the zero electrostatic voltmeter, of the curious results of an instrument the parts of which were immersed in a liquid dielectric, or of the latest direct reading pivotted voltmeter. Prof. S. P. Thompson gracefully complimented the authors upon their latest achievement, and then flung himself at Prof. Ayrton's notion of Ohm's law, namely that V/C = a constant, which we call the resistance, since it is this which Ohm's experiments really proved. Prof. Thompson has been heard on this subject before, and apparently having Ohm on his side, and being mindful of his logic, and less careful of his cynicism, he tore into shreds the idea that Ohm cared two straws about the constancy of the resistance of a conductor. Prof. Ayrton enlisted a speaker or two on his side, but had to confess that although that which his apparatus proved was well proved, it was possible that it was not that which Prof. Thompson claimed to be Ohm's law. Our junior readers need not fear that the fundamental tenet of their creed, $C = E/R$, is in danger; the fight was chiefly one of words, but none the less interesting and entertaining.

Scientific sparring of this kind can be keen enough without a suspicion of that unpleasantness which may often be observed at another institution when one manufacturer "goes for" another. Even the professors cease to be professional at the friendly meetings of the Physical Society, and do not treat their audience like a class of naughty boys. Commercial success, the necessary ideal of engineers, is lost sight of for that success which was achieved by Faraday, Maxwell and Hertz, a success which loses nothing by being incomprehensible to the ordinary commercial man. It is the custom of the members of the Society of Chemical Industry to dine together before the meeting. This excellent arrangement *mutatis mutandis* is adopted by the Royal Society, and the Physical Society has followed its example and provides tea in an upper room half-an-hour before the meeting. Another feature of this Society, to which we have alluded on former occasions, is the excellent report of the discussion. Corrections such as the one which will be found in another column are so rare that they serve to call attention to the versatility and carefulness of the official reporter, who, while he rarely fails to give publicity to any new scientific facts and theories which may be communicated to the meeting, can hardly be expected to reproduce in detail the dialectical tournament which was the feature of last Friday. We congratulate the Physical Society of London on the new departure which is marked by its change of quarters, and if the commercial man desires evidence of prosperity we would inform him that at the last meeting a whole contingent of Cambridge physicists who are not already members were proposed for election.

EXPERIMENTS IN CABLE SIGNALLING.

BY PATRICK B. DELANY.

Within the past few months I have made some experiments in signalling over the Direct United States cable and the cables of the Anglo-American Company, the results of which may be of interest. The trials were mainly with a specially designed system of automatic transmission. Over the Direct cable—Ballinskelligs, Ireland, to Halifax—the entire traffic was transmitted for three weeks under very unfavourable conditions, owing to the almost unprecedentedly severe electric disturbances which prevailed at the time (February last); but the trials demonstrated very clearly, nevertheless, the great superiority of machine working over hand transmission.

In order to get at exact results, on February 27th, during the busiest part of the day, 274 messages sent consecutively were carefully timed, showing the following speeds:—

Number of messages.	Letters per minute.	Number of messages.	Letters per minute.
3	88	32	85
22	91	16	88
12	95	30	87
10	86	29	88
2	91	26	87
4	84		
88	87	274	

Average, 88 letters per minute approximately.

On the morning of March 2nd, when the cable was comparatively clear of earth currents, 31 messages were transmitted consecutively as follows:—

Number of messages.	Letters per minute.
7	100
5	98
17	95
5	89

Average speed 95½ letters per minute, and without an "R.Q."

The foregoing results were with *regular traffic*, code messages, and under duplex conditions of cable.

Experimentally, code messages sent at 103 letters per minute were repeated back promptly from the recorder slip, while newspaper matter transmitted at speeds ranging from 110 to 120 letters per minute was readily repeated back correctly. I specify two instances of official and careful timing.

February 14th: 268 letters from a newspaper paragraph, comprising figures and fractions of stock market reports, were transmitted at the speed of 111 letters per minute, and immediately repeated back from the strip at Halifax without an error.

On February 14th, 190 letters were transmitted at the rate of 120 letters per minute, and repeated back promptly and correctly with exception of one word of two letters.

While speeds with actual traffic are the real tests of both cables and systems, it is but fair to assume that these experimental speeds would soon be reached with regular traffic, for experience has proven that after a few months' familiarity with automatic signals, operators read them at a speed 20 per cent. above the speed considered safe at the beginning.

During the month of September experiments were made with the same system over the four cables of the Anglo-American Company—Valentia, Ireland, to Halifax:—

Highest Speed with Regular Traffic.

	Letters per minute.
1873 cable	153
1874 ,,	153
1880 ,,	133
1894 ,,	249

These figures require some explanation, however. Instead of translating signals into manuscript the Anglo-American Company cuts the recorder slip into short sections, and pastes them on a blank, so that re-punching or re-transmission by key is done directly from the received record. In order to facilitate this cutting, *three* spaces are made between words in the punching. In arriving at the foregoing results, two extra spaces are allowed for every word of five letters, which is the average for ordinary telegrams, and these extra spaces were computed on the basis of 3·7 impulses to the letter, which is the average shown by the analysis of 10,000 words made a few years ago in France. As a matter of fact, however, *cable* words average about *seven* letters to the word; therefore, extra spaces should be reckoned accordingly. This would modify the foregoing figures as follows:—

	Letters per minute.
1873 cable	149
1874 ,,	149
1880 ,,	129
1894 ,,	243

which was the *actual* speed of transmission with regular traffic code messages, carefully timed by officials of the Company at the station.

It is customary to reckon speeds by counting revolutions of the wheel of the transmitter—in which case, of course, all spaces are included; but, unless a stop watch in experienced hands is employed, the count is apt to be inaccurate. A count of the actual letters transmitted during a trial of several hours leaves no room for doubt as to exact results, and as re-transmission from the received strip requires signals which may be read by the average operator without studying, absence of complaint from the receiving station is the best evidence of their legibility. During these experiments at Valentia all signals were judged by the "good for traffic" standard, and the strictness with which this rule was followed was proven by the fact that, except in the case of the '80 cable, none of the speeds reached with regular traffic were exceeded in the experimental transmissions. On several occasions 141 letters per minute, over '80 cable, were reported "good for traffic," and 116 "fair for traffic"; but after a lapse of a day or two, when traffic was carried, the speed did not rise above 129 letters, the decline might easily be attributed to some change in the adjustments at the receiving station.

Working from London to Heart's Content direct.

An experiment was made with a repeating system arranged by the writer which, judging from the results obtained, foreshadows, it is believed, important changes in cable working in the near future.

Regular traffic was punched in London, and transmitted direct to Heart's Content over the '94 cable as follows:—

September 25th.—24 messages regular traffic, speed 178 letters per minute.

September 26th.—14 messages regular traffic, speed 160 letters per minute. No "R.Q's."

These experiments were hurriedly prepared, but were sufficient to show beyond a shadow of doubt that transmission may be effected from long land lines into ocean cables, at the same speed as the cables are worked from their landing places. London may transmit to Heart's Content, and New York may send direct to Valentia, thus saving repunching, retransmission, and considerable time. So far as transmission is concerned cables may, in effect, be thus extended directly to the great inland centres where the bulk of the cable traffic originates, and this too, without any of the dangerous drawbacks of bad coasts, shore ends, &c., and without any sacrifice in speed by the practical extension.

Working by Sounder across the Atlantic.

For several years the writer has been engaged in devising a system for working long cables by key and sounder, and hoped for a successful demonstration while at Valentia; but, unforfortunately, the key-controlled transmitting apparatus sent from London to Heart's Content failed to arrive in time. With an ordinary Morse key at Heart's Content, however, and a special receiving relay at Valentia, on September 30th Valentia received over the '94 cable on an ordinary Morse sounder 66 letters per minute, and these were automatically repeated to London, who pronounced the signals good. With the special transmitter designed for the experiment I think a speed of 100 letters per minute would have been reached, and I am quite satisfied that this speed can be accomplished between New York and London through automatic repeaters. I am strongly of the opinion, however, that in the near future all long cables will be operated by the automatic machine system of transmission.

ALUMINIUM LEADING-IN WIRES FOR GLOW LAMPS.

A plan to replace platinum by aluminium, to the use of which metal objections based on rarity are not now ever likely to apply, has been suggested by Mr. Werner Bolton, who exhibited lamps made with the substitute, at the recent meeting of the German Electro-Chemical Society in Berlin. The coefficient of expansion of aluminum is much larger than that of glass, and direct sealing in is impracticable. The joint between glass and metal is, however, made in the following ingenious manner. The aluminium is heated in a glass tube until it fuses and the envelope of glass fuses round it. When the composite rod (having a glass envelope and an aluminium core) cools, the glass cracks; but this is of no moment, as the function of the glass is merely to prevent the aluminium melting when it comes to be sealed into the thick glass envelope which ultimately forms the base of the lamp. The arrangement is shown at Fig. 1, where the aluminium wires *Al* (about 3cm. in length) are fused into the thick glass envelope *Gl*. The glass envelope carrying the wires is shown sealed into the lamp in Fig. 2, which needs no further explanation.

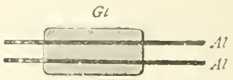

Fig. 1.

The joint between the glass and the aluminium is made tight during the exhaustion of the lamp in the following manner. It is a well known fact that aluminium when amalgamated by contact with a solution containing mercury, oxidises rapidly, becoming covered with the oxide alumina, in the form of a dense powder. This incrustation of oxide, if caused to occur between the aluminium wires and the glass into which they are sealed, is said to make an air-tight joint. These properties are given effect to by applying a drop of a strong solution of mercuric chloride to the outer ends of the wires during the exhaustion of the lamp. The liquid is sucked in between the wires and the glass, and causes the amalgamation of the surface of the metal and its consequent oxidation, the oxide being tightly enclosed and forming an air-tight lute. As soon as the joint is tight the ingress of air is, of course, prevented, and oxidation ceases. Should a small leak occur it cures itself by the action of the oxygen on the remaining aluminium amalgam resulting in the production of a further supply of luting material (alumina) precisely at the point where it is needed. The aspect of the wires with their coating of alumina *o o* is shown in Fig. 3.

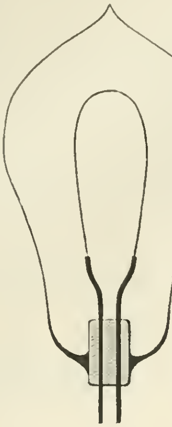

Fig. 2.

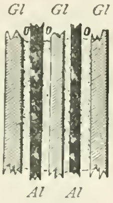

Fig. 3.

THE DIRECT CONVERSION OF THE CHEMICAL ENERGY OF CARBON INTO ELECTRICAL ENERGY.*

BY DR. W. BORCHERS.

The investigations about to be described are not to be regarded as final or exhaustive, but may be properly considered as an attempt to realise those conditions necessary for the successful conversion of chemical into electrical energy which were laid down by Prof. Ostwald in his recent address to technical electricians (see *The Electrician*, Vol. XXXIII., June 29, p. 235).

All who are familiar with the analysis of gaseous fuel are aware that a solution of cuprous chloride is an excellent absorbent, both for carbon monoxide, CO, and for oxygen. Those who, in addition, are acquainted with electrolytic processes can, with equal ease, conceive the formation of a gas battery having oxygen and carbon monoxide as the active materials and a solution of cuprous chloride as the electrolyte connecting them. It follows that the idea of producing electrical energy by the oxidation in the cold of carbon monoxide by means of atmospheric oxygen, the operation being conducted with cuprous chloride as an intermediary, is a perfectly obvious conception. It does not appear, however, that it has been previously put on record.

The experimental apparatus designed to test the practicability of this process was at first constructed of ordinary stoneware cells and porous pots filled with an acid or ammoniacal solution of cuprous chloride, and provided with carbon electrodes. On introducing air into one compartment and carbon monoxide into the other, a feeble current was obtained on connecting the carbon electrodes. By increasing the surface of contact between the gases and the electrolyte by filling the compartments with broken coke, a slightly increased output was obtained. The earliest results, although not exactly discouraging, yet fell distinctly short of what was expected. Further trial might have been made with platinum or some similar metal for the electrodes, but the cost of this material made its adoption of small utility in the present case, where the main object was the devising of a cell of industrial applicability. The difficulty was partly met by the use of copper at the anode of the cell, for a solution of carbon monoxide in a cuprous salt tends to deposit copper rather than to take it into solution, and thus obviates risk of corrosion of the electrode itself. Provided, then, that the introduction of gas into the air-compartment of the cell be so regulated, with regard to the amount finding entrance to the carbon monoxide compartment, that the amount of oxygen only suffices for the oxidation of the carbon monoxide, the solution of the copper composing the walls of the cell is prevented. The vessel containing the electrolyte can, therefore, be made of copper, and serve both to hold the electrolyte and to act as an electrode.

The apparatus shown in Fig. 1 was designed to carry out this plan. A glass vessel, A, is divided into three parts by two glass plates, B B, which do not quite reach to the bottom of the vessel. A carbon cylinder, C, closed at the top, serves as one electrode, and two copper tubes, D D, in the outer compartment constitute the other. Air is driven into the middle compartment, and carbon monoxide into the two outer divisions. The electrolyte used was cuprous chloride solution. In performing the tests, the results of which are quoted below, carbon monoxide was replaced by coal gas (which contains at least 5 per cent. CO) for the sake of convenience. No decrease of weight of the copper electrodes occurred in any of the experiments; but, on the contrary, a slight deposition of copper once took place when the supply of air to the carbon compartment chanced to be irregular. Better results were obtained with an acid than with an ammoniacal solution of cuprous chloride.

The following table gives the figures observed when using carbon monoxide mixed with a large proportion of carbon dioxide, an acid solution of cuprous chloride and air :—

Table I.

External resistance. Ohms.	Electromotive force. Volts.	Current. Amperes.
0·1	0·05	0·5
1	0·20	0·20
2	0·23	0·13
3	0·25	0·10
4	—	0·075
5	0·275	0·060
7	—	0·050
10	0·300	0·040
15	—	0·028
20	0·400	0·020
25	—	0·015
30	—	0·012
40	—	0·010
50	0·400	0·008

An attempt was then made to render the conditions more favourable for complete absorption of carbon monoxide by filling the outer cells with copper turnings and clippings. With this improvement, and with the use of a gaseous mixture similar to that obtained from a generator fed with bituminous coal, a current of 0·64 ampere was obtained when the cell was short circuited, and a voltage of 0·56 volt was reached when the external resistance was made large.

This result cannot be considered satisfactory, as the main reaction occuring in the cell—*i.e.*, $CO + O = CO_2$—corresponds with a calculated voltage of 1·47 volt. Taking the figures in Table I. as a basis for calculation, it is evident that a conversion of 27 per cent. of the energy of the fuel (CO) into electrical energy can be attained. The efficiency of the cell appears more favourable when a gas containing hydrogen and hydrocarbons as well as carbon monoxide is used as a fuel, so that according as the highest or lowest value for the total energy of the gas supplied, is taken, the percentage of energy converted correspondingly varies from 26 to 38 per cent. Seeing, then, that in a somewhat crude apparatus an efficiency of $\frac{1}{4}$ to $\frac{1}{3}$ reckoned on the chemical energy of the fuel can be secured, considerable encouragement may be drawn from these circumstances for the prosecution of further research.

Before turning to the question of the apparatus to be used one other point must be dealt with.

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* From Proceedings of the first annual meeting of the German Electro-Chemical Society.

It is well known that cuprous chloride is capable of dissolving hydrocarbons. Ordinary coal is a substance resembling a hydrocarbon in certain respects. It may be, therefore, that the previous conversion of coal into carbon monoxide (or other gaseous products) is superfluous. On substituting powdered coal for carbon monoxide in the apparatus already described, results were obtained not greatly inferior to those previously given by carbon monoxide. The copper electrodes suffered no noticeable decrease in weight. The experiment was, however, unfavourable upon the whole, and was continued for a comparatively short period. The mean results of several determinations are given in the appended table :—

Table II.

External resistance. Ohms.	Electromotive force. Volts.	Current. Amperes.
0·1	0·040	0·40
1	0·170	0·20
2	0·200	0·10
3	0·225	0·08
5	0·250	0·05
10	0·270	0·04
20	0 300	0·02
50	0·300	0·01

If only the carbon of the coal be considered, the calculated voltage of the cell will be two volts. The highest voltage obtained (0·3 volts) corresponds, therefore, with an efficiency of only 15 per cent. Moreover, even when a brisk circulation of the electrolyte is maintained, a diminution in the current is soon apparent. When carbon monoxide is used, as in the previous series of trials, no such falling off was observed. Finally, it must be remembered that even if the carbon of the coal were completely oxidised there would be a gradual accumulation of impurities in the electrolyte which would prove a serious drawback, even if the results were more favourable than they are. A previous gasification of the coal, and the consumption of its products of distillation and limited combustion, appear to be essential to the successful employment of the method.

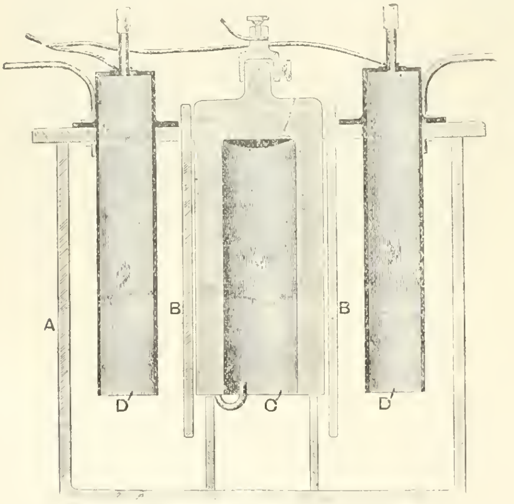


Fig. 1.

Attention may now be turned to the constructional details of the ideal cell described by Prof. Ostwald in his late address (cited above) designed for the direct conversion of the chemical energy of a fuel into electrical energy. Figs. 2 and 3 represent an apparatus of this kind designed for the utilisation of gaseous fuel, and Figs. 4 and 5 show one intended for fuel in the solid state. The body of the apparatus may be in all cases of copper, and the internal chamber of stoneware. The stoneware vessel B serves as the cathode compartment. It consists of three parts, viz., the vessel proper, an internal vessel open top and bottom, and a cover with two tubular connections. Holes are bored in the sides of the vessel and the liner, and between the two a porous material can be filled in, if necessary. Air is driven through the cathode compartment, and in order to provide the largest possible surface of contact between the air and the electrolyte, the compartment is filled with broken coke or retort-carbon. A carbon electrode K lying on the bottom of the vessel is connected with the carbon-rod *k* passing through the cover of the vessel. The outer compartment A, which is of copper, serves to contain both the electrolyte and the inner vessel, and to act as an anode.

When a gaseous fuel is to be burned, the whole of the anode chamber may be filled with copper turnings, or, in order to save metal, a shelf may be fitted—as shown on the left-hand side of Fig. 2—upon which the turnings may rest. The electrolyte flows in through the inlets in the cover, and sprinkles the copper turnings, meeting carbon monoxide, supplied in the form of producer gas. The electrolyte may be allowed to flow from one cell to another, set slightly below it in the manner usual in electrolytic installations. Circulation of the gaseous fuel can also be adopted.

Should solid instead of gaseous fuel be used, only the anode compartment needs modification ; the differences are shown in Figs. 4 and 5. The powdered coal should be agitated, and no residue should be left in the cell. An upward circulation of the liquid should be provided for this purpose, the principle having already proved useful in the electrolytic treatment of alloys in a granulated state. The liquid is caused to flow in through a slit at the bottom of the vessel, and is removed by a pipe at the top, the rate of flow being adjusted so that solid particles do not fall down to the lower opening.

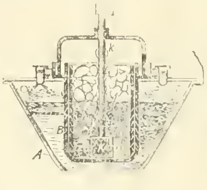


Fig. 2.

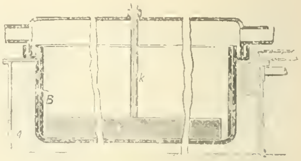


Fig. 3.

In choosing an electrolyte for a purpose of the kind now under consideration, selection is, of course, not confined to copper salts. Various substances which act as carriers of oxygen may be used—*e.g.*, the salts of iron, manganese, cobalt, and lead. No figures can yet be given for the performance of the two apparatus illustrated, for no trial of their capabilities has been made. They have been put forward merely as attempts to fulfil the conditions laid down by Prof. Oswald when depicting the character of a cell of this kind from a theoretical standpoint. He then said : "The carbon cell of the future must have its oxidising agent at the place where the burning carbon is not, and this oxidising agent must be either atmospheric oxygen or a carrier thereof. Such a cell will exhibit exactly the same chemical processes as an ordinary furnace. On the one side coal would be shovelled in, and upon the other oxygen would be injected, and carbon dioxide would escape as the result of their union. There must be a suitable electrolyte interposed, serving as a medium for the electrical process, but acting only as an intermediary and suffering no consumption." Nothing in the foregoing apparatus is incompatible with these requirements. The theoretical views thus put forward have simply been reduced experimentally to practice. Whatever the outlook for the direct utilisation of the energy of coal may be, it is at least evident that, by the present method, combustion in the cold can be effected of natural and artificial products of distillation and limited combustion (*e.g.*, natural gas, coke-oven gas, coal gas, producer gas of all kinds, and blast furnace gas) with the production of electrical energy. Even though the temperature of the electrolyte may be raised and the disposition of the parts may be altered, yet the apparatus of the future for the direct conversion of the chemical energy of fuel into electrical energy cannot far depart in principle from that which has been now devised and explained.

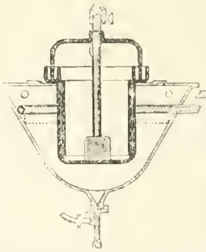


Fig. 4.

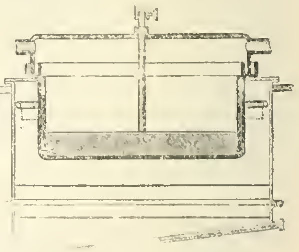


Fig. 5.

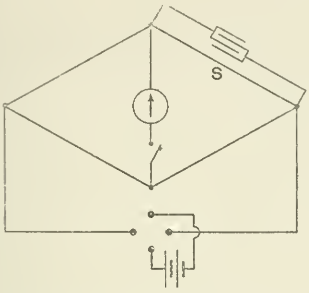
PHYSICAL SOCIETY.

Ordinary general meeting, November 23, 1894, Prof. Rücker, F.R.S., President, in the chair.

Mr. Womack read a Paper on

A Modification of the Ballistic Galvanometer Method of determining the Electromagnetic Capacity of a Condenser."

The condenser is placed in parallel with one arm (S) of a Wheatstone's bridge arrangement of non-inductive resistances. A balance for steady currents having been obtained, the condenser is placed in circuit, and the throw on depressing the battery key determined. The condenser is then thrown out of circuit, and the proportionality of the arms of the bridge disturbed, by changing the value of S to $S+dS$. The steady deflection due to this change is then read. From these two readings, and the known values of S and dS, the capacity is immediately determined. In practice, readings of deflection may be taken with equal positive and negative values of dS. To avoid changes of E.M.F. of the battery, the author finds it best to use a reversing key in the battery circuit, and to observe the throw on reversing the current instead of on simply breaking it. One advantage of the method is that there is no need to know the galvanometer or battery resistance, and the author points out that it may be of service in the simultaneous determination of the resistance and of the joint capacity and inductance of a submarine cable or of a telephone or telegraph line.



Prof. PERRY asked what were the advantages of the method as compared with the Rayleigh-Sumpner method.

Mr. BLAKESLEY thought that the correction for damping in the ballistic part of the experiment might be avoided if in the second part the disturbance of balance due to the increment dS were measured by half the first throw of the needle on making the galvanometer circuit, instead of by the steady deflection. He doubted whether reversing the current in the battery circuit would have just twice the effect of simply breaking the circuit.

In reply, Mr. WOMACK said he had not tried the method of reading suggested by Mr. Blakesley, but with regard to the reversing of the battery circuit, that was found to give in practice as nearly as possible twice the deflection which resulted from simply breaking.

A Paper by Prof. S. P. Thompson and Mr. Miles Walker on

"Mirrors of Magnetism"

was read by Prof. Thompson. It was pointed out that corresponding to the theory of electric images produced by insulated conductors there is a theory of magnetic images produced by insulated bodies of infinite magnetic permeability. A magnet pole in the latter theory is the analogue of an electric charge in the former, and a body of infinite magnetic permeability is the analogue of an insulated conductor (which is electro-statically indistinguishable from a body of infinite dielectric capacity). Experiments were made to determine how far the magnetic images due to thick sheets of iron accorded with those deduced by theory for the case of infinite permeability. The image of a north pole in an infinite plane sheet should consist of a south pole of the same strength at a point coinciding with the optical image of the north pole, together with an equal north pole distributed uniformly over the surface of the infinite sheet, as a free electrical charge would be, and so exerting no finite action. Working at distances of a few inches in front of the surface, a sheet of iron a few feet in length and breadth, and a couple of inches thick, was found to realise the theoretical conditions with very tolerable exactness. In a coil of wire placed on one side of the sheet a current was started or stopped, and the electromotive impulse produced in a subsidiary exploring coil was detected by means of a ballistic galvanometer. That the effect of the actual mirror was equivalent to that of the theoretical image was verified by substituting for the iron a coil equal and similar to the first, and coinciding with its optical image. Sending the same primary current, as before, round the two coils (with due regard to the direction in the second coil), hardly any appreciable difference in the secondary impulse was observed. This was found to hold good, whether the original primary coil had its axis perpendicular or oblique to the plane of the magnetic mirror. Some observations on spherical sheets were also recorded, but in this case the conclusions were less simple.

The Paper was followed by a discussion, in which Mr. Addenbrooke, Mr. Boys, Prof. Perry, Prof. Ayrton, Dr. Burton, Mr. W. Bailey, and Prof. Carey Foster took part.

Prof. Ayrton exhibited a "Student's apparatus for verifying Ohm's law," designed by himself and Mr. Mather. The current flowing through a circuit is to be measured (not necessarily in terms of any defined unit) by means of a galvanometer, while the potential difference between two fixed points is measured by means of an idiostatic electrometer. Within small limits of experimental error the current and potential difference are found to vary in the same proportion; but the electrometer and its manner of use constituted the chief interest of the Paper. The fixed and moving parts (inductors and needle) are alike cylindrical in form (the term being understood in its most unrestricted sense) and the generating lines are vertical. There is a vertical axis of symmetry such that the disposition of these cylindrical parts would remain unchanged if the instrument were rotated through 180° about the axis. The needle is hung by a very thin phosphor-bronze strip, and to obtain a reading when it differs in potential from the inductors by an amount which we have to measure, it is brought back to its ordinary zero position by turning a torsion-head to which the upper end of the suspending strip is fixed. The potential difference is then proportional to the square root of the angle through which the torsion-head has been turned; but the E.M.F. of a moderate battery of accumulators can be read with very fair accuracy. The authors have bestowed great care on the design of the needle, so that, for a given potential difference, the turning-moment divided by the moment of inertia may be as great as possible. The whole instrument is protected from external inductive influence by having the inner surface of its glass case coated with a transparent conducting varnish, which Prof. Ayrton has described elsewhere.

Prof. Ayrton also showed an idiostatic electrometer, whose needle, instead of being suspended, was pivoted on an axle. The instrument is rapid and nearly dead-beat in action, and gives a scale-reading of about three inches for an E.M.F. of 100 volts.

Prof. S. P. THOMPSON expressed great admiration for the instruments exhibited, but denied that the law which they served to prove was Ohm's law at all; and this led to an animated discussion as to what Ohm's law really is.

Prof. AYRTON briefly replied.

THE CANNON-STREET ACCIDENT.

BOARD OF TRADE INQUIRY.

The inquiry into the causes of the accident in Cannon-street, on November 10th, was resumed on Friday last, by Major Cardew, this being the third day of hearing evidence.

Mr. THOMAS GEORGE CHESTERMAN, M.R.C.V.S., said he made a *post mortem* examination of the body of the horse killed on the evening of the accident, and found all the organs and tissues of the body in a perfectly healthy state; so much so that had he not been told that the horse died from an electrical shock, he would not have been able to account for its death. There was absolutely no apparent cause of death. There was no unusual stiffness of the body, and no congestion, and no signs of asphyxia.

HENRY SMITH, foreman of cable mains in the city for the City of London Electric Lighting Company, stated that he superintended the laying of the mains from the Watling-street transformer station to Bankside, the work being commenced on October 11th, and taking about a week to carry out, as though there was an interval of delay. The mains had only to be drawn in through pipes already laid. The cable was in about 15 separate lengths, and the ends were joined at the junction boxes. He had nothing to do with the jointing, but as soon as the cables were drawn in he had labels affixed at the ends as a guide for the jointers. Each length of cable was labelled at each of its ends.

By Mr. GRIFFITHS: He superintended also the laying of the Milk-street cable, the work in that case having been commenced on October 9th. Each end of each length of that cable was labelled in the same way as in the case of the other. It was his duty to examine these cables in the junction boxes to see that the labels were properly affixed. As the end of the cable was brought through into the junction box he would write the label for it and hand it to the man in the box. In both these cases he satisfied himself that each label was attached to its proper main. He did not make any test for continuity, but merely saw that the label was affixed as the cables were drawn through one at a time. All he had to do to the cable at Bankside was to see that the end was taken up into the station and laid with the other cables, a label being affixed to that end also.

By Major CARDEW : When he last saw the ends of the mains at Bankside, prior to the accident, they were lying by the side of the switch pillars, in the racks used for the purpose, the ends being ready to be put into the switch pillars.

By Mr. WALLACE : The labels were attached to the ends of the cables with iron wire ; they were themselves sometimes of paper and sometimes of linen. The tubes in which the cables were laid were crossed in places, one such place being opposite the Edison-Swan building in Queen-street. In laying iron tubes in the streets that could not very well be avoided. The Watling-street cable and the Milk-street cable were drawn in on different dates, and the labels affixed at different dates, so that if the men, in jointing, paid attention to the labelling, there should have been no difficulty.

By Major CARDEW : The laying of the Watling-street cable was commenced on October 11th, and of the Milk-street cable on October 9th ; but he had to stop when he got to the box outside the Edison-Swan building, so that operations were going on on both mains at the same time there.

By Mr. WALLACE : The cables were drawn in one after the other, and the label was affixed to each immediately after it was drawn in.

WILLIAM PARROTT, jointing foreman to the Company, said he superintended the work of making the connections in the Watling-street main. This work was finished about November 7th. Each length of cable was labelled, and the main was jointed up according to the labels. He personally saw that each end had its label on before they were jointed up. The paper and linen labels were left on until after the plumbers had been over the cable and completed the work of jointing ; lead labels were then put in instead of the others. The labels on the ends of the cables were certainly wrong ; the mains had been gone over afresh quite recently, and it was found that there was a crossing in the tubes between the Watling-street main and the Milk-street main. This crossing took place between Maiden-lane and the box outside Edison-Swan's. The cables had been correctly connected since, but the labels were left as they were, excepting at the end in Bankside. The only way in which he could explain the labels being in their wrong places was that somebody made a mistake when both cables were labelled at the same time in one box.

By Mr. GRIFFITHS : He personally examined the labels. He got into the box before the jointer started, and handed him the ends of the cables. He examined the cables all the way through from Bankside to Watling-street, opening each box, on the Sunday following the accident, and found that the cross connection was made between the Edison-Swan box and the Thames-street box. Mr. Bates, the second engineer, came on the Tuesday or Wednesday, and witness showed him where the mistake was caused ; one cable was labelled "Watling-street" at one end of its length, and "Milk-street" at the other end. He did not agree with the previous witness that the labels were properly affixed, and he was sure the mistake was not the fault of the jointers.

Mr. ALEXANDER COOK, superintendent of cable laying and transformer stations for the City of London Company (Limited), said the process of laying both the Milk-street and the Watling-street cables was going on at the same time, and part of the way both were drawn in on the same day, this being the case with that particular part where the mistake occurred, in Queen-street. Witness did not identify the mains or examine the labelling. The reason for the delay in laying the Watling-street main was in the first place that they had not sufficient cable at the time, and another reason was that they were altering the boxes at the corner of Thames-street. The boxes were being enlarged at that particular part. On the day after the accident witness saw the Edison-Swan box and Thames-street box opened, but did not examine the labels closely ; Mr. Parrott pointed out that the cable which he had traced was labelled Watling-street in one box and Milk-street in the other. He did not satisfy himself at the time whether that was so or not. He made no electrical test at all to identify the cable throughout; they had a testing department, and he took the word of the foreman of the department. He (witness) had been engaged in electrical work for about 12 years, and he knew how to test a cable for continuity ; he should say that was the first test to make before bringing it into use. Such a test would have revealed the existence of the fault in this case. He was in charge of the transformer stations ; but he was not present in the Watling street station when the pressure was switched on to the main. He certainly considered the switching on of a new main an important operation ; but he was prevented from being there by having to be at the stores at Worcester Wharf, where the men were being paid just at that time. He was aware that the main was going to be made alive, but not of the exact time. They had intended making it alive earlier in the morning, but they were not quite ready at Bankside station. The foreman was left at Watling-street with instructions to switch on as soon as he got word from Bankside. He looked at the arrangement for switching the main ; and it was just the same as they had used for making alive the mains of all previous stations. There was a safety fuse, but it was rather heavy, taking about 450 or 500 amperes. Such a large fuse was not necessary for the operation, it could have been done through quite a fine wire. There were periodical tests of the main, made under his supervision, by the foreman of the testing department. He gave the instructions for this, and received reports as to the results. The whole system of mains tested fairly high between outer and outer. He examined the piece of main which broke down at Budge-row ; all that could be seen was that the main had been burnt clean through by the short circuit ; the fault was close to the end of the pipes. The main was bent at that point, but the angle was not a very sharp one. The insulation was faulty, but the outer was not exposed ; there was a mechanical abrasion of the outside covering. There was no periodical inspection of the state of the insulation of the cable at the junction box. It might be, in the case of rubber cables, that where they passed through junction-boxes abrasions were likely to occur.

By Mr. GRIFFITHS : The actual current in the cable would not exceed 15 amperes at that particular time, so that, practically, a fuse to carry 450 to 500 amperes was no sort of protection. They were anxious to have the new cable connected that day because they wanted to make another main dead, the Pancras-lane main, which was required to be cut out for some alterations to be made at Bankside. Had all gone right the Pancras-lane main would have been cut out on the afternoon on which the accident occurred, and the supply of current for the lamps would have depended upon the Watling-street main on that afternoon. The alterations at Bankside could only be made on Saturday or Sunday. It was the duty of the foreman of the testing department to see that the main was in proper order to be switched on. The latter informed witness by telephone that the main was fit to be connected to the switch pillar, and he also gave Mr. Parrott a note to that effect. In the ordinary way he would have sent a written report of the tests in to witness within a day or so ; but, as they were in a hurry with this main, the report was sent by telephone instead of in writing. Witness rung down to Bankside, where Mr. Peard, the foreman of the testing department, was, and asked him if he had tested this main. He said he had made a rough test of it. Witness said, "Is it good enough to put it on ?" And the reply was : "Yes, it is good enough." Mr. Parrott handed witness the note he received from Mr. Peard. There was first a note to Mr. Peard from Mr. Parrott, reading thus, "Can Watling-street main be put into pillar ? Wanted to be at work by 11 a.m." Under this was Mr. Peard's note to Mr. Parrott, running, "The cable is good, but the final test has not yet been taken. Can go in pillar."

Mr. OLIVER PEARD, electrical engineer in charge of the testing department, gave a statement as to the way in which the high-tension mains were usually tested before being put to work. First of all, there was a notification from the cable-jointing department that the main was ready for testing. This notification was sent to witness on a special printed form. This sheet was really a sheet out of a voucher book, and it was for him to sign before the cable was put to work. When he returned that sheet signed, it signified that he had done with the main, and if anything happened to the main he was responsible for it ; until that was returned he was not responsible. It was really a certificate or guarantee from the testing department that the main was all right. If a main was wanted in a hurry, he was informed of the fact and made a rough test to ascertain whether it was necessary to send back workmen to detect whether there was any fault in the insulation ; but he did not then make a test for continuity. The purpose of the rough test was not to get any record of the insulation of the cable, but merely to get an idea of whether it was necessary to send a workman back over the line to remove any fault before they started on the testing proper. The next thing done was that the cable was so put in that it was in exactly the same condition as it would be when it was made alive; that is, it was put into the switch pillars and put into the terminals of the transformer station, so that if there was anything wrong with the terminals of the transformer station or the switch pillar that would come out in the final test and avoid any error that might otherwise be made. That was the meaning of the words going into the switch pillars. That was the meaning always attributed to the phrase by the cable foreman and everybody else. Going into the switch pillar did not mean that the switch could be closed, or that the cable might be made alive. The meaning of the phrase "the cable is good" meant that there was no fault in it with regard to insulation.

Major CARDEW : The meaning of your words "Can go in pillar" is simply that the cable was ready for the final test, and not that it could be made alive ?—It could not be made alive. It can only be made alive when I have returned the voucher ticket. If it is done before that, then I am not responsible in any way.

Witness continued, under examination, to say that after the cable was put into the pillar they took a careful insulation test—a carefully recorded test. Then the pressure test was put on. The cable was "identified" between the rough insulation test and the first proper insulation test. It was identified by putting a galvanometer at both ends, a man being stationed at each end, and a number of deflections being sent through. There would be a battery at the Bankside end, and the core would be put to earth at both ends through the galvanometer and battery. The deflections must be seen to come on and go off and stop off. The galvanometers were then removed to between the two conductors ; that is, from inner to outer. This test was always applied in the case of the new high-tension mains after they were connected with the switch-pillar and the terminals at the other end. After the accurate insulation test the pressure test was taken. It depended upon circumstances whether or not the pressure was put on at Bankside, but as a rule this was how it was done. For these particular cables 10,000 volts were applied between the inner and outer conductor, and 5,000 volts between outer and earth. He had never applied any test to the rubber cables, which were being rapidly replaced by the new cables ; there were still six or seven rubber cables left. He knew that 2,000 volts had been put on them several times, owing to the partial breakdown of transformers and the earthing of the inner ; but he had never made any proper department test. On one occasion, he remembered, when the Coleman street high tension main was put to work, 2,000 amperes came on a transformer and went to earth at the inner pole. The porcelain insulator of one of the transformers cracked and dust got between, and there was a spark through on the inner pole, which started an arc. But it did not blow a 45-ampere fuse which was on the transformer at the time. After the tests he had described another insulation test would be taken to see if it had been affected by the pressure. It generally went up a little owing to dampness at the terminals. The pressure was kept on for about 15 minutes—never less than 10. After the insulation test copper resistance and electrostatic capacity were tested for. To complete whole series of tests he generally took two or three days. He did not periodically take the copper resistance ; they could not at present do that, as it would mean isolating the mains, but they hoped to be able to do it when the whole system of mains was complete. When he wrote the note to Mr. Parrott on the day of the accident he knew that it was intended to charge the main ; but he thought Mr. Cook would sufficiently understand, when informed that only a temporary test had been made, that it would not be right to charge it. It was for Mr. A. Cook, the superintendent, to give orders to Mr. Parrott for putting the cable to work, and at the time the cable was put alive he did not believe Mr. Cook was aware that note to Mr. Parrott was in existence. It was usual for him (witness) to send a written report to Mr. Cook ; but as the matter was urgent the latter sent an inquiry on the telephone.

Major CARDEW : Mr. Cook said the message he received in answer to his inquiry as to whether you had tested the main was that you had made a rough test. Do you say that is quite accurate ?

WITNESS : That is quite accurate, but the remainder of the telephone message is not true.

Major CARDEW : Did Mr. Cook ask you, "Is it good enough to put on ?"

WITNESS : Mr. Cook asked me nothing of the sort. I told him there was very fair insulation ; he said, "All right," and I heard the click of the telephone being replaced, and that is all that passed between us.

Examination continued : The form which he, witness, always filled up when the tests were complete was not in the possession of Mr. Cook or the cabling department until November 17th. Witness never dreamed that Mr. Cook or anybody else would put a high-tension main to work upon which only a rough test had been made. He did not think it had ever been done before. Witness put in a record of tests on the Benetfink main. They had never taken tests of the main itself without connections ; to disconnect the main at the station would have meant cutting out the lights all the time. They were only allowed by the Board of Trade to shut down for half-an-hour on Sunday mornings ; as a matter of fact they were not allowed half-an-hour, but they generally took that time. The tests put in showed a sudden drop ; they had several sudden drops, and had localised the faults, but they had never been due to cable so far as he remembered, they were generally due to dampness of the porcelain.

Cross-examined by Mr. GRIFFITH : He most decidedly thought it was necessary in the case of a high-tension cable with a pressure of 2,000 volts that all those tests should be carried out before the cable was charged. There had been no recorded test of the cable at all when it was made alive, and except that it was not necessary to send a workman back on the line to remedy a fault, he knew nothing about the cable. He thought when Mr. Cook got his answer he would not make the cable alive ; his answer was most distinct, and ought to have conveyed to him the idea that the main was not ready for being charged. He (witness) would only have made a cable alive under such circumstances under extreme pressure, and after very careful attention all round ; upon consideration, he might say he would not have done it at all.

JOSEPH MACMAHON, foreman of the transformer department, stated that upon instructions he received from Mr. Cook he waited at Watling-street station until he received word from Bankside, when he switched on the new main. He had received orders from Mr. Cook never to make alive first, and he was under the impression that the main was already made alive from Bankside when he switched on. Having complied with his instructions, he did not notice anything for about a minute and a-half, when he noticed a kick in the lights, and he immediately switched out again. There was no unusual sparking. He had no voltmeter under observation : there was not a high-tension voltmeter in the station. The station at that time was fed by two inter-connecting mains, one from Cole Abbey, and one from Pancras-lane, and both these were in circuit.

J. P. BUCK, superintendent of conduits, said he had found it necessary to cross the pipes in laying them, when they met with obstacles in the shape of gas-pipes, water-pipes, or sewers. He saw the boxes open in Cannon-street after the accident. The top of the one at Budge-row had been removed and the brickwork disturbed. There appeared to have been fire in the box, which was blackened, and the insulation of the cables appeared to have been burned off. He did not notice that the insulation of the low-pressure cables was injured. Up to the time of the accident he had two men going round street after street examining the conduits for gas. They had no special instructions to look at the cables ; but if they found anything wrong with the insulation or anything else, he thought their common sense would tell them that they should report it. If gas was found, witness reported the fact to the Secretary of the Company, who communicated with the gas company, and the latter usually asked for a man to meet them to assist in removing the lids of the boxes, and so on, when they would put in a detector. The iron pipes in the boxes were screwed together with red lead. There were seven pipes in the boxes, four of which were empty, and there was communication through from box to box. He did not think, however, the gas came through the pipes, but that it accumulated in the boxes. Larger boxes were gradually being put in by the Company, and he thought there might be more danger with regard to explosions in these larger boxes. Plugging up the pipes in the way suggested by Major Webber would interfere with the ventilation if the scheme proposed by the engineer and manager, Mr. David Cook, was carried out.

Mr. F. H. JACKSON, third engineer, having charge of the generating station, stated that he was at the telephone at the time of the accident, and heard the disturbance on the telephone. Mr. Ferguson, one of his assistants, at once came to him and told him there was an arc in the new switch-room. Witness went there and saw an arc at the back of the switch pillars, near the new mains that were being put to work. The Watling-street cable was arcing across to the lead coverings of the St. Andrew's Hill cable. Witness ran down to the telephone room to get the Watling street main switched off, and found Mr. Parrott already sending a message to that effect. He thought the arcing went on for about five minutes. There were four machines running at the time, two Brush machines, a 500-kilowatt and a 250-kilowatt ; and two 350-kilowatt Thomson-Houston machines, one of which was only running at half-engine power. He had no voltmeter under observation, but he noticed that the lamps went down and out. The load just before was 190 amperes. He saw the amperemeters of the Thomson-Houston machines, which were hard over. The maximum reading of these was 300 amperes. After the Watling-street cable had been cut out and the switches of the Benetfink and Pancras-lane mains had been combined, the lamps lit up again. He came to the conclusion that the cause of the disturbance was a short circuit on the Benetfink main. He had several of their main fuses go at different times. The Bates fuses, which were in tubes, went very quietly, but at about one-third of the right current according to Mr. Preece's table, because they were bunched. The other fuses they had were copper wires in pots with divisions between ; when these went they did not go with a bang, but they roared and flashed.

This concluded the inquiry, and Major Cardew thanked those, counsel and others, who had assisted them.

ON VILLARI'S CRITICAL POINT IN NICKEL.*

BY ADOLF HEYDWEILLER.

Hitherto, researches on the behaviour of nickel and iron under mechanical stress while magnetised have shown considerable differences in the behaviour of the two metals ; cobalt, apparently, occupying a mean position. In this connection we may notice especially the alterations of magnetisation produced by tension or compression along the lines of force ; and the researches of G. Wiedemann, Nagaoka, and Zehnder on the effects of torsion on longitudinal and circular magnetisation. The latter phenomenon is only a variant of the former, and, therefore, we may say that the chief difference between iron and nickel lies in the fact that the former, with moderate magnetisation, has its magnetic moment increased by slight tension, and decreased by slight compression ; but when the tension or compression reaches a certain point, the effect reverses. Villari observed that the increase in permeability reached a maximum, fell again to its original value at a certain value of the tension, and fell below this when the tension was increased further still. The point at which it attains the same value that it has under no tension is known as Villari's critical point. Up to now, no such point has been observed in nickel ; the application of tensile stress having always decreased the permeability, and *vice versâ*.

The phenomena observed in iron are in accordance with what we should expect if the Ewing molecular theory of magnetism is correct. The working of the tension is, perhaps, to be thought of as facilitating the change from the first to the second stable position of the molecular chains; while, owing to the mechanical deformation, it diminishes their magnetic moment when the second stable position is attained. So long, therefore, as there remains a large number of groups in the first stable position—that is to say, when the magnetising force is small—the tension can increase the induction ; but when the majority of the groups have broken up, and the individuals have formed new alliances, the diminution of magnetic moment begins to tell.

This explanation of the phenomenon would be contrary to experimental evidence should it really be that the difference between iron and nickel was qualitative, and not merely due to the fact that no one has hitherto used sufficiently low values of induction in searching for the effect in nickel. The author's experiments were undertaken with the intention of settling this point.

Method of Experiment.—Owing to the small magnetic moments whose changes were to be observed, it was necessary to use delicate apparatus ; and the arrangement of an almost astatic magnetometer needle system was found to be the most handy. The astatic system consisted of two ring magnets 11cm. apart ; the nickel wire under examination was placed vertically 4·7cm. away from the magnetometer, the lower end being fixed in its position. This wire was enclosed in a very small glass tube, in which it fitted loosely, but had no side play. This tube was 50cm. long, and prevented the wire from sideways movement when compressed ; on it was wound the magnetising coil of 400 turns, and it was fixed to the same stone pillar as the magnetometer. The lower end of the wire was about on a level with the upper needle and right inside the magnetising coil, about 7cm. from the end, and, therefore, in a uniform field ; the height could be easily regulated so that the deflection should be a maximum, and should not be affected by small vertical displacements of the wire—0·5cm. displacement produced an alteration of deflection by only 1 or 2 per cent. The upper end of the wire, which projected from the magnetising coil, was fastened to a brass lever in such a manner that tension up to 3·9 kilogrammes, and compression up to 2·7 kilogrammes, could be easily and gradually applied by sliding a lead weight. The earth's field was not sufficiently large to produce an appreciable alteration of the magnetising force from the longitudinal direction.

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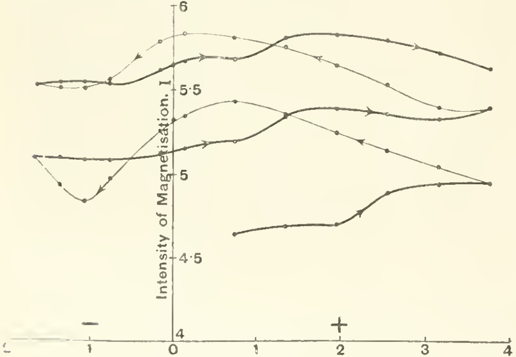
* Abstract from *Wied. Ann.*, 1894, No. 7, p. 462.

The magnetometer was roughly calibrated by comparison with a single needle instrument, and was found to give 40mm. deflection for one C.G.S. unit of induction with the scale 1,860mm. away. This value may be anything less than 10 per cent. out, but this is of no consequence as only relative values are required.

A great difficulty is experienced in removing the last traces of permanent magnetism, the method of decreasing alternating currents being insufficient; and, even when completely demagnetised, the repetition of the experimental cycle brings about a permanent set.

The nickel used was chemically pure, and was supplied by Desaga, of Heidelberg. It had a diameter of 0·15cm., and was about 46cm. long. A piece drawn to 0·6cm. thick, and then annealed has a specific conductivity of 7·7 times pure mercury at 0° and a temperature coefficient of 0·00391 between 5° and 25°. These values agree with those found by Feussner, and differ from those of Matthiessen and Vogt, and of Dewar and Fleming. The following results are certain characteristic ones. First come four sets in which the tension (or compression) is varied cyclically. The arrows show the direction in which the alteration was made. Table V. shows the effect of alternate application and relaxation of the mechanical stress.

Results.—With weak magnetisation the curve representing the relation between the longitudinal induction I and a tension or compression, P, applied to the wire, shows a maximum and a minimum. Beginning with a maximum compression, the induction falls with decreasing compression, reaches a minimum, and rises again until no mechanical force acts; goes on rising with increasing tension, to a maximum, and then falls as the mechanical force increases. Maximum and minimum get nearer and nearer together as the initial induction increases, and at a certain value of magnetising force they entirely disappear. The position of the maximum and minimum relatively to the zero of mechanical force depends on the previous magnetic and mechanical history of the nickel; they are generally unsymmetrically placed; this is probably due to mechanical hysteresis.



Curve plotted from Table III.

At low values of induction the magnetism shows distinct hysteresis with regard to the effects of mechanical force, in contradistinction to its behaviour under stronger magnetisation. This is in accordance with the theoretical explanation advanced earlier in this article of the action of mechanical forces on magnetism.

If the behaviour of nickel here described be compared with that of iron as observed by Villari, W. Thomson, and Ewing, it will be seen that the differences between the two metals are merely quantitative, and are due to the differences in strength of the molecular magnets.

Table I

Load.		Intensity of magnetisation.				
Kg.	Kg/mm².	C.G.S. units.				
1·81	1·02	...	0·26	..	0·33	.
1·51	0·85		0·54	0·31	0·59	0·37
0·90	0·51	.	1·09	0·46		0·51
0·30	0·17		1·52	0·66	1·57	0·70
0	0	1·06	↑		↑	...
0·30	0·17	↓ 1·11	1·73	↓ 0·95	1·74	↓ 0·99
0·90	0·51	1·31	1·83	1·32	[illegible]	.
1·51	0·85	1·62	[illegible]	1·63	[illegible]	.
2·11	1·19	1·80	[illegible]	[illegible]	[illegible]	
2·71	1·53	[illegible]	[illegible]	[illegible]	[illegible]	
3·31	1·87	[illegible]	1·82	1·87	[illegible]	..
3·91	2·21	1·73	...	1·79	.	...

Table II.

Load.		Intensity of magnetisation.				
Kg.	Kg/mm².	C.G.S. units.				
– 2·71	1·53	...	...	..	3·45	...
2·41	1·36	...	...	...	...	3·38
2·11	1·19	...	3·70	...	4·09	3·46
– 1·51	0·85	...	4·39	3·76	4·58	3·58
– 0·90	0·51	...	4·65	3·95	4·80	3·84
– 0·30	0·17	...	4·73	4·24	4·95	4·04
0	0	2·33	↑ ...		↑ ..	...
+ 0·30	0·17	↓ 2·30	4·39	↓ 4·30	4·71	↓ 4·31
+ 0·90	0·51	2·56	4·15	4·37	4·51	4·47
+ 1·51	0·85	2·99	3·96	4·39	4·37	4·54
+ 2·11	1·19	3·36	3·83	4·32	4·29	4·51
+ 2·71	1·53	3·59	3·71	4·12	...	4·34
+ 3·31	1·87	3·60	3·54	...	..	...
+ 3·91	2·21	3·37	...	...	...	...

Table III.

– 1·66	0·94	...	5·10	...	5·53	...
– 1·36	0·77	...	4·94	5·10	5·52	5·55
– 1·05	0·60	...	4·84	5·08	5·51	5·55
– 0·75	0·43	...	4·97	5·08	5·57	5·54
– 0·15	0·09	...	5·25	5·12	5·79	5·63
0	0	. .	5·33	.	...	5·65
+ 0·15	0·09	...	5·34	5·15	5·84	5·67
+ 0·75	0·43	4·64	↑ 5·43	5·19	↑ 5·82	5·68
+ 1·36	0·77	↓ 4·69	5·36	↓ 5·34	5·76	↓ 5·82
+ 1·96	1·11	4·71	5·25	5·39	5·65	5·83
+ 2·56	1·45	4·89	5·14	5·36	5·53	5·80
+ 3·16	1·79	4·94	5·05	5·33	5·40	5·73
+ 3·77	2·13	4·94	...	5·39	...	5·63

Table IV.

– 2·71	1·53	..	...	...	10·44	...
– 2·11	1·19	...	9·95	...	9·69	10·19
– 1·51	0·85	...	9·37	9·67	9·09	9·84
– 0·90	0·51	...	8·77	↓ 9·34	8·30	9·48
– 0·30	0·17	...	8·34	8·97	7·52	9·03
0	0	8·19	↑ ...	...	↑ ..	...
+ 0·30	0·17	↓ 8·08	7·88	8·41	6·81	↓ 8·41
+ 0·90	0·51	7·56	...	7·84	6·26	7·76
+ 1·51	0·85	...	...	7·17	5·82	7·06
+ 2·11	1·19	...	...	6·48	5·47	6·36
+ 2·71	1·53	...	...	5·72	5·18	5·66
+ 3·31	1·87	..	...	4·93	...	4·98
+ 3·91	2·21	...	...	...	...	4·27

Table V.

Kg.	Kg/mm.²	Intensity of magnetisation (C.G.S. units).		
0	...	...	2·08	...
– 1·51	0·85	...	2·03	...
0	...	...	2·34	...
0·90	0·51	...	2·25	1·98
0	...	...	2·60	2·07
0·60	0·34	..	2·59	2·07
0	...	...	2·77	2·08
0·30	0·17	...	2·79	2·08
0	...	...	2·84	2·09
0·15	0·09	..	2·86	...
0	...	2·44	2·94	↓ ...
+ 0·13	0·09	↓ 2·46	2·93	...
0	...	2·46	2·92	...
+ 0·30	0·17	2·48	2·92	...
0	.	2·47	..	...
+ 0·60	0·34	2·48	.	...
0	...	2·47	2·91	..
+ 0·90	0·51	2·48	↑ 2·90	...
0	.	2·47	2·89	
+ 1·51	0·85	2·51	2·92	...
0		2·45	2·88	
+ 2·11	1·19	2·68	3·02	...
0		2·55	2·89	...
2·71	1·53	3·02	3·08	...
0		2·72	2·86	.
3·31	1·87	3·10	3·11	.
0		2·82		
3·91	2·21	3·08	...	..
0	.	2·83	.	...

CORRESPONDENCE.

PHYSICAL SOCIETY DISCUSSION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: It is, I perceive, rash to attempt to contribute to a discussion from a distance, in accordance with a request made by the Physical Society of London; because if one happens to be misunderstood there is no opportunity of correcting the mistake until it gets into print.

A hastily-written note showing interest in some Paper to be read is sent to the secretaries by a country member, and nothing further is heard by him until an abbreviated version, perhaps entirely erroneous, appears in the public Press.

May I ask your readers to expunge from their minds the first portion of a statement attributed to me in the report of the meeting of the Physical Society on p. 99 of your last issue. Dr. Larmor's summary of Wiener's results was perfectly lucid; it was Herr Wiener's own summary of the consequences of one of his own beautiful experiments which I ventured tentatively to criticise.—Yours, &c., Oliver J. Lodge.

Liverpool, November 23, 1894.

LIGHTING INSTALLATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I hasten to correct two important errors in my Paper on "Lighting Installations," and also in the discussion printed in your current issue.

First I am made to say that the fact of a consumer adopting the five-wire system saves "current"; this should obviously read "copper."

Then with reference to the case of the Free Trade Hall: the metering was done by one Ferranti meter (not two Thomson) connected on the positive outer, the reading being multiplied by four. It is true that there is now fixed a Thomson five-wire meter, and by comparison with the number of units registered under the old system the number now registered seems excessive; but it must not be taken that this fact reflects any discredit on the accuracy of the meter.—Yours, &c.,

H. A. Henderson.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

New York, *November* 16, 1894.

Cable versus Electric Roads.—It has recently been announced that two important cable roads in Philadelphia and two others in Chicago will be transformed into electric roads. In a discussion on a Paper on conduit roads, read last week before the New York Electrical Society, some figures were given in regard to the relative cost and construction of cable and electric roads. In New York cable roads cost $150,000 per mile of single track; but in Washington the corresponding figure was only $30,000; ordinarily, however, it was asserted that the cost is from $60,000 to $70,000 per mile of single track. It was stated that the electric conduit system being laid down in New York and Washington will cost more than what corresponding cable roads would, and that the difference for each car would be $1,000 in favour of the cable car, this being the difference between the cost of the grip and the motor equipment. In the course of the discussion an instance was cited where a trolley road cost $70,000 per mile of single track, the franchise requiring the street to be paved by the traction company from track to track. As to the relative cost of operation of trolley and cable roads, one speaker stated that in a case of which he knew, where the same company operated both systems, the figures were practically the same. The weight of opinion, however, during the discussion was that the cable road was cheaper to operate.

Electric Conduit Roads.—In the above Paper by Mr. Joseph Sachs on "Electric Conduit Railways" the conduit system to be used in New York and Washington was described for the first time. As the traction companies apparently thought that it was uncertain whether the adoption of electricity would prove successful, they required that the same conduit and construction should be used as with cable roads, in order that a cable might be substituted should the electrical system prove a failure. The insulators for the contact conductors are placed at the usual cable manholes 30ft. apart. The insulators are of soap-stone, rectangular in form and supported in cups embedded in sulphur. At the top is fastened an iron arm, and to this is secured a contact conductor of 4in. channel iron. The contact shoe comes down to the slot, and has two arms which press outwardly from the single supporting bar which rests on the rails, making a continuous rubbing contact. The conductors, of which there are two, are very nearly directly under the slot. The voltage is to be 250 to 300 volts. A statement made by one of those participating in the discussion of this Paper is significant in view of the disfavour which conduit railways have met with in the United States. He quoted from one whom he stated to be an authority that "a successful underground system would be a great calamity to the street railway interests of this country in view of the fact that if one were adopted every little city throughout the country would demand that all the wires be put underground, and it would ruin nine-tenths of the street railways in this country if they were compelled to operate under such a system." In addition to the opposition from that source, conduit railways have also undeniably been kept in the background by the great electrical companies who did not wish to have competition with their trolley systems. The electric conduit roads being built in New York and Washington will almost undoubtedly result in a demand by municipalities for the substitution of that system for trolley lines, and may possibly in many cases result in great hardship, as pointed out above. On the other hand, the enormous value of the franchises given away in the larger cities in the United States would entirely justify the expenditure. While among electric street railway franchises none approach in value that of the Metropolitan Elevated Railway of New York City, which is now valued by its owners at $50,000,000, yet some of them have a value up in the millions, for which the municipalities have received little or nothing. This fact will, doubtless, be used as an argument to force the adoption of the electric conduit after its practicability is once demonstrated.

PARIS NOTES.

(FROM OUR OWN CORRESPONDENT.)

Paris, *November* 27, 1894.

The Popp Company.—The *première commission* of the Municipal Council has had a proposal brought before it to withdraw from the Compagnie Parisienne de l'Air Comprimé its right to lay cables under the public way. This is the illogical outcome of several gentlemen on the Board of the Société du Secteur de la Place Clichy having taken up analogous positions on the Board of the Popp concern. Although in possession of the finest district in Paris, the operations of the Compagnie Parisienne de l'Air Comprimé show a deficit of some 28 million francs. The financial supporters of this disastrous enterprise are determined at all costs to get out of this rut, and they have come to an agreement with the Société de la Place Clichy to undertake the transformation of the Popp system into a five-wire network. This being so, the Municipal Council immediately thought that the Popp Company's area was going to be annexed by the Société de Clichy, but if the statements of the two Boards are to be credited the two concerns will remain autonomous. For the first six months of 1894 the Compagnie Parisienne has improved its position, thanks not to increased receipts but to reduced expenses. The profit and loss account shows a profit of 100,845fr. against a loss of 157,000fr. for the first six months of 1893; the working expenses exhibiting a reduction of 100,000 francs. The final net result, however, thanks to the financial burdens that weight the undertaking, is a loss of no less than 584,000 francs.

The Compagnie Générale des Lampes Incandescentes Edison-Swan.—This Company has now gone into voluntary liquidation with a view to reconstruction on a new basis and with a reduced capital. Competition has seriously affected this Company for some years past.

The Incandescent Gas Burner.—The Compagnie d'Incandescence par le Gaz Auer has just won a case against an infringer. Its actions against several other alleged infringing companies will come before the Courts towards the end of January next. Whatever the drawbacks of this mode of lighting may be it is impossible to gainsay its rapid progress. There are now some 600,000 Auer burners in use.

Canal Boat Traction.—M. Galliot, the promoter of the idea of electric traction on canals, has just returned from a journey to Russia, which he made with a view of studying the question of the navigation of the Volga by means of the Hutin-Leblanc device now at work on the Burgundy Canal. The hauling of boats up steep inclines, which has been greatly improved by M. Maurice Levy, has the weak feature of not lessening the twisting effect; on one side of the poles the hauling cable is twisted up and on the other it is untwisted. The result is excessive molecular strain and mechanical friction of spiral against spiral, tending to considerably abridge the life of the cable.

LEGAL INTELLIGENCE.

Shelfer v. The City of London Electric Lighting Company, and Meux's Brewery Company v. The City of London Electric Lighting Company.

The case of Shelfer *v.* the City of London Electric Light Company, and Meux's Brewery Company *v.* the same, came before Lords Justices Halsbury, Lindley and Smith in the Appeal Court on Friday last.

Counsel for Mr. Shelfer, Mr. Warmington, Q.C., and Mr. Waggett; for Meux and Co., Mr. Warmington, Q.C., and Mr. Badcock; for the Electric Lighting Company, Mr. Moulton, Q.C., M.P., Mr. Renshaw, Q.C., and Mr. Braithwaite.

The case came originally before Mr. Justice Kekewich, whose judgment was delivered on April 19, 1894 (see *The Electrician*, April 20, p. 699). It was against this judgment that the defendant Electric Light Company now appealed.

Mr WARMINGTON said that the appeal was not taken on the ground that the learned judge decided against the appellants, or that he had decided against the evidence; but that the learned judge had not given the appellants the right sort of relief—namely, the judgment had given damages, whereas the appellants desired injunction. The action was an action brought by the plaintiff, who was and is the lessee of premises which are known as the "Waterman's Arms," Bankside, Southwark, for a term of 21 years from March 25, 1893. He brought his action against defendants for a nuisance, the nuisance being—(1) vibration, (2) noise, (3) steam. Very early in the case the nuisance of steam was eliminated, because of an admission made by the defendant Electric Light Company that the apparatus necessary for the condensation of the steam had been completed.

Lord Justice LINDLEY: The learned judge granted damages instead of an injunction?

Lord Justice SMITH: Do you say that he could not?

Mr. WARMINGTON: Yes, my lord, I say he could not.

Lord Justice LINDLEY: That is a point which is rather crotchety.

The issue being thus stated, the argument now resolved itself into one of a point of law, and the question of construing the meaning and powers of the Acts and Provisional Orders under which the Electric Light Company carries on its work, as well as that of the Common Law as laid down in the judgments of former analagous cases. From Mr. Warmington's point of view, the case of Martin *v.* Price was cited, and Mr. Warmington's arguments were directed to the point that Mr. Shelfer, having proved that the nuisances complained of were detrimental to his house, to his custom, to the health of his wife and daughter, and to his own and his wife's sleep, it was not possible for any Court to assess damages for these things in the past and in prospective; but that the only natural, proper, and legal remedy and relief was by a restraining injunction. Moreover, Mr. Warmington averred that there was no evidence given that these nuisances were unavoidable. The Company could carry on their business without the nuisances if they liked. He further pointed out that whereas when the action for these nuisances was first entered the Electric Light Company were only using 4,000 H.P., the Manager of the Company, Mr. Cook, admitted that the Company intended to increase it to 20,000 H.P., and hence the nuisances complained of were likely to increase rather than diminish. Mr. Warmington said he had looked up all the reported cases where damages had been given in lieu of injunction, and in not one was there a suggestion that the damages had been given, except where the injunction would have to be of a mandatory character, such as to pull down some building.

Mr. RENSHAW, Q.C., for the Electric Light Company, argued that damages were a proper, legal, and sufficient relief and remedy. He rested his case very largely on Section 10 of the Provisional Order, which not only conferred powers to acquire land, construct works, and acquire licences and patents, &c., but also empowered the Electric Light Company to "generally do all such acts and things as may be incidental to such supply." The working of steam power, dynamos, &c., were, he argued, "incidental" to and necessary for the supply electric light.

Mr. MOULTON, Q.C., followed on the same side, and extended the same line of argument, contending that the Electric Light Company were not only granted powers to construct works and do other certain things, but they were also under other statutory *obligation*—they were in duty bound to make a sufficiency of electrical energy, and to supply, and continue to supply, any and every applicant for it. Cases were cited, and counsel argued that under such powers as were conferred on railway companies, water and gas companies, and electric supply undertakings, the necessary works must be made and maintained, even though they were a nuisance to the neighbourhood. The whole question was—first, that the Company should not cause unnecessary nuisance; and, secondly, that they should pay damages for what nuisance was caused. But if an injunction were granted to stop the works it would mean the prevention of the Company carrying out the supply of electricity, for which statutory duties had been imposed and statutory powers granted.

Monday, November 19th.

Mr. MOULTON, Q.C., resumed his argument in support of Mr. Justice Kekewich's judgment as against the appellants. The learned counsel's enunciation of the law was that his Company were not only under a privilege, but they were also under statutory duties; to wit, under their Provisional Order they were bound to lay down mains within 21 months of the date of the Order, and they were bound to keep those mains charged. There might be some doubt, there might be ground for argument, whether or not the Company, having laid down their mains, were bound to charge them; but at any rate, having once charged those mains and commenced the supply of electricity to the public, there was no doubt whatever that the Company were bound to continue to keep the mains charged. And as the Provisional Order gave the Company powers to do all that was necessary for this supply of electricity, the learned counsel argued that his Company were now simply obeying the Provisional Order, one inevitable result of which was a certain amount of vibration, which, although it might be a nuisance, was a justifiable nuisance under the powers of the Provisional Order, the remedy and liability for which was by payment of damages, and could not be by injunction, inasmuch as an injunction would prevent the Company from obeying their statutory duties.

Lord HALSBURY pointed out that it might be argued that the Electric Light Company might have several generating stations, where engines of less horse-power might be used, and consequently less vibration caused—in other words, was it or was it not compulsory for the purpose of carrying out the Provisional Order to concentrate all the necessary generating power to this one station at Bankside, or at any one station?

Lord Justice SMITH asked Mr. Moulton: Suppose you take out the nuisance of steam, and supposing that the nuisance of vibration is obliged to go on; the tenant being in possession for 21 years, how is the prospective nuisance for these years by vibration to be properly estimated?

Mr. MOULTON said that possibly there might be such a nuisance as to destroy the value of the property. Here was the Company under an obligation of supply by statute, and an ever-increasing obligation, under which circumstances incidental nuisances or injuries would have to be paid for undoubtedly, but not to deprive by injunction the Company of power to work out their obligations.

Lord HALSBURY pointed out that the construction of the statute was that the Company should not commit a nuisance.

Lord Justice LINDLEY remarked that he thought the House of Lords had ruled that where a nuisance had been proved, and where it was recurrent, an injunction followed naturally. His lordship quoted the ruling of the House of Lords, to which he referred; but

Mr. MOULTON pointed out that that ruling was given prior to Lord Cairns's Act, and it was on Lord Cairns's Act he relied as giving the Courts discretion to award either damages or injunction. Later on Mr. Moulton argued that people could, and did, very soon get accustomed to vibration, and the feeling of its being a nuisance abated.

Lord Justice SMITH asked how money compensation could be given for loss of sleep during the 21 years' tenancy?

Mr. MOULTON argued that Mr. Justice Kekewich apparently took the view that although the vibration might make a person less willing to take the house, yet that the vibration was not so severe as to cause permanent loss of health.

Lord Justice SMITH pointed out that the next-door neighbours of Shelfer testified to the vibration also.

Mr. MOULTON contended that the Court below apparently thought that when the nuisance and noise of steam was removed damages was a sufficient remedy for what remained.

Lord HALSBURY said that the construction of the Act was that powers were conferred to do certain things if those things could be done without committing a nuisance.

The Court then asked Mr. Warmington to address himself in his reply to the powers of the Act.

Mr. WARMINGTON said that under Section 10 of the Act the whole of the powers to be taken by the undertakers is to be subject (among other things) to the provisions and restrictions of the Act itself; secondly, the Act draws a distinction between construction of works and use of apparatus; and thirdly, that under Section 17 the question of awarding damages was confined exclusively to damages caused in the execution of the works. Then, too, Section 82 of the Order stipulates that "nothing in this Order shall exonerate the undertakers from indictment, action, or other proceedings for nuisance in the event of any nuisance being caused by them." Under these terms Mr. Warmington contended that the undertakers could either take up the powers of the Order or not, but that if they did they were subject to every action as any other person. In support of this view Mr. Warmington cited Mr. Justice Fry in a gas company case, where that learned judge held that the company was not justified in causing a nuisance by the construction of gas, even if the gas could not be made of the requisite purity without so doing.

Meux's Brewery Company Appeal.

The court then proceeded to hear the appeal of Messrs. Meux, and at the outset Mr. Renshaw, Q.C., objected that the appeal was out of time, the judgment of the court below being dated April 19th, and the date of the appeal being October 23rd. Learned counsel held that the time limit was three months, which had been exceeded. A somewhat elaborate legal argument resulted upon this technical point, and in the end the Court overruled the objection without calling upon Mr. Warmington.

Opening Messrs. Meux's case, Mr. WARMINGTON said he asked for damages on a much wider scale than that granted by the Court below. Argument turned upon the presence of a crack in the house rented by Mr. Shelfer, Messrs. Meux contending that they wanted their house to be as lettable at the end of the present lease as it was when the lease was granted, and they disputed the allegation of the Electric Light Company that this crack was caused by subsidence consequent on the deep foundations of the Company's works, and contended that the cause of the crack was the vibration, which vibration was likely to continue, and to grow worse, and, therefore, to cause an extension of the crack—all which could not be subject to assessment for prospective damages.

Lord HALSBURY expressed the view that if the effect of the excavations at the electric works was to render the "Waterman's Arms" less secure than it was, would not the effect of vibration be to produce further injury to a weakened house?

Mr. WARMINGTON, continuing his argument, held that the state of the law on the point was that, there being a nuisance of a permanent character, the reversioner had a right to an injunction, unless it could be shown (if he might use an Irishism) that the nuisance would not last until the expiration of the term.

Mr. RENSHAW, opening the Electric Light Company's case, maintained that Messrs. Meux, being reversioners, were not entitled to other or further relief than that already given by the Court below—viz., their remedy and relief was limited to damages. The state of the law, he said, was that the reversioner is not entitled to either damages or injunction, unless he showed that the nuisance complained of was of a permanent character. Against the permanent character of the vibration in question Mr. Renshaw argued that no one could say it would be permanent, because no one could say that before the reversioner gained possession of the house some new method of making electricity might not be discovered; or the Electric Light Company might, perhaps, remove the site of their works, and so end the vibration and nuisance. He proceeded to cite rulings to support this view.

On reference to the writ, the Court doubted if the reversioner could ask relief on account of inconvenience and loss of custom to the tenant in possession: but

Mr. BADCOCK explained that Messrs. Meux and Co. were mortgagees as well as reversioners, and therefore their interests were identical with those of the tenant in possession.

This being an entirely new point—not before mentioned in the case—the Court allowed it.

Mr. BRAITHWAITE (for the Electric Light Company) took the ground that as electrical science might be so improved as to allow of its being generated without causing vibration, it could not be proved that the nuisance would be permanent.

Judgment reserved.

Stamp Duties on Telephone Rental Agreements

In the Queen's Bench Division this week an important question of stamp duties has been ably argued in the action "Jones, appellant; Commissioners of Inland Revenue, respondents." Mr. Gore-Browne and Mr. R. Bankes were for the appellant, and the Solicitor-General and Mr. Danckwerts for the Crown, who claimed *ad valorem* duties on an instrument under which Mrs. Jones, carrying on business as Keith, Prowse and Co., entered into an agreement (under seal) with the National Telephone Company for telephonic communication to be supplied by them. Mrs. Jones was desirous of establishing telephonic communication from her head office, 48, Cheapside, London, to her other London branches, and to various theatres, hotels, and other places, such telephonic communication being by means of metallic circuits, and including telephone instruments at the head office; and the Company had agreed to supply the means of such telephonic communication, and to maintain them, she undertaking to pay quarterly instalments in advance to the Company for the use of the telephonic lines and apparatus, and for the telephonic communication the annual sum of £11. 5s. per line, the minimum amount to be payable being calculated on a rent of 45 lines, or £506 per annum, the agreement to be in force for ten years subject to a power for the Company to terminate it by notice. The Inland Revenue Commissioners were of opinion that the instrument was the only or principal security for the sum of £506 payable annually for an indefinite period by quarterly instalments; that such sum was not interest nor rent on a lease; and that it was an instrument charged under the Stamp Act of 1891 with the *ad valorem* duty of 2s. 6d. for every £5, which would make the duty payable £12. 15s. Mrs. Jones appealed for the smaller duty.

After hearing counsel on both sides, the Court gave judgment for the Crown, and came to the conclusion that, though Mr. Gore-Browne and Mr. Bankes had argued the question with great ability, their contention could not be maintained, but the Crown was entitled in both cases to the *ad valorem* duty.

Mr. Justice WRIGHT, in giving judgment on the appeal, said that he could see no lease in the agreement. It was an agreement under seal to pay the £506, and that was a "covenant," and it came under the head of bond or covenant for payment of the money by quarterly payments: and it came within the words, "bond, covenant, or instrument," &c., which required an *ad valorem* duty. The document, therefore, was required to be so stamped as the Commissioners had determined. The word "security" meant any obligation, not merely an auxiliary security. The document could not be considered as a lease, as no exclusive possession was to be given of the wires. The money was to be paid not merely for wires, but for services to be done, and therefore there was "rent to be reserved on a lease." The judgment, therefore, must be for the Crown.

The Electrical Power Storage Company (Limited) v. The Chloride Electrical Storage Syndicate (Limited).

Sir RICHARD WEBSTER, in the Chancery Division on Friday last, mentioned a patent action, in which he said he was not in a position to move, but was desirous that it should be effective next week, and for that purpose he asked that the defendants should undertake to file any evidence they desired to use by Tuesday last.

Mr. Justice NORTH reminded him that next week Mr. Justice Chitty would be taking his motions, and, consequently, they would be heard on Thursday instead of Friday.

Sir RICHARD WEBSTER said it was another example of the inconvenience of shifting motions from one Court to another, and he hoped the time was not far distant when the old state of things would be revived. Under the circumstances, he thought he had better make a virtue of necessity, and allow the motion to stand until Thursday week.

Bannister v. Julius Sax and Co. (Limited).

This was an action heard at the Liverpool Assizes, in which the plaintiff, Mr. Maunsel C. Bannister, civil engineer, of Liverpool, sued the defendants, Julius Sax and Co., electrical engineers, of Smithfield Market, London, to recover £356 for moneys paid and work done. The defence was that a third party was liable.

The plaintiff's claim was for services rendered during January, February, and March last, in preparing specifications and estimates for the building of cold storage premises at a cost of £26,000. The defendants had taken from the City of London Corporation a piece of land at Smithfield on which to erect apparatus, &c., for supplying electric light to the market, and the building was to be erected within twelve months. This was just prior to Julius and Charles W. Sax turning their firm into a limited liability company, now known as Julius Sax and Co. (Limited). It was subsequently proposed to establish a syndicate to be known as "The Metropolitan Cold Air Storage Company," with a capital of £5,000: but this syndicate was not formed, and the plaintiff sent in his claim to Mr. C. W. Sax, charging 1¼ per cent. for the work done up to that point. The solicitors for the defendant Company answered that there was no pretence for the claim against their clients.

When the defendants' case had been partly heard defendants' counsel proposed a settlement, which was agreed to.

Displacement Current Phenomena.—At a recent meeting of the Academy of Science of Amsterdam, Herr C. H. Wind read a note on the Kerr phenomenon. The author breaks up the electric current into two parts—a current of conduction and a displacement current—and to these attributes, as Lorentz has done, the Hall effect. He supposes, however, says *Nature*, that the electromotive force which constitutes the Hall effect is different for the two constituents, while Lorentz supposes them to be equal. The introduction of this hypothesis into the calculations of Van Loghem does not alter the general form of the results, but has the effect of giving expressions for the phase and the amplitude of the magneto-optic component which differ by a constant quantity and a constant angle from the old values. In this way the difference of phase discovered by Sissingh is explained; and from the observed value of this difference of phase the ratio between the intensity of the Hall effect for the displacement and conduction currents can be calculated, and then from observations of the amplitude the value of each of these can be found. From the calculations made by the author it appears that the values thus obtained are of the same order as those got by direct observation of the Hall effect, if we suppose that the specific resistance of metals for periodic currents of extreme rapidity is greater than for continuous currents. This view is further supported by other calculations which have been made by the author. The Paper concludes with a comparison between the above theory and the theories propounded by Thomson, Goldhammer, and Drude.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices* :—

Laboratory Notes and Forms.—With the above title, we have in preparation a set of Elementary (nearly ready) and Advanced Notes and Forms for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. They are prepared with the object of saving the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

The 1894 Edition of "The Electrician" Electrical Trades' Directory and Handbook contains 1,000 closely-printed pages, and several new and useful features have been added. The price of this edition of the Directory and Handbook is now 5s. post free; abroad 5s. 6d. *The 1895 edition is in active preparation*, and subscription and advertisement orders should now be sent in.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is just out, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d., post free 11s. (abroad 11s. 6d.).

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"The Work of Hertz."—The lecture delivered by Dr. O. J. Lodge at the Royal Institution on June 1st is reprinted with corrections and additions, and many original illustrations, price 2s. 6d. net.

"Electrical Engineering Formulæ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"Electromagnetic Theory" (Vol. I.), by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application. Vol. II. is in preparation.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application to the Publisher.

"Drum Armatures and Commutators."—This book, written by Mr. F. Marten Weymouth, is also ready; price 7s. 6d (abroad 8s.). Prospectus on application.

Tenders Invited.—The Corporation of the City of Melbourne invite tenders for the supply, delivery, and erection of alternating current dynamos, exciters, switchboard, transformers, instruments, &c. Specifications and conditions of contract may be seen at the offices of *The Electrician*, and tenders have to reach Mr. John Clayton, Town Clerk, Town Hall, Melbourne (Australia), not later than 11 a.m. on Tuesday, January 22nd next.

———— It will be seen by our advertisement columns that the Cowpen District Local Board (Blyth, Northumberland) require tenders for the lighting by electricity or otherwise of the lighting area within their district for a period of seven or ten years respectively, from August 15, 1895. Tenders must be sent to Mr. R. T. Guthrie, the clerk to the Board, by December 20th.

———— The Corporation of Coventry invite tenders for electricity meters. Some information appears in our advertisement columns, and full particulars can be obtained of Mr. R. Hammond, consulting electrical engineer, Ormonde House, Great Trinity-lane, E.C. Tenders have to be in on or before Wednesday, December 12th.

———— The Governors of the Enniscorthy District Lunatic Asylum invite tenders for supplying instruments and apparatus for internal telephonic communication, equal to 13 stations. Tenders must be sent in to the Chairman of the Board not later than 6 p.m. on December 11th.

———— The General Secretary of the Exhibition to be held at Bordeaux next year is inviting proposals from electrical engineering firms for the contract for the electric lighting of, and the supply of electrical energy in, the Exhibition grounds, from May 1st to November 1, 1895. The London Chamber of Commerce notify firms who are interested in this exhibition that they should put themselves in communication at once with the Secretary, Botolph House, Eastcheap, E.C.

Tenders Accepted.—The Governors of Harrow School have provisonally accepted the tenders of Messrs. Crompton and Co. for the supply and erection of plant, and for the maintenance of the same, for lighting the school by electricity, the amount being £8,762 for plant, apparatus, &c., and £1,686 for maintenance. Seven other tenders were received. The estimate of the engineer to the Harrow Local Board was £9,300 and £2,092 respectively.

———— The tender of Messrs. B. Verity and Sons has been accepted for the lighting of the Salisbury estate, for the sum of £5,437.

———— The Sunderland Town Hall Committee have accepted the tender of Messrs. Reed, Ferens and Co. for the wiring of the Town Hall. Messrs. Crompton and Co.'s offer for alterations to the existing gas fittings for £35 was accepted. Other tenders were agreed to, bringing the total estimated cost up to £450, against the original estimate of the electrical engineer at £595. The selection of designs for arc lamps and pillars has not yet been made.

Tenders Received.—The Ottawa *Daily Citizen* says that tenders for the laying and maintenance of the proposed Pacific cable were received from the following London firms:—Telegraph Construction and Maintenance Company (Limited), Messrs. Siemens Brothers and Co. (Limited), Fowler-Waring Cables Company (Limited), W. T. Henley's Telegraph Works Company (Limited), India-Rubber, Gutta-Percha and Telegraph Works Company (Limited), and Francis A. Bowen. The tenders are said to apply to each of the eight routes proposed, and are all under Mr. Sandford Fleming's estimates.

Sales by Auction.—*Postponement of Sale.*—The sale by auction by Messrs. Wheatley Kirk, Price and Goulty at the Deptford Central Lighting Station, Stowage Wharf, Deptford, S.E., of a quantity of surplus plant and stock, for the London Electric Supply Corporation (Limited), originally announced for the 28th inst., has been postponed until the beginning of December.

Plant for Sale.—The Brighton and Hove Electric Light Company (Limited), announce for sale the whole of their plant, machinery, and stock, at Brighton, including engines, boilers, dynamos, converters, meters, cables, instruments, and apparatus, &c. Some further particulars are given in our advertisement columns, and all information can be obtained of Mr. G. C. Sneath, 44, Gresham-street, London, E.C.

Appointments Vacant.—The Technical Education Committee of the Hampshire County Council invite applications for the post of director of technical education, at a salary of £300, rising to £400, per annum. Mr. V. Cornish, 13, Southgate-street, Winchester, Hants, will supply all further information, and applications must be sent in not later than December 8th.

———— A science master is required for Owen's School, Islington, London. Salary, £240 per annum. Further information can be obtained of the head-master.

Liquidation.—A first dividend of 4s. in the £ in the liquidation of Newington, Priddle and Co. (Limited) is payable at the Official Liquidator's, 33, Carey-street, London, W.C., any day except Saturday.

Dissolutions of Partnership. The partnership between Messrs. H. T. Middleton, J. F. Nugent, F. B. Spencer, and E. C. Wild, carrying on business at 34, Victoria-street, London, S.W., as H. T. Middleton and Co., electrical engineers and contractors, has been dissolved.

———— Messrs. G. S. Tunks and E. R. Polehampton, carrying on business as electrical and mechanical engineers at Cardiff, under the name of Tunks and Co., have dissolved partnership; the business will be carried on by Mr. G. S. Tunks.

New Works.—It is stated that Messrs. Willans and Robinson (Limited), of Thames Ditton, have just acquired a fine site of 30 acres of land, situate in Newbold-road, Rugby, close to Rugby Station, and are preparing to erect works on a large scale, the firm having found the Thames Ditton premises too small for their requirements. The new works will have a frontage of about 1,000ft. to the London and North-Western Railway, will cover about 20 acres of land, and, it is expected, will provide employment for about 300 hands. We are pleased to learn that the firm were not very seriously inconvenienced by the recent floods in the Thames Valley, in the neighbourhood of which their present works are situated.

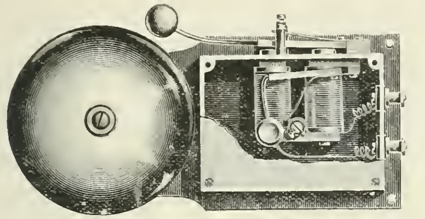
Mr. F. Bathurst.—This gentleman, who has for some time past been engaged by Mr. G. H. Johnson, formerly a partner with Edison, is about returning to this country with the object of introducing one of the American underground systems.

The Institution Dinner.—Messrs. Crompton and Co. supplied seven large electric ovens, four hot plates, and other electrical apparatus for cooking the dinner at Freemason's Tavern last week. Some difficulty was at first experienced in convincing the *chef* that cooking could actually be carried out by electricity, and he was so incredulous that he demanded a trial beforehand. He was, however, soon convinced of the practicability of the process, and in the end cooked 16 saddles of mutton, 30 brace of game, and numerous small dishes by electricity. Several other dinners served at the Tavern on the same evening were also partly cooked by electricity. The *chef* subsequently wrote Messrs. Crompton, expressing himself highly pleased with the results obtained.

The Holmes Switch.—A bill is to be introduced into the next session of Parliament to continue and confirm the patent No. 3,256 of 1884, granted to Mr. J. H. Holmes, of Newcastle-on-Tyne, for a quick-break loose-handle switch.

"Hedgehog" Transformers.—Messrs. Swinburne and Co., of Teddington, have received a letter from Messrs. New and Mayne, informing them that during the late floods in the Thames Valley, one of the ordinary type "Hedgehog" transformers, without cover, was discovered to have been working for at least two days in 15in. of water. The transformer was lifted above the water level, and has since continued to do its work without intermission.

A Watertight Electric Bell.—The accompanying illustration shows a new form of electric bell, recently protected by Mr. F. C. Allsop. It has been designed for use in mines, railway stations, on board ship, and other places where bells are exposed to damp and the direct action of the weather. The chief feature of the invention is that the magnet coils, contact breaker, and all other parts liable to be affected by moisture, &c., are hermetically sealed in a metal box. The bell will, it is claimed, work under water, and may be left submerged for a long period without in any way affecting its working. The illustration is of a 6in. bell. Both the base and the box are of metal, and are cast in one piece, the box being fitted with a metal lid and a layer of indiarubber to make it watertight. Inside the box are the magnets, the poles of which pass through one side, while outside the box and opposite these poles are the usual armature and hammer working on the gong below. Inside the box polar extensions are fitted to the magnets, and off these poles is worked a second armature, fitted with a contact breaker. Thus the armature inside the box makes and breaks the circuit, causing the one outside to vibrate in unison with it. The bells give a powerful stroke, and do not, it is stated, require more battery power than the ordinary form.



Nalder and Harrison Construction Syndicate (Limited).—In order to provide an increase of capital to cope with the large amount of business now in hand, the private firm of Nalder and Harrison has been converted into a limited liability concern, with the above title. The shares are, we understand, being privately subscribed by the Directors and their friends. The business will be carried on under the same management as hitherto.

Awards.—Under this heading last week, reference was made to the awards recently obtained by Roothaan, Alewijnse and Co. The sole agents in this country for this firm's manufactures, including lamps, dynamos, and general fittings, are Messrs. Slade, Templeton and Co., 15, New Broad-street, E.C., who hold a large stock in London ready for immediate delivery. The same firm make a speciality of machinery, stores, and appliances for submarine cable steamers, and a stock of buoys, grapnels, mushrooms, &c., are kept on hand for the prompt fitting out of telegraph steamers.

French Catalogue of English Instruments.—We have received a copy of a catalogue which we are sure will prove useful to our French readers. It is issued by Mons. H. T. Cheswright, of 18, Rue de Maubeuge, Paris, agent in France, Spain, and Belgium for the electrical and other instruments and apparatus manufactured by Mr. R. W. Paul, of Hatton-garden. The catalogue illustrates and describes many of these instruments, as well as giving prices.

"Trade" Journalism.—The *Financial Times* is very properly calling attention to the tactics adopted by the *Journal* of the Chamber of Commerce in connection with its advertisement business. If the circular which our financial contemporary reproduces is genuine, it throws a remarkable, and, we presume, quite up-to-date, light on so-called representative or official journalism.

Electro-Harmonic Society.—A "ladies' night" is announced for this (Friday) evening, at St. James's Hall Restaurant, Regent-street, W., at eight o'clock. An excellent programme is provided.

Aberdare.—At a meeting at the Boot Hotel to make arrangements for the formation of a local company to deal with the electric lighting of the town a very sanguine view was taken of the revenue-earning prospects of the new company.

Acton. A deputation waited upon the Local Board last week to discuss the proposed transfer of the electric lighting Provisional Order to Messrs. New and Mayne. The object of the deputation was to urge upon the members the ultimate benefit to be obtained by the Board keeping the Order in their own hands, and supplying the light for both public and private purposes. A lengthy discussion followed, in which Mr. Baker, a prominent resident, pointed out that a profit would certainly accrue to the local authorities if, in conjunction with the lighting scheme they combined the refuse destructor. In reply, the chairman of the Board said that the scheme would cost the parish a fourpenny rate, and as they had received an offer from a private company to put up a dust destructor, destroy the dust, and put up a lighting plant value £25,000, all the initial loss would be borne by that company, and when a profit accrued the Board would participate in it. Mr. Baker finally pointed out that it was the view of the deputation that the question of the electric light had been brought before the Board in a too hurried manner, and he suggested that the final decision should be left over until the new Board came into existence.

African Telegraphs.—Mr. Cecil Rhodes has recently ordered 650 miles of material for his Cape to Cairo line, and it is estimated that this will, when used up, complete the line from Blantyre to Ujiji on Lake Tanganyika.

Asylum Lighting.—Messrs. Ernest Scott and Mountain (Limited) were some time back entrusted with the contract for lighting by electricity the new Craig House, Morningside, Edinburgh, and have now successfully completed the work. The generating plant consists of two Lancashire boilers, four 60 h.p. engines, four Tyne dynamos, with all the necessary main switchboards, coupling switches, and about 1,350 16-c.p. incandescents and fittings. The fittings in the great hall, corridors and principal rooms throughout the Asylum have been made by Messrs. Singer and Sons, of Frome, to special designs by the architects, Messrs. T. Mitchell and Wilson, of Young-street, Edinburgh. Distributed over the building, there are about 600 pendants. The whole of the work in connection with the lighting has been carried out under the supervision of Mr. Bryson, of 11, Bothwell-street, Glasgow.

Automatic Machines to the Rescue.—At the meeting of the Manchester Engineering Association on Saturday last Mr. Joseph Nasmith read a Paper on "Prepayment Gas Meters," in which he said that 12,000 penny-in-the-slot machines were in actual use in Liverpool, and that the London gas companies were taking the machines by hundreds weekly. By this means the gas companies would be able to fill the gap caused by the use of the electric light amongst the better-off section of their old customers.

Ayr.—A committee of the Town Council has been appointed to acquire and conclude the purchase of a site for the electric lighting works.

Birkenhead.—A Local Government Board inquiry was held on Wednesday last at the Town Hall by Mr. Rienzi Walton, M.Inst.C.E., into the application by the Town Council for sanction to borrow £35,000, of which £20,000 was required for electric lighting purposes. No opposition was offered to any of the schemes for which the money is required. Mr. Shoolbred explained the electric lighting scheme of the Corporation, for which he said low pressure current would be used.

Bristol.—Mr. George Pearson has been appointed chairman of the Electrical Committee of the Corporation for the ensuing year, and Mr. Stephen Tryon deputy-chairman. As the response from the occupiers of premises in St. Stephen-street was not considered satisfactory, it was decided not to make this extension at present. Several other applications were considered, and the extensions agreed to.

Cardiff.—The Electric Lighting Committee of the Corporation are already talking of extensions. At the last meeting of the Committee the Mayor said the opinion prevailed that the glass of the street arc lights was too dense. Mr. W. H. Massey pointed out that the lamps selected were of the same type as those seen by the Sub-Committee in use in Victoria-street, London, and being deemed the best were selected. Councillor Riches suggested that the upper part of the glass, above the point of combustion, should be of transparent glass, the lower part to remain opaque as at present, and it was resolved that the experiment should be made. According to the *Western Mail* a hitch has occurred in the supply of meters, and in a reported interview with the borough engineer this delay is accounted for by the fact that there is such a great demand for these instruments throughout the country that they cannot be made fast enough. A new supply scale has been drawn up, under which it is proposed to charge for an 8-c.p. incandescent, 15s. per annum; for a 16-c.p., £1. 2s. 6d.; for a 25-c.p.,

£1. 14s.; for a 32-c.p., £2. 5s.; for a 50-c.p., £3. 6s.; for a 100-c.p., £5. 13s. 6d.; for a 200-c.p., £11. 7s.; for a 300-c.p., £17. 0s. 6d.; in place of a general rate of 6d. per unit. For private residences and offices the charge is to be one-third less.——Numerous applications have been made for the post of foreman of works at the electric lighting station, and Messrs. P. Rehers (Worcester), T. J. Archer (Chelmsford), and C. H. Yeaman (London) are to attend at the next meeting of the Electric Lighting Committee.

Ceylon.—It has been definitely decided to light the new post-office buildings at Colombo by electricity. The contract has been entrusted to Messrs. Boustead Bros., and the work will be under the supervision of Mr. J. Torr Todman, the Company's electrical engineer. 28 arcs and about 100 incandescents will be required.

Chester.—Councillor John Jones has recently placed his views on things generally, and on the Chester City affairs in particular, before his constituents. He thinks the ratepayers of Chester have been wise in delaying the introduction of the electric light, as, in view of the developments and improvements that have been and are daily taking place, the delay would ultimately prove to be a benefit to the city. He welcomed the electric light on the grounds that it would be cleaner, more healthful, and eventually much cheaper than gas.

Church Lighting.—The parish church of Buckland, near Dover, and of St. Mary's Church, are both to be lighted electrically.

City Electric Athletic Club.—This club, formed last winter amongst the staff of the City of London Electric Lighting Company, gave a smoking concert on Friday last at the London Tavern, Fenchurch-street, E.C. Mr. J. Cecil Bull was in the chair, and a capital programme, arranged by Messrs. Trowein and Harrison, was successfully gone through.

Coventry.—At the last weekly meeting of the City Council, Mr. Drinkwater called attention to the subject of the supply of electricity meters, and pointed out that an unusual course, he thought, had been adopted in having the tenders for these instruments sent in to a private individual acting on behalf of the Corporation, instead of, as usual, to the Chairman of the Electric Lighting Committee. Mr. West, Vice-chairman of the Committee, admitted that it was somewhat out of the usual course, but Mr. Hammond, their technical adviser, had reported that only very few firms made these meters, in which there was a great deal of difference, and he (Mr. Hammond) was anxious that the Corporation should obtain a meter that would perform its work to their satisfaction. After a long discussion, in which the course adopted by the Committee was generally disapproved, the Town Clerk said he would arrange with Mr. Hammond that the tenders should, in the first place, be sent in to the Town Clerk. The amendment to the Committee's recommendation was then withdrawn. An instruction has been given to Mr. Hammond to prepare rules for the wiring of houses connected with the public supply mains, and consumers applying before June 30th next are to be connected free of charge.

Croydon.—The County Council have rescinded a decision come to in March last that gas pipes should be laid throughout the new municipal buildings in High-street, at a cost of £290, and have recommended that the building be wired for the electric light. Arrangements are being made for a temporary installation pending the completion of the public supply scheme.

Dewsbury.—The Town Council have been approached with the object of inducing them to bring the electric light to the neighbourhood of the Dewsbury and District Infirmary, the Guardians of which have, in addition, under consideration a scheme for introducing telephonic communication between the infirmary and St. Mark's Church.

Edinburgh.—Included in the extension of the Corporation's electric lighting scheme current is now supplied to the M'Ewan Hall and Medical School at the new University, in addition to a number of large business premises, including the Globe Mart at the top of Cannongate.

Halifax.—The electricity works will, it is expected, be completed in about three weeks. Some of the boiler fires have already been lighted, and it is anticipated that the formal opening will take place early in January. There are already about 100 customers on the books, representing nearly 2,500 lamps.

Hotel Lighting.—Messrs. Rashleigh Phipps and Co. have just completed the lighting of Wimpole Hotel, Wimpole-street, and Limmer's Hotel, George-street, Hanover square, London, W.

India.—Mr. Lester Betts, agent of the Oriental Telephone and Electric Company, who has recently returned to Calcutta from up-country, has succeeded in securing some good orders for electric lighting in the Agra district.

Islington (London, N.).—The chief business at the last meeting of the Vestry was the consideration of a report from the Special Committee appointed on the electric lighting question with reference to a tender for structural iron and steel work required in the erection of the central station at Eden-grove. It will be remembered that fresh tenders for this work had been issued by the Vestry, and the Committee now recommended that Messrs. Moreland and Son's tender for £1,943. 12s. 7d., which was the lowest, should be accepted, and this was agreed to. Six tenders, ranging from £2,504 to £2,250, had been sent in.

Liverpool.—The Special Committee recently appointed by the City Council to deal with the lighting of the city on Wednesday last held a conference on the subject with the Directors of the Liverpool Electric Supply Company (Limited).

Llandudno.—A public meeting of the ratepayers has been held to consider the lighting scheme of the local electric supply company, and the opposition of the Commissioners thereto. Mr. Bellis, who has from the first taken a leading part in the introduction of the electric light into the town, and who, with Mr. Kingsland, has been instrumental in forming the company, explained to a crowded meeting the steps that had been taken by those interested in the subject. Several speakers complained at the Improvement Commissioners having voted money for the purpose of opposing the private company, and a resolution was moved calling upon the local authority to assist the company in its undertaking; but, after much discussion, the resolution was put to the meeting and lost.——A letter was read at the last meeting of the Improvement Commissioners from Mr. A. Dickenson, C.E., the consulting engineer to the promoters of the proposed electric tramway from Deganway, in which he stated that he had obtained the consent of the Land Company, and the Ecclesiastical Commissioners had approved of the scheme which he had prepared. Matters of detail only now remain to be completed. A 40ft. roadway is to be made along the shore of the river Conway, and the overhead system is to be adopted. The Improvement Commissioners have approved of the principle of constructing the electric tramway in accordance with the plans prepared by Mr. Dickenson.

Luton.—Official advertisements are issued by the Local Corporation notifying its intention to apply to the Board of Trade for a Provisional Order for lighting the town by electricity. Messrs. Sharpe, Parker, Pritchards and Barham, of 9, Bridge-street, Westminster, are the Parliamentary agents.—The advisability of making an application was again discussed at the last meeting of the Town Council, and a point which appears to have been insisted upon somewhat too strongly by the speakers was that the application for the Provisional Order necessarily committed the Council to no further action. Some doubt was expressed as to the actual amount to be voted for the scheme, sums of £10,000 and £12,000 being mentioned; but, as the Luton area is an extensive one, it is probable that this sum will be considerably exceeded.

Mill Lighting.—The extensive works of Messrs. E. D. Milnes Bros., Lumn Mills, Lumn, near Bury, have recently been completely fitted with arc and incandescent lamps from designs and under the superintendence of Mr. W. H. Campbell, of Bury-road, Tottington, Lancs. Siemens' dynamos and Yates' and Thom's condensing engines are included in the generating plant.——The mills occupied by Messrs. Mannering at Buckland (Kent) are to be lighted electrically.——St. George's Woollen Mill, Laxey Glen, Isle of Man, is now lighted electrically, the work having been done by Mr. Tennant, of King Orrey.

Mullingar.—After a long discussion at the meeting of the Town Commissioners last week, the application of Major Hackett, on behalf of the Irish Electrical Supply Company (Limited), for the approval of the Commissioners to the Company's application for a licence to supply the town with electric current, was approved.

Newcastle-on-Tyne.—The City Lighting Committee have decided to put up a number of additional electric lamps, and have ordered the removal of gas lamps in certain places in the city. The Board of Guardians have agreed to adopt their resolution of the Lighting Committee, recommending that the workhouse be lighted electrically, and that tenders be asked for. It is estimated that the first cost for plant, &c., will be from £1,200 to £1,500; and that ultimately a considerable saving will be effected over the present charge for lighting by gas.

Nottingham.—The Great Market Place has been illuminated this week by four 4,000-c.p. Brockie-Pell arcs, on pillars 22ft. high. These four lamps take the place of nine large gas lamps previously used.

Passage (Ireland).—It is stated that the Directors of the Passage Docks have purchased the machinery connected with the electric lighting at Donnybrook Fair, and that they have under consideration the lighting of the town.

Rhondda Valley.—At the last meeting of the Local Board letters were read from several large colliery companies in the district regarding the proposed scheme to light the valleys by electricity. Several of the companies were prepared to supply current upon terms to be agreed, and the Pentre Collieries Company offered to give further consideration to the scheme if the Sanitary Authority would grant a licence for supplying the district generally. Further replies are awaited, and it is fully anticipated that amongst the others made a scheme will be devised for lighting the valleys electrically.

St. Luke's (London).—In reference to the subject of transformer chambers, the Vestry have received a letter from the Board of Trade, pointing out that differences of opinion exist between the London County Council, the electric lighting companies, and the vestries with regard to the laying of these chambers for the public street lighting. The Vestry were invited to send a deputation to a conference on the subject held yesterday (Thursday). In the meantime work in connection with the transformer chambers has been temporarily suspended.

The Telegraph Messengers.—Over 700 lads, employed in the telegraph delivery service, were inspected by the Postmaster-General in the grounds of the Tower of London last week. Some time back exception was taken to the action of the Postmaster-General in ordering these lads to be drilled; but the feeble agitation which was organised speedily collapsed, and it was generally agreed at the inspection, which took place before the chief postal officials, that the department has in its employ a very smart body of lads, who will undoubtedly prove useful as auxiliaries to the volunteer forces.

Waterhead (near Oldham).—The Directors of the Equitable Co-operative Society have arranged with the Electric Lighting Committee of the Oldham Town Council for the extension of the electric lighting mains from Mumps Bridge to the large range of premises occupied by the Society at Bottom-o'-th'-Moor, where the whole of the shops are to be lighted electrically.

Worcester.—The charge per unit for electric current for cooking, heating, and motive power purposes has been fixed at 3d. The City Council have accepted an offer from Mr. Willis Bund giving the Council control of the floodgates of the Teme to prevent interference with the electric lighting works in the event of floods.——The Finance Committee have recommended that the Local Government Board's sanction be obtained for the raising of £18,030 for electric lighting purposes, in addition to £1,000 authorised in October, and for a further £1,200 for wiring the Guildhall and Public Hall. This matter was discussed at the last meeting of the City Council, and approved.

York.—The City Council have received from the Board of Trade a request for observations upon a letter received from a prominent resident complaining of the delay in proceeding with the work under the Provisional Order obtained by the Corporation in 1890. The Council's reply was to the effect that a number of tenders for the electric lighting of the city were under the consideration of a committee appointed for the purpose, and that the report, with the committee's recommendations, is expected to be presented at an early date.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

October 31, 1894.

20,853. F. Villiers-Stead. London. Improvements in advertising and electrical station and stopping-place indicators for vehicles.

20,886. A. D. MacDonald. London. Improvements in and relating to telegraphic relays.*

November 1. 1894.

20 917. H. H. Hall. Liverpool. Improvements in or connected with incandescent electric lamps.

20.944. G. L. Anders. London. Improved telephonic switch for intercommunication.

20,959. A. E. Williamson, E. L. Joseph, and The Electric Light Regulating Syndicate (Limited). London. New or improved regulating switch for electric lamps, and other electric apparatus.

November 2. 1894.

21,045. M. Hu[illegible]n and M. Leblanc. London. Improvements in alternate-current dynamo electric machines.

21,080. C. Lau[illegible]er. London. Improvements in secondary batteries.

November 3, 1894.

21,098. W. Bor[illegible]ers. Manchester. A novel or improved process and means for obtaining electrical energy from fuel gases.*

21,104. G. Grant. London. Improvements in grooved mouldings or casings for the concealment of electric wires and the like, in combination with picture rail and such like mouldings.

21,140. Siemens Bros. and Co. (Limited). London. Apparatus for controlling electrical illumination. (Messrs. Siemens and Halske, Germany.)

21,141. Siemens Bros. and Co. (Limited). London. Improved means for controlling the induced currents in short-circuited windings of the armatures of electromotors worked with rotary phase alternating currents. (Messrs. Siemens and Halske, Germany.)

21,142. Siemens Bros. and Co. (Limited). London. Improvements in apparatus for starting and reversing the motion of electromotors. (Messrs. Siemens and Halske, Germany.)

November 5, 1894.

21,185. C. T. Powell. Birmingham. Improvements in oil, gas, electric, and other light pendants.

21,202. G. C. Walker and T. S. Paynter. London. Electric typewriter.

21,218. C. P. Ehman. Manchester. Improvements in electric switches.

21,244. N. Z. Levy. London. Apparatus for electrically signalling from the locomotive to the carriages of a railway train.

21,250. A. Piedfort. London. Improvements in or relating to multiple telegraphic apparatus.*

November 6, 1894.

21,323. W. P. Thompson. Liverpool. Improvements in apparatus for welding electrically. (C. Lewis Coffin, United States.)*

21.330. G. Hübner. London. Improvements in galvanic batteries.*

21,347. W. Childs. London. Improvements in systems of telegraphic or telephonic exchanges.*

21,353. H. S. Park. London. Improvements in electric motors for railway vehicles.*

21,366. F. King. London. Improvements in connection with electrically propelled vehicles for running on ordinary roads.

21,367. F. King. London. Improvements relating to the connections of battery receptacles employed in electrically propelled vehicles.

November 7, 1894.

21,439. E. M. Lacey. London. Electrical sewer ventilator.

21,446. C. J. Barley. London. Improvements in electric meters.

21,452. P. R. J. Willis. London. Improvements in automatic electric fire alarms and signals. (Louis Aloysius Werner and C. J. Werner, United States.)

21,461. C. Riordon. London. Electric motors.

November 8, 1894.

21,489. E. Deming. Manchester. An electric track machine for railway system.*

21,531. W. C. Hodgkins. London. Improved electric sash balance.

21,549. H. G. O'Neill and E. Jewell. London. Improvements in electrically heated robes, towels, quilts and other articles of flexible fabric.*

November 9, 1894.

21,555. I. A. Timmis. London. Improvements in secondary batteries.

21,613. E. C. Parker. London. Improvements in telephones.

21,629. S. Hanisch and The Hoerder Bergwerke and Huttenverein. London. Improvements in and relating to electric railways.*

21,630. Heinrich Leupold. London. Improvements in electric meters. (H. Leupold, Italy.)

21,640. G. J. Gurl. London. Improvements in or connected with electric switches.

November 10, 1894.

21,684. H. Dando. London. Automatic hydro-electric indicator and alarm. (H. A. Dando, New Zealand.)

21,707. A. Slater. London. Improvements connected with electric conductors of electric railways. (J. Platt, United States.)*

21,731. C. A. Day. London. Improvements in arc lamps. (G. J. Shoeffel, United States.)

21,750. J. W. Rogers. London. Improvements in arc lamps.

November 12, 1894.

21.782. T. Caink. Worcester. Improvements in automatic electrical rheostats.

21,814. J. Torge. London. Improvements in electric arc lamps.

21,821. T. Parker (Limited) and T. Parker. London. Improvements in two-pole single-limb dynamo-electric machines and electromotors having vertical magnets with the poles downwards.

21,822. J. C. Newburn. London. A vessel for electrolytic separation and alloying of metals in the molten state. (The firm of Fr. Hornig and W. Borchers, Germany.)

21,827. J. Imray. London. A method and apparatus for exciting dynamo-electric generators. (La Société Anonyme pour la Transmission de la Force par l'Electricité, France.)

21.838. W. Bein. London. New or improved process for electrolysing chemical combinations and winning the products of decomposition formed by electrolysis.*

21,845. R. Myers. London. Improvements in dry batteries.

November 13, 1894.

21,855. W. P. Adams and R. E. B. Crompton. London. Improvements in tools or appliances for use in the trueing-up, scouring, or like treatments of dynamo-electric machines, cylinders and the like.

21,879. B. H. Thwaite and H. Allen. London. Improved methods of effecting electro-fusion of metals and in apparatus therefor.

21,893. J. O'Neil. London. Improvements in autographic telegraphs.*

21,929. H. V. Keeson. London. Improvements in electric current regulators.

21,948. J. Y. Johnson. London. Improvements in holders for incandescent electric lamps. (Alfred Swan, United States.)

November 14, 1894.

21,991. H. Edmunds. London. Improvements in or connected with electric tramways and vehicles.

22,029. J. H. Pickup and J. H. Hindle. London. Improvements in electrically propelled fans.

22,030. F. King. London. Improvements in or connected with electrically propelled carriages for common roads.

22,043. W. Holland, Jun. Birmingham. Improvements in means to be employed in connection with the electrical heating of metals for various operations.

22,046. F. M. Lewis. Leeds. Improvements in arc lamps.

22,070. J. Hargreaves and T. Bird. Lancashire. An improved process and apparatus for the electrolytical decomposition of metallic salts and for treating products therefrom.

22,134. A. G. New and A. J. Mayne. London. Improvements in the electrical propulsion of boats and vessels.

November 16, 1894.

22,157. W. McGeoch, Jun. Birmingham. Improvements in electrical switches.

22,192. Siemens Bros. and Co. (Limited) and Alexander S. Schloemer. London. An electric exploder.*

22,197. A. Damaskinos. London. Improvements in recording telegraphic apparatus.*

November 19, 1894.

22,302. J. Wilkinson. Blackpool. Improvements in chairs for electric tramways, underground channel or conduit.

22,303. V. H. Coates. Belfast. Improvements in arc lamps.

22,325. R. G. Tyler. London. Improvements in safety and distributing fuses for electric light wire and for other purposes.

22,340. G. L. Addenbrooke. London. Improvements in and relating to multipolar dynamo machines.

22,361. W. S. Rawson and Woodhouse and Rawson United (Limited London. Improvements in connection with the pickling of articles with the aid of electricity, and apparatus therefor.

22,394. W. Blenheim. Egham. Electric liquid level indicator.

22,403. J. Weir and J. G. Latta. Glasgow. Improvements in and connected with steam engines for driving dynamo-electric machines.

22,453. J. Robinson. London. Improvements in the manufacture of insulated electric conductors, and in the method of and apparatus for producing the same.*

22,453. F. King. London. An improved electrically-propelled carriage.

22,460. F. King. London. Improvements in or connected with electrically-propelled vehicles for common roads.

22,465. W. T. Burrey. London. Improvements in electrical switches.

November 21, 1894.

22,517. W. Begg. Glasgow. Improvements in commutator brushes for dynamo-electric machines.

22,521. Axel Orling. Manchester. Improvements in electric gas-lighters.

22,531. M. H. Smith. London. Improvements in and connected with resistances and switches for electric circuits.

22,547. A. E. H. Honrichs. London. Improvements in electrodes applicable for use in electric accumulators and other electric apparatus. (The firm of Hirschwald, Schaffer and Heinemann, Germany.)

November 22, 1894.

22,613. J. C. Richardson. London. Improvements in or relating to the electro-chemical decomposition of solution of salts.

22,615. S. Denayrouze. London. Method and apparatus for illumination by means of combustible gas, with forced supply produced by electrical energy.

22,637. C. E. Hebard. London. Electric uterine batteries. (Date applied for under Patents, &c., Act, 1883, Sec. 103, July 10, 1894, being date of application in United States.)*

November 23, 1894.

22,700. A. Lesquoy. Westminster. Improvements in accumulators.

22,718. A. J. Boult. London. Improvements in or relating to electric motors. (Emmanuel Depoux, France.)

November 24, 1894.

22,770. G. Ashford. Newport. Electrically illuminated timepiece.

22,802. W. F. White. London. Automatic electric wonder.

22,819. E. Tyer. London. Improvements in lock and block electric apparatus for railway.

22,831. J. Tatham. London. Improvements in conduits for electrical conductors, and in the mode of making same.

22,824. F. N. Denison. London. Short circuiting device for stopping dental motors.*

22,826. J. Brock, A. E. Wareing, and F. Hurter. London. Improvements in the treatment of solutions of zinc chloride for the purification thereof for electrolytic purposes.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1893.

19,427. Myers. Electrical toys.

20,698. Hardingham (Felten and Guilleaume). Electric cables.

20,837. Ayrton and Mather. Electrical measuring instruments.

21,631. Caldwell. Electrolytic apparatus.

22,876. Hopkinson. Elcetric switches.

23,074. Theerman. Electrical switches.

23,211. Goolden and Lewis. Electro-mechanical governors.

23,327. Howes Electric lamp fittings.

23,605. Ebbutt and Verity. Attaching reflectors to electric lampholders.

24,001. Coombes (Coombes). Thermo-electric lubricating apparatus.

24,081. Niewerth. Electric carbons.

24,217. Ayrton and Mather. Electrical measuring instruments, &c.

24,276. Guthrie. Electrolytic apparatus.

24,353. Mills (Barbier). Electric accumulators.

24,389. Lehmann. Secondary battery plates.

24,442. Mills (Barbier). Electrical accumulator plate.

24,606. Claremont. Suspending electric lamps and fittings.

24,730. Curtis. Indicatiog time of consumption of gas or electricity.

24,889. Young. Phonographs, graphophones, &c.

24,979. Baron Kelvin. Measuring and recording electric pressures and currents.

1894.

62. Kingdon. Dynamo-electric machines.

67. Mensing. Arc lamps.

646. Walker and others. Voltaic batteries.

1,478. Young. Phonographs, grammaphones, &c.

2,321. Yates and Clegg. Dynamos.

7,116. Bradbury (Trinks). Telegraphic or telephonic call.

8,654. Grenville and Terry. Electric light chandeliers.

9,763. Cadot and Charron. Electricity air, &c., meters.

9,975. Thompson (Coffin). Heating, &c., metals by electricity.

11,439. Wagg. Electric indicator or signal.

13,499. Sinding-Larson. Electrolytical decomposition of alkali salts.

13,749. Allison (Standard Electric Signal Company). Electric signalling apparatus.

13,750. Allison (Standard Electric Signal Company). Electric signalling apparatus.

13,751. Allison (Standard Electric Signal Company). Electric signalling apparatus.

14,202. Fitzpatrick (Boughton Telephotos Company). Signalling by electric lamps.

15,082. Lilman and Lexow. Magneto-electric machines for cycles, &c.

15,506. Brown. Voltmeters, &c.

16,243. Brintnell. Electric propulsion of cars.

16,695. Bruck. Electric lighting and extinguishing devices for gas lamps.

16,825. Murray and Allen. Electro-magnetic car brake and traction device.

17,284. McElroy. Transforming and distributing electric currents.

17,296. Lake (Eickemeyer). Dynamo-electric machines.

17,297. Lake (Eickemeyer). Armatures for dynamo-electric machines.

17,846. Devonshire (Thomson). Electric arc lamps.

RECENT FRENCH PATENTS.

226,679. Bahm. Certificate of addition to a patent taken December 26 1892, for the defecation by electricity of the unrefined juice of beetroots and molasses, and generally of all kinds of juice and of saccharine matters.

231,205. Hutin and Leblanc. Certificate of addition to patent granted June 29, 1893, for improvements in continuous-current dynamos and motors.

238,783. Nashold. Improvements in automatically-tightening supports for electric conductors.

238,811. Scott. Improvements in underground conduits and in insulators for electric cables or conductors.

238,813. Laur. Production of sponge nickel and the magnetic treatment of materials and reduced oxydised minerals.

238,818. Fonville. Alternate-current electric tramway system.

238,851. Balasny. Permanent continuous-current dry battery.

238,856. Reignard. Disinfecting, ventilating, and odorising apparatus, called "Ozonateur électrique."

238,859. Dorgnon. Improvements in dynamo machines.

238,838. Hoepfner. System of electrodes applicable to electrolytic apparatus and to electric generators.

238,915. Marino. Composition of special and new electrolytes for the direct plating of all metallic and metallised objects with a polished metallic dense and adherent coating of aluminium and and aluminium combined with tin, metal, lead, zinc, copper, silver, gold, platinum, &c.

238,965. Girardin. Electric safety bolt.

238,975. Gulcher. Improvements in lead electrodes for electric accumulators.

239.009. Gillmore. New telephonic relay.

239,016. Hampel. Apparatus for casting grids for electrodes of condensation batteries.

239,020. Tamasovits. New system of automatic electric target which will show any mark any number of times.

239,034. Diaz de Liaño. Electro-thermo etherising apparatus.

239,041. Von Siemens. Substance suitable for electric heating.

239,066. Verny. New system of interruptor-regulator for arc or incandescent lamps, or for the regulation and interruption of an electric current of any kind.

239,099. Société Electrogénique. An electric accumulator.

239,112. Egger, Wessel and Naumburg. Improvements in electric vehicles.

239.946. Auvert. System of electric traction in which compressed air is used for the transmission of the power from the electric motor to the moving wheels.

COMPANIES' MEETINGS AND REPORTS

Westminster Electric Supply Corporation (Limited).

An extraordinary general meeting of this Corporation was held on Wednesday, at the offices, Eccleston-place, Belgravia, S.W., Mr. J. Heslop Powell presiding.

The SECRETARY (Mr. Frank Iago) read the notice convening the meeting and the minutes of the extraordinary general meeting held on November 14th.

The CHAIRMAN, after expressing regret at the unavoidable absence of Lord Suffield (Chairman of the Corporation) formally proposed the following resolutions:—

"That out of the newly-created share capital of £100.000, £40,000, in 8,000 shares of £5 each, be forthwith issued at a premium of £1 per share, and in the first instance allotted to shareholders on the register on the 14th day of November, 1894, in the approximate ratio of one to every complete eight shares then held; and that the Board be empowered to allot any balance of the 8,000 shares, not allotted to the shareholders, to members of the staff of the Corporation, or to such other persons as they may think fit on the same terms."

"That the amount due on the shares be payable as follows:—£1 (premium) on January 3, 1895; £2 on January 15, 1895; and £3 on July 1, 1895, and that the new shares rank for dividend (on amount of capital paid) from January 1, 1895."

"That the balance of 12,000 shares be retained, and that the Board be authorised to issue them as required, they being first offered to the shareholders on the register at the time of such issue, and on such terms as the Board may consider desirable."

Mr. E. BOULNOIS, M.P., seconded the resolutions.

Mr. A. TOOTH complained that by issuing the shares at a premium the shareholders were forming a reserve fund out of their own pockets. The £1 premium would swallow up a dividend of 5 per cent. for four years. Up to the present they had never received 5 per cent., and he thought the shares ought to have been issued to the shareholders at par, and he would move accordingly.

Mr. WALLER, referring to the words in the first resolution, that the shares would be allotted "in the approximate ratio of one to every completed eight shares," inquired if holders of 15 shares would be entitled to two new shares?

The CHAIRMAN: Yes. With reference to Mr. Tooth's remarks, I may say that it is not open to any shareholder to propose an amendment. The resolution must be either accepted or rejected.

The SOLICITOR (Mr. R. W. Wallace) remarked that if Mr. Tooth had sent in notice of his amendment he could have proposed it.

Mr. W. COOPER regretted that the £1 premium was not to be brought into the year 1894 and divided amongst the present shareholders who had, while the Corporation was being built up, been without any dividend for several years.

Capt. GRANT asked if shareholders might pay up the whole £5 and the premium on January 3rd?

The CHAIRMAN: No, we do not want the money. All the remarks which have been made have been carefully considered by the Board, more particularly the question of the premium, and we think we should have been acting injudiciously if we had not issued the shares at a premium, looking at the great price they now command in the market. With regard to the payment on the shares we have made that as convenient as possible to shareholders. Taking into account the fact that a large number of people receive a considerable portion of their income after January 1st we thought the 3rd of that month a very fair time to ask for a call. We thought the postponement of the final payment was advisable. As was explained by Lord Suffield, we do not want this money for buildings, but for the extension of our machinery, and it would be folly for us to draw upon your resources before we actually want the money. By July 1st the probability is we shall either want the whole or a considerable part of the money.

The resolutions were then carried unanimously.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "The Electrician" Electrical Trades' Directory and Handbook, 1894, pages 274-300, *&c., &c.*]

ALLSUP AND CO. (LIMITED).—This Company was registered on November 22nd, with a capital of £20,000, in £5 shares, to acquire the business carried on by William Allsup and Sons (Limited), at Preston, of engineers, iron founders, steel makers, and converters, machine and engineering tool makers, &c.

GRANADA RAILWAY COMPANY (LIMITED).—The objects of this Company, which has been registered with a capital of £300,000, in £20 shares, are the construction, equipment, and maintenance of railways, light railways, tramways, wire, electric, or other powers, telegraph and telephone lines and works, and any means of communication, connection, and propulsion, in the kingdom of Spain or elsewhere.

METROPOLITAN TRAMWAYS AND OMNIBUS COMPANY (LIMITED).—This Company was registered on November 21st, with a capital of £1,000,000, in £5 shares, to acquire by purchase, lease, or otherwise, any tramways or any omnibus undertakings in London, its suburbs, or elsewhere; to construct any tramways; to equip, maintain and work the same by horses, or by steam, electricity, gas engines, wire ropes, or other means; and to carry on the business of manufacturers of and dealers in tramway cars, trucks, omnibuses, locomotives, accumulators, dynamos, &c.

PNEUMATIC TYPEWRITER (LIMITED).—This Company was registered on November 21st with a capital of £100,000 in £5 shares, to acquire certain patents, &c., particulars of which do not transpire, and to carry on the business of manufacturers of and dealers in typewriters, chemical manufacturers, electricians, suppliers of electricity, metallurgists, &c.

BLOCKLEY ELECTRIC LIGHTING AND MANUFACTURING COMPANY (LIMITED).—The annual return of this concern, made up to July 9th, has only just been filed. The nominal capital is £20,000 in £5 shares: 461 Ordinary and 72 Preference shares have been subscribed for and allotted. On each of these shares the full amount has been called, resulting in the total payment of £2,665.

DAWSON GAS ENGINE SYNDICATE (LIMITED).—The statutory return of this Company, made up to October 24th, has been filed. Out of a nominal capital of £70,000 in £10 shares 6,696 have been taken up, and 5,600 of these shares have been issued as fully paid. The full amount has been called on seven shares, and a call of £6 per share has been made on 1.089 shares, resulting in the total receipt of £5.786, and leaving £818 in arrears.

CITY NOTES.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend of 3s. per share, being at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended September 30th last. The dividend will be payable on and after December 21st. The transfer books of the Company will be closed from December 14th to 20th inclusive.

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ended November 27th were £957, as against £897 in the corresponding period of 1893, being an increase of £60. The total receipts for the half-year amount to £18,648, as against £17,370 for the corresponding period of 1893, an increase of £1,278.

ELECTRIC AND GENERAL INVESTMENT COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend on the capital paid up on the Ordinary shares of the Company, at the rate of 10 per cent. per annum, for the six months ending November 30th inst., payable on and after December 20th.

ELECTRIC CONSTRUCTION COMPANY (LIMITED).—Notice is given that a drawing of the Six per Cent. Second Mortgage Debentures of this Company will take place at the offices of the Electric and General Investment Company (Limited), 1 and 2, Great Winchester-street, E.C., on Friday, December 7th, at three o'clock. The bonds drawn will be paid off on January 1st next.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended the 25th inst. amounted to £931. The amount for the corresponding week last year was £580.

STOCK EXCHANGE NOTICES.—The Committee of the Stock Exchange have appointed Monday, December 3rd, a special settling day in the £150,000 Four and a-Half per Cent. First Mortgage Debenture Stock of the Metropolitan Electric Supply Company (Limited), and have ordered this security and the further issue of £39.000 Four per Cent. Perpetual Debenture Stock and 650 Five per Cent. Perpetual Preference Shares (Nos. 7,001 to 7,650) of the City and South London Railway Company, to be quoted in the Official List.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended November 23rd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,415.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Nov. 21.		Price Wednesday, Nov. 23.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 28.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	9/0	Anglo-American	38	39	38	39	5 2 7	Jan., Apr , July, Oct.	38¼	38
£2,993,560	Stock	18/0	Do. Preferred	72	73	72	73	2 14 10	" "	72¾	72½
£2,993,560	Stock	5/0	Do. Deferred	6½	7	6½	7	..	.. ..	6½	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 17 6	January and July ..	..	..
130,000	£10	4/0	Brazilian Submarine	11	11½	11	11½	5 13 11	Mar., June, Oct., Dec.	11¼	11
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	110	114	110	114	4 9 3	June and December	..	–
10,000,000	$100	$1¾	Commercial Cable Capital Stock	135	145	140	150	4 13 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12½	13½	12½	13½	5 18 6	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	" "	..	..
12,931	5	1/8	Direct Spanish (£4 paid)	4¼	4¾	4½	4¾	4 4 3	April and October –	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¼	9¾	9¼	9¾	5 2 7	" "	..	–
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	4 3 4	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8¼	8¾	8¼	8¾	5 2 10	Jan., Apr., July, Oct.	8½	..
400,000	10	2/6	Eastern	15¾	16	15¾	16	4 1 3	" "	15 13/16	15¾
70,000	10	6%	Do. 6 per Cent. Preference	16½	17	16½	17	3 10 7	" "	16 11/16	16⅝
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock x d	117	120	117	120	3 6 8	May and November	119	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	110	106	110	4 12 7	February & August	..	..
250,000	10	2/6	Eastern Extension	15⅞	16⅛	15⅞	16⅛	4 6 10	Jan., Apr., July, Oct.	16⅛	15⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	116	120	117	121	3 6 2	February & August	120½	120
£62,700	100	5%	* Do. 5 p. c. (Austla. Gov. Sub.) Debs. 1900	103	107	103	107	4 15 3	January and July	–	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	103	107	4 15 3	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	104	107	104	107	3 15 10	February & August	105¾	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	107%	110%	107%	110%	3 12 9	May and November	108½	..
180,227	10	1/3	Globe Telegraph and Trust	8¾	9	8¾	9	4 15 9	Jan., Apr., July, Oct.	8 13/16	8¾
180,042	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16¼	3 13 10	" "	16⅛	15¾
150,000	10	5/0	Great Northern	20¾	21¼	21¼	21¾	3 18 4	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	..	
17,000	25	12/6	Indo-European	46	48	47	49	6 8 2	May and November	48½	47¾
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	102	106	102	105	5 15 11	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	104	107	104	107	3 15 10	..	..	..
11,839	8	4/0	Reuter's	3	5	3	5	..	April and October	..	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	103	108	103	108	5 11 7	" "	106	..
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	100	103	100	103	4 18 3	March & September	102	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	100	105	100	105	7 12 5	June and December	102½	100¾
88,321	10	9d.	West India and Panama	1	1¼	1	1¼	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	11	11½	11	11½	5 4 4	May and November	11⅜	11⅛
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 11 9	June and December	..	..
64,242	15	7/6	Western and Brazilian	10	10½	10½	11	..	May and November	10 13/16	10½
33,129	7½	7/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	..	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	4½	4¾	4½	5	..	..	4⅝	4½
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 16 6	February & August	101½	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 16 6	" "	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	112	118	112	118	5 18 8	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 17 1	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	..	..	..
224,850	10/0	2⅝d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	..
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	7/16	9/16	7/16	9/16	..	Yearly	..	..
484,597	5	3/4	National	4⅞	5⅛	5	5¼	4 15 3	June and December	5⅛	5
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	16	15	16	3 15 0	" "	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	" "	15¾	15½
119,234	5	3/4	Do. 5% Non-Cumulative 3rd Pref.	5⅝	5⅞	5⅝	5⅞	4 5 1	..	5⅝	5⅝
1,000,000	Stock	4½%	* Do. Debenture Stock, 4½% (red.)	110	113	110	113	4 1 1	January and July	..	..
58,000	5	1/0	United River Plate	2	3	2	3	..	" "	..	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	88	94	88	94	5 6 5	" "	..	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	12½	13½	12½	13½	..	..		
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	14¾	15¼	14¾	15¼	3 18 8	..	15⅛	15
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	131	133	131	133	3 15 2	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	4½	5½	4½	5½	3 12 9	–	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	..	..	..
8,322	£5	..	House-to-House Electric	..		..		–	–	..	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		–	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	.		..		–	January and July –	..	–
45,000	£5	2/6	Liverpool Electric Supply (fully paid)	7 1/16	7 3/16	7 1/16	7 3/16	–	..	..	–
111,000	5	..	London Electric Supply	⅛	⅜	⅛	⅜	..	..	..	..
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	9¼	9¾	9½	10	2 10 0	..	9¾	9 7/16
£150,000	Stock	4½%	* Do. 4½% Debs. (Bonds of £10, £20, and £40)	111½	115½	114½	115½	3 19 6	June and December	..	..
6,452	£10	..	Notting Hill Electric	6½	7½	6½	7½	–	..	..	..
19,980	£5	2/0	St. James and Pall Mall	7½	8	7½	8	.	..	7 13/16	7½
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8½	9	3 17 9	–	.	.
59,900	5	2/0	Westminster Electric Supply (fully paid)	7	7½	7	7½	3 0 0	–	7⅜	7 5/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2½	2¾	2⅜	2⅝	5 14 3	..	2 7/16	2⅜
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2¼	2½	4 16 0	..	2¼	2 5/16
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	110	113	110	113	4 0 4	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2¾	3¼	2¾	3¼	–	January and July	..	..
12,139	5	..	Edison and Swan United	–		–		–	..	–	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	–	–	..
120,000	2	..	Electric Construction	⅜	⅝	⅜	⅝	–	–	..	..
12,845	2	2/9	Do. 7 per Cent. Cumulative Pref.	1½	2	1½	2	..	–	.	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1¼	1⅜	1¼	1½	..	–	1⅜	..
20,000	5	.	Fowler-Waring Cables (fully paid)	½	1½	½	1½	.	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	25	26	25	26	4 10 1	February & August	[illegible]	25½
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 5 0	March & September	105	–
15,995	£10	6/4	International Okonite Ordinary	..		..		–	.	..	–
16,000	£10	..	Do. 8 per Cent. Preference	..		–		–	December and June	..	–
21,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	–	¼	–	¼		..	..	
[illegible]	12	12/0	Telegraph Construction and Maintenance	41	43	41	43	5 11 6	March and July	43½	42½
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July	–	..
[illegible]	£5	–	Woodhouse and Rawson Ordinary (£3 15s. paid)	–		–		..	..	..	–
41,098	£5	..	Do. Preference (fully paid)	..		–		..	–	..	–
[illegible]	10	10/0	W. T. Henley's Telegraph Works Ordinary	8	9	8	9	5 11 1	..	..	..
£30,000	10	..	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1%	City and South London Railway	39	41	40	42	2 7 7	May and November	..	..
7,000	10	5%	Do. 5% Perpetual Preference	13½	14	13¾	14¼	3 10 2	..	..	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	120	122	122	124	3 4 6	May and November	..	..
37,500	£10	1	Liverpool Overhead Railway	7 13/16	8 1/16	7 13/16	8 1/16	1 4 10	..	..	..
6,295	10	5%	Do. 5% Preference	13	13½	13	13½	3 15 6	..	–	–
£125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July ..	–	–

In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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NOTES.

The Board of Trade "Light Railway" Conference which met yesterday, after listening to a sympathetic address by the President and a four hours' discussion, adjourned until the end of January, having appointed a Committee to go into details and draw up a report. The variety, not to say contrariety, of opinion to which expression was given at the Conference was indicative of the nebulous state of the English mind on the subject of light railways. The only two points on which there was anything approaching unanimity was that State aid, parochial aid, or railway company aid, was an absolute *sine quâ non,* and Parliamentary expenses must be reduced to a minimum. On all other points no two successive speakers agreed. Sir Douglas Fox was not particularly in favour of high speeds; other engineers regarded them as indispensable. Mr. Jackson, ex-Chief Secretary for Ireland, laid solemn emphasis on the desirability of getting the existing railways to undertake the whole job, if possible; Mr. Pain was equally emphatic against the idea: and both spoke from experience. The Committee, which includes Sir Benjamin Baker, Mr. Alexander Siemens, and Mr. Stephen Sellon, will, it is to be hoped, be able by the end of January to lay down the broad lines on which powers and money for light railways can be easily and cheaply obtained, and the degree to which existing regulations may be relaxed. That done, and effect given to the suggestions by Parliament and the Board of Trade, light railways may be trusted to "gang their ain gait."

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The Electrical Trade Section on Friday last discussed several matters of considerable commercial importance. For some time past the rating of electric lighting stations has given rise to much muttering, and if the case of the St. James' and Pall Mall Company is a fair sample, there would seem to be ample cause for dissatisfaction, and for the determination to take united action in the matter. In 1893, the St. James' Company spent something over £21,000 in earning something more than £31,000, a sum of £887, equal to nearly one-tenth of the money available for dividend, being included in the outgoings under the heading of "Rates and Taxes." A rich man may do well to give of his own free will one-tenth of his goods to the poor; but shareholders may be excused if they fail to see the applicability of this precept to their involuntary contributions to the parochial purse.

As to the opposition of the metropolitan local authorities, headed by that busy bee the London County Council, to the construction of transformer pits under the pavement, we cannot help thinking that the late lamentable loss of two quadrupeds, and other similar incidents, must have a good deal to do with it, and if so, this is but another instance of the unfortunate way which accidents of one kind have of making the public ferret out grave public dangers in all manner of queer places. At any rate, it is satisfactory to think that the objection cannot be one of general principle, since the Vestries of Hampstead and Islington, who appear among the opponents, are themselves builders and owners of a number of these "grave public dangers." At the same time, if the objection be merely to the particular style of construction proposed in Wandsworth and the wilds of St. Luke's, why, then, it hardly seems necessary to invoke the aid of that *deus ex machinâ* the Board of Trade. We observe with some regret that the parties interested are to appear before Sir Courtenay Boyle on the 13th inst. "by counsel or expert evidence." If one wishes to win a case or obscure an issue, no better means could be devised than counsel and expert evidence; but if one wishes for facts the matter is otherwise. Truth, we believe, was found at the bottom of a well, but it is doubtful whether it will be met with in a transformer pit: the apparent watts and spurious amperes that surround a transformer as with a raiment are likely to prove too much for Truth.

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In a very brief article which we print elsewhere, Mr. G. W. Partridge, of the London Electric Supply Corporation, calls attention to an entirely new phenomenon in the behaviour of transformers, which he has recently discovered. We hasten to explain that it is only new in a relative sense. As far as we know, it has never been published before, and we believe it will be as new to a large majority of our readers as it is to Prof. Ewing, who comments on it. But who ever found anything that is new to a transformer maker, or to the alternate-current expert? They always knew the new things long ago, but were keeping them to themselves. Of course, they put the phenomenon down to damp at first, and knew all about it; when it was proved to have nothing to do with damp, of course they knew the real reason all the time. It is wonderful how far ahead of their time these clever people are. Transformers from five separate makers have been found to behave in the way described by Mr. Partridge. Of course, they can all now cure the defect—not an admitted defect, of course, only a trick due to the alternator, or to the School Board election, or to anything but the transformer. Mr. Partridge informs us that he has not seen a cured transformer yet; but, of course, that proves nothing. The fuss which has been made about one or two per cent. difference of iron loss becomes rather ridiculous in the face of an increase of 40 per cent. Mr. Partridge's article is, as we have said, very brief, and the only additional information that we have to give about the matter is that Dr. Fleming's wattmeter method was used. From those who know all about it we would beg, not for bald statements that their alternators do not produce this loss, that their transformers have been cured, and so on, but for a little scientific information; or, if that is not to be had, for a few data from which such men as Prof. Ewing may be able to extract some scientific deductions.

If we may judge by the result of an action brought by the London Electric Supply Corporation in the Westminster County Court on Wednesday against an individual who, after having entered into an agreement "to take current," endeavoured to back out of it, these agreements are to be considered as something more than mere matters of form. We are not altogether sure that in the general interests of the electric supply business the conversion of these innocent-looking agreement forms into awe-inspiring legal documents is altogether to be desired. The occasions on which a customer plays one company against another, signing an agreement with each and repudiating the least favourable one, are not likely to be frequent; but when it is discovered, the shabbiness ought to be punished. On the other hand, many a person may in good faith enter into an engagement "to take current," and subsequently have good cause to change his mind. In such cases the intimation that he has made a solemn covenant is not perhaps quite the best way *pour encourager les autres*. It would then on the whole be better policy to grin and bear the loss entailed than to insist on one's £15 of flesh.

The question of meter rents is vexing the minds of gasmen, but the agitation in favour of their abolition is not likely to spread to the electric supply business just yet. The public already know that the modern electric meter is a highly scientific instrument; and that, if any suspicion of inaccuracy arises, the supply company will at once replace it with a recently calibrated instrument that gives much less trouble than the wheezy rattle-trap, or the thirsty "wet" machine, which makes the gas-lights bob so merrily. But a rental of 5s. per quarter is a good deal for an "installation" consisting of one 16-c.p. lamp under the beams of which a barrister may wait for briefs and an 8-c.p. for his office boy to read "Silly Bits," or a lonely consulting engineer to consult the weekly technical papers. One of the London companies recently refused to accept 1s. per unit and no meter rent for a humble office, and the supply was discontinued. The meter rent for lighting small offices is ridiculously out of proportion to the charge for supply, and unless the supply companies really want to earn money by letting out meters on hire, it would be better for the consumer to provide his own meter. For such purposes a simple hour meter is all that is wanted; nothing would be saved by turning off less than all the lamps, but some variety could be secured by the use of two-way switches. Such meters are in common use for shop lighting and for arc lamps, and appear to be very trustworthy.

We recently called attention to the service which had been rendered to mathematical nomenclature by Oliver Heaviside and other mathematical physicists in the substitution of single symbols and simple expressions for a complicated, but persistent, series of ideas. This process of naming is a strictly logical one, and at the same time it is very common. Every name is but a code word for a fearfully complex set of ideas: a "table," for example, representing legs, top, fittings, and endless sundries in one short term. We refer to this point again, because we can no longer refrain from pointing out the need for some such codification in the science of organic chemistry. In so far as the names are concerned, this is degenerating into something merely barrel-organic. It is some time since we systematically "sat under" a professor of organic chemistry; but we should nowadays very much object to have to listen to a lecture peppered with such words as "monocarboxyethylacetoacetate" or "metanitrobenzeneazoparacresol." This toy-brick-castle system of building up names has no major limit, but must increase indefinitely with the progress of research. How much better to have one little word which, to the initiate, might express all the ideas in such a rigmarole as either of these! How much simpler to talk of a "table" than of a "fourstraightlegtopflatroundwoodenfurniture"! The German language lends itself admirably to such compounds. An English engineer was asked by a Swiss correspondent if he could recommend the use of electric launches for the Swiss lakes. He replied (in German) that they were tolerably good where facilities for charging are to be found; but, in the absence of such facilities he could recommend a kind of launch for which he did not know the German name, but the English was "earthoilairgasdampkettleboatlet."

High Water in the Thames.—It is reported that during the high tides caused by the large quantity of flood water in the Thames the level of the river rose to within one foot of the staging which has been erected at the mid-river shaft of the City and Waterloo Railway tunnel.

Electric Traction on the Ice.—The *Frankfurter Zeitung* is responsible for the statement that a St. Petersburg company proposes this winter to run an electric tramway from the Palace Quay to the Mytninski Quay along the frozen Neva. A speed of 15 miles an hour is to be attained.

Cable Interruptions and Repairs:

	Date of Interruption.		Date of Repair.
Falmouth-Bilbao	Nov. 15.	...	Dec. 3.
Amoy-Gutzlaff	Nov. 10.	...	—
Ceara-Maranham	Nov. 25.	...	—
Latakia-Cyprus	Nov. 27.	...	—

Glow Lamp Litigation in the United States.—Judge Lacombe, says *Electricity* of Chicago, has refused to grant the injunction recently applied for restraining Bloomingdale Bros. from using Buckeye lamps, holding, as did Judge Dallas in Philadelphia, that lamps lawfully made in one circuit could be lawfully sold in any other circuit.

The Origin of the Telegraphic "O. K."—It has been generally said that "O. K." was President Andrew Jackson's abbreviation for "all correct." Prof. W. S. Wyman, of the University of Alabama, however, thinks that President Jackson borrowed the phrase from the Choctaw language, in which the word "okeh" means "it is all right."

Berlin-Vienna Telephone Line.—Telephonic communication between Berlin and Vienna was opened to the public early on Saturday morning last, and the first persons to use it were Kaiser Wilhelm, who spoke from the new palace at Potsdam, and Kaiser Franz Joseph, who utilised the apparatus in the Hofburg. The tariff for other than Emperors will be three marks for three minutes' conversation.

The Gresham University.—This projected university, after having received Parliamentary sanction, has collapsed from an unexpected difficulty. King's College was, of course, to form an essential part of the new institution; but under its statutes it imposes a religious test on its professors and students. This arrangement is incompatible with the regulations of the proposed university, and it seems that neither side can or will give way. A long and warm discussion was held at King's College, but led to no result. Hence, pending the elaboration of some *modus vivendi*, the Gresham University is at a standstill.

Royal Institution.—At the general monthly meeting of this Institution, held on Monday, the special thanks of the members were returned to Mr. Ludwig Mond and Dr. William S. Playfair for donations towards the fund for the promotion of experimental research at low temperatures. The Friday evening meetings will commence on January 18th, when Prof. Dewar will deliver a discourse on "Phosphorescence and Photographic Action at the Temperature of Boiling Liquid Air." Succeeding discourses will probably be given, amongst others by Sir Colin Scott-Moncrieff, Prof. A. Schuster, Prof. A. W. Rücker, Prof. Roberts-Austen, Prof. H. E. Armstrong, and the Right Hon. Lord Rayleigh.

Exhibition of Oil Engines.—An exhibition of petroleum motors will take place at Berlin next June. The chief points of the programme issued by the Special Committee of the Union of German Mechanical Engineers are: (1) Those motors only are to be admitted which work with petroleum of at least 0·80 specific gravity (which excludes benzine and other light oils); (2) the motors will be tested previous to the Exhibition to ascertain if they comply with the standard, and the exact results will be communicated to the exhibitors and published; (3) the trials will be made as regards power developed, smoothness and ease of working and handling, accessibility, simplicity, and solidity of construction, price, lubrication, safety, &c.

American Telephone Wires in American Gales.—The damage to the long distance telephone wires in America caused by the recent severe storms has been confined to the district between Boston and West Boylston, where a trunk line goes through, a distance of 41 miles. Out of 2,100 poles 300 were down, and service was temporarialy demoralised. These wires, says the *Electrical Review* of New York, were the best in the State, and were put up only a few years ago, but the formation of ice three inches deep on each wire proved too great a strain. One of the officials estimated that the weight of a single wire with this ice formation was about 250lb., or about five tons for the 41 wires in a section of 130ft. The service west and south-west of Massachusetts is intact, the damage to wires being mainly confined to Massachusetts, Connecticut, and Rhode Island.

Epping Forest Railway.—Messrs. Le Brasseur and Oakley have written as follows to the daily papers, under date November 30th:—"In reference to the paragraph that appeared in a recent issue of your paper, we, as solicitors to the London, Walthamstow, and Epping Forest Railway Company, are instructed to inform you that no meeting has been held at which it has been decided to abandon this undertaking. A Bill is being promoted by the Company this session to connect the railway with the London, Tilbury, and Southend and the Tottenham and Forest Gate Railways, and for other purposes. It is true that a notice for the abandonment of the undertaking was published, but this was only done in conformity with the requirements of the Company's bankers, pending the execution of certain documents which are now being completed. It is not proposed to proceed further with the abandonment."

Electric Traction in Dublin.—The introduction of electric traction for tramcars in Dublin is a matter of considerable interest, and it is understood that by May 1st next the Dublin Southern Tramways Company will have an entire electrical equipment on their lines. Already the actual beginning of work on the conversion of lines has been made, and will be pushed forward energetically. Some unexpected delays were encountered in the initial stages of the undertaking; but now Parliamentary powers have been acquired by the Company, and everything points to the speedy conclusion of what will be a novel and useful change in the method of conveyance in the city. The Company intend to have their power station at the present depot at Ballsbridge. The electric lines will consist of eight miles of double track. The change will also involve an entirely renovated plant. New cars lit by electricity will be built, and the general equipment of the lines will be thoroughly up to the best standard. This transformation may be expected to be completed by the end of next spring, and the results of the experiment will be awaited with general interest.

The Leaf as a Thermal Engine.—In a recent Paper read before the Royal Society Prof. Dixon and Dr. Joly investigate the energy relations of the leaf of a plant with its surroundings, on the assumption that evaporation at capillary water surfaces is mainly responsible for the elevation of sap. The authors describe an engine in which the energy entering in the form of heat at the capillary surfaces may be in part utilised to do mechanical work: a battery of twelve small porous pots, freely exposed to the air, keeping up the continuous rotation of a flywheel. Replacing the porous pots by a transpiring branch, this, too, maintains the wheel in rotation. This is, in fact, a vegetable engine. In short, the transpiration effects going on at the leaf are, in so far as they are the result of spontaneous evaporation and uninfluenced by other physiological phenomena, of the "sorting demon" class, in which the evaporating surface plays the part of a sink of thermal energy.

Electric Traction for Canal Boats.—A trial of the Bovet system of electric traction for canal boats (see *The Electrician*, Vol. XXX., March 3rd, p. 508) recently took place on the fifth reach of the St. Denis Canal. A series electric motor actuated the towing pulley, a 14mm. chain, placed at the bottom of the canal, being carried over the pulley to the extent of three-quarters of a turn, although half a turn suffices. A two-wire circuit running along the bank of the canal was connected to a 110-volt generator driven by a locomotive engine. The current was collected by means of two trolleys running along the wires and connected to the motor by a flexible cable, which was passed over a pulley at the top of the mast of the boat. The trial was completely successful, and showed that for an expenditure of 2,000 watts it was possible to make a 300-ton barge move at the rate of 2·8 kilometres per hour. The getting under way took place without shock, and the normal speed was rapidly reached.

Telegraphy to the Far East.—The concluding festival in connection with the celebration of the twenty-fifth anniversary of the establishment of submarine telegraphy to the Far East was held on Saturday evening last, when the staff of the London stations of the Eastern Telegraph Company were entertained at dinner at the Holborn Restaurant. Mr. T. A. Bullock, the London superintendent, occupied the chair, the company present numbering between 60 and 70. Mr. G. Draper, the secretary, proposed "Success to the Eastern Telegraph Company," and mentioned many interesting facts of the early days of the Company, referring to the very excellent service they were now able to offer to the telegraphing public. Mr. W. Hibberdine, who responded to the toast, said the Company with which they were associated was the largest of its kind in the world, and owned something like 75 per cent. of the total cables of the world. The Chairman, in proposing "The Health of the Staff," pointed out that the staff had each and all contributed towards the great success which the Company had achieved. He urged the younger members to follow the example of their predecessors, and to do all they could to strengthen the position of the Company in whatever part of the world they might be located.

Mathematical Instruction.—Writing in *Nature* on the subject of science teaching in schools, Prof. Henrici says that it is his belief that "mathematics might be taught through experimental science. If the boys themselves make, as they should do, experiments where they perform actual measurements, they will learn there are certain laws connecting various quantities; they will see that such laws can be expressed in simple symbols, and they will thus grasp in the concrete form the meaning of a formula or an equation which in the abstract form of pure mathematics remained a mystery to them. Mathematics could in this manner be made very much easier and more interesting to the majority of boys. Geometry can be treated to a very great extent experimentally by aid of geometrical drawing and a development of the Kindergarten methods; the abstract logic of Euclid can then follow, or it can be treated at the same time. Trigonometry need not be at once as fully gone into as is generally done, but the definitions of sine, cosine, &c., as names for certain ratios, can be easily and early introduced and made use of at once in mechanics or physics. Here also special experiments may easily be devised where measurements of angles or lines are made, and lines and angles calculated. At present I wish only to urge that, while many attempts are being made to improve science teaching, and with it technical education, mathematics should be included, and to express my opinion that this science also allows of experimental treatment."

The Telephone Exchange as a News Centre.—During the recent elections in the United States about 15,000 people in Chicago received news of the election returns by telephone. By special arrangement of the General Manager of the Chicago Telephone Company, a sort of verbal newspaper was kept in circulation throughout the city from seven o'clock till midnight. It was the first time that bulletins of the election were transmitted throughout the telephone exchange. Special wires to and from New York, from Milwaukee, Detroit, Cincinnati, Indianapolis and other cities were used for the purpose. Also special wires were connected with the City Hall, the Republican and the Democratic headquarters. The news was taken to the central telephone exchange, from the City Hall and elsewhere, and by the special wires. There the matter was edited, and "line news bulletins" were dictated and transmitted to each of the 10 "exchanges" in the city. At each branch office the bulletin was manifolded and a copy was handed to each of the 80 operators in each branch. Each operator re-transmitted the bulletin simultaneously to 12 different telephones in residences and club-houses in all parts of the city. The news was heard at 1,000 different points of the city in two minutes after it was received at the telephone company's headquarters. Just 100 bulletins were sent. At all times the bulletins were from 15 minutes to half an hour ahead of those received by telegraph. Not one error was made (intricate figures were avoided); the scheme was a great success.

The London County Council and the Working of the Tramways.—At Tuesday's meeting of the County Council the Highways Committee reported that the transfer of the London Street Tramways Company's undertaking would probably be completed within a short period, and measures were being taken to expedite the transfer of the North Metropolitan Tramways Company's undertaking. As the Council was at present not in a position itself to work the tramways, the committee had had under consideration the length of time for which the lines should be leased. It seemed expedient that no lease should extend beyond the period at which the bulk of the tramway undertakings would become purchasable, as by that means, when the leases expired, virtually the whole of the tramways system would be in the hands of the Council. They therefore recommended "That in all agreements for leasing tramways on the north side of the Thames acquired or to be acquired by the Council, provisions be inserted to insure that the undertakings shall revert to the Council on December 31, 1900 (but giving power to the Council, but not to the lessee, to determine the agreement on, or at any time after, December 31, 1898, by three months' previous notice), by which date nearly all the principal tramway lines on that side of the Thames will have come under the operation of the purchase clause of the Tramways Act, 1870; and that similar provisions be inserted in all agreements for leasing such tramways on the south side, the date of reversion to the Council being, however, in those cases December 31, 1903, instead of 1900." The recommendation of the committee was adopted, after an amendment had been negatived.

The Arithmetic Value of a High-Speed Car Service.—The *Street Railway Review* of Chicago recently treated its readers to the following little problem in arithmetic, which, with the necessary modifying coefficients, is equally applicable to this country:—"An electric car, running 18 hours a day for 340 days of a year, with conductor's and motormen's wages at 20 cents an hour each, will require $2,448 for trainmen's wages for the year. If horses do the same work, the speed will be about one-half slower, and two cars will be necessary, so that on the same basis $4,896 will be taken for trainmen's wages. Very good electric cars, with complete equipment, can at present be bought for $2,000 and under, and as the yearly saving in wages of trainmen by electric traction was seen to be $2,448, the startling fact is deduced that the electric car saves more than its entire first cost every year by the reduction of trainmen's wages due to the increased speed. In other words, a road could completely wear out its electric cars every year and save money over horse traction on wages alone, to say nothing of other items. It is not necessary to use this argument in support of electric traction, because, as was said at convention, the introduction of electricity is an accomplished fact, and street railway men no longer discuss its advantages or disadvantages as compared with other methods. The matter is mentioned here simply to show what an important factor a large daily mileage per car is in economic operation. There is such a thing as overdoing the work required of a car, but the mistakes in management are usually in the other direction."

The Pitting of Boilers.—In an article recently published, M. Olroy, French engineer, gives, says *Engineering*, the result of his investigation into the pitting of boilers. Pitting is particularly likely to occur if a water very free from lime is used in a clean boiler. The pits take the form of conical, or more frequently spherical depressions, which are filled with a yellowish-brown deposit consisting mainly of iron oxide. The volume of powder is greater than that of the metal oxidised, so that a blister is formed above the pit, which has a skin as thin as an egg-shell. This skin contains usually both iron oxide and lime salts, and differs greatly in toughness. In many cases it is so friable that it breaks with the least shock, falling to powder, whilst in other cases the blister detaches itself from the plate as a whole. An analysis of the powder in the pits showed it to consist of 86·26 per cent. of peroxide of iron, 6·29 per cent. of grease and other organic matter, and 4·25 per cent. of lime salts, the remainder being water, silica, aluminium, &c. The skin over the pits was found to contain 38 parts of calcium carbonate, 12·8 parts of calcium sulphate, and 32·2 parts of iron oxide, with about 8 per cent. each of magnesium carbonate and insoluble matter. Feed heaters often suffer badly from pitting, particularly near the cold water inlet, and in boilers the parts most likely to be attacked are those where also the circulation is bad, especially if such portions are near the feed inlet. When a boiler forms one of a battery, and is kept standing for a long interval, the top of the boiler is liable to pitting. Steam finds its way into it, and condenses on the roof, causing bad pitting there. Perfectly pure water containing no air does no harm, and steam alone will not cause pitting, unless it gets a supply of air. The Loch Katrine water of Glasgow, which causes pitting on clean boilers, contains much gas. MM. Scheurer-Kestner and Meunier-Dolfus enclosed a polished iron bar in a natural water containing much oxygen, and no lime salts. The bar gradually rusted, but the corrosion ceased when the oxygen was used up. The bar was then removed, re-polished, and put back, after which it remained perfectly bright. Repeating the experiment with water containing lime, the rusting was much less complete, the lime salts forming a protective layer on the iron, but on polishing this off corrosion recommenced. In distilled water the bar remained quite bright. The corrosion is much more rapid if the water contains carbonic acid gas as well as oxygen. In this case a voltaic action takes place. The rust first formed is electro-positive to the iron, which then dissolves away, decomposing the water. It is for this reason that in cases of pitting it is essential that all traces of the iron peroxide should be cleaned from the metal, for, unless this is done, the rusting will continue.

MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 128.)

Double and Triple Cranks.—By arranging two cranks at right angles on the same shaft, and driving them by the two cylinders of a receiver compound engine, or by separate high-pressure cylinders, it is possible to obtain a much smaller fluctuation of torque on the shaft. Fig. 36 shows this fact.

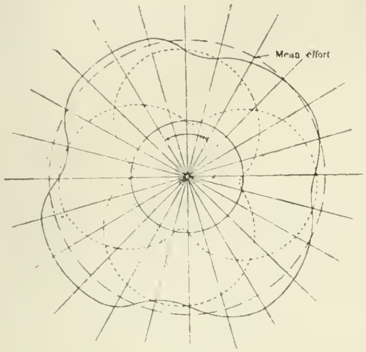

FIG. 36

The two similar dotted lines, placed with their similar axes at right angles, are the separate diagrams of crank effort of the two cylinders of a compound engine cutting off steam at 75 per cent. of the stroke. The continuous line is their combined effort, and represents the torque on the shaft during one complete revolution; and the broken circle shows the mean torque. Taking this mean torque as 100, the minimum is 81 and the maximum is 120, showing a fluctuation of only 39 per cent. As the method here adopted is quite incompatible with balancing the reciprocating weights, when the engines are vertical, it is common practice to have as many as three cranks, driven either by the cylinders of a triple expansion engine or by three separate engines. Fig. 37 shows the separate and combined crank efforts in such a case, the cranks being at 120°. Here the fluctuation of torque is only 17 per cent., the cut-off taking place at three-quarter stroke. Had the cut-off taken place earlier, the fluctuation would have been greater; and at one-third stroke a fluctuation of 36 per cent. would occur. It will be seen, then, that while combining several cranks gives a reduced amount of fluctuation, the reduction is insufficient in itself to ensure steady driving, but must be assisted, as with single crank engines, by a heavy flywheel. But the mass of the flywheel need not necessarily be so large.

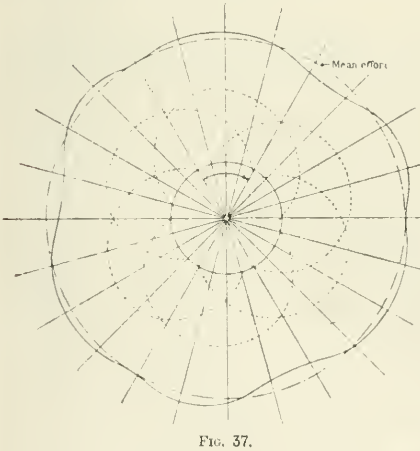

FIG. 37.

Engine Governing.—Between the flywheel and the governor there is a very sensitive and intimate relationship. We have already said that it is necessary for the governor to be less sensitive to changes of speed than the flywheel; that is, the flywheel must tend to preserve a condition of less unsteadiness than that which will call the governor into action. Otherwise the governor would come into action several times during every revolution. But there is another point of relation, namely, that the flywheel will tend to maintain a constant speed whenever a sudden alteration of load calls for a re-adjustment of the governor. The governor takes time to alter the steam distribution, and in that time the energy of the flywheel tends to keep things going with a minimum alteration of speed. The action is only for a few moments; but that is all that a good governor requires. This is especially useful where the engine must run at constant speed at all loads; it is less useful where a slight change of speed must occur; and it is, of course, positively objectionable where a prompt regulation of speed proportionally to the load is required to take place.

The Performance of Steam Engines.

Performance During Full Load Trials.—Considering the steam engine by itself, and apart from the gearing to which in some cases it is necessarily connected, there are two methods of estimating the performance of an engine: (1) in terms of steam consumption per indicated horse-power per hour; (2) in terms of the steam consumption per brake horse-power at the pulley or shaft per hour. When the use of gearing is necessary, it would be more proper to estimate the consumption of steam per actual horse power hour at the dynamo end of the gearing, as this is the true commercial basis on which to estimate the value of the engine economy. Leaving the question of gearing alone for the present, the most satisfactory basis on which to estimate the economy of an engine is the weight of steam passed into the engine—including the jackets, &c., divided by the useful work, in brake horse-power hours, obtained from the engine. Comparisons made on this basis are far more honest than those based upon the performance per indicated horse-power, because the latter takes no account of the loss of power which is bound to go on within the engine itself. However, as a guide to the ultimate possibilities of the steam engine, as well as in order to furnish information about engine friction, it will be well here to consider both indicated horse-power and brake horse-power trials.

Some interest may attach to the highest yet attained economy, the more especially as a very high ideal has recently been laid before electrical engineers in Mr. Crompton's Paper on "The Cost of Electrical Energy." Probably the best practice in this respect is to be found in the engines of large ocean-going steamers of the first class. It will, however, be some time before the conditions of electric supply will warrant the use of such engines—economical though they be, at full load—in electric power stations. Turning now to engines which are in use in electric stations, we find that the best recorded result has been attained by the large, horizontal, slow-speed, triple expansion, condensing engines of Messrs. Sulzer et Cie. These engines are largely used in European electric supply stations, and in many respects resemble the Corliss engines used in this country. As the result of a series of trials of a 200-I.H.P. Sulzer engine, supplied with steam at 171lb. pressure, Prof. Schroeter found that the consumption per indicated horse-power hour amounted to 12·2lb. of steam actually supplied to the engine. In other trials of these engines, a consumption of less than 12lb. of steam has, it is claimed, been reached. The mechanical efficiency of these engines is probably not higher than 85 per cent., quite 15 per cent. being required for driving the heavy, unbalanced parts; so that the steam consumption per brake horse-power hour, in the case

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of the first-named trial of the Sulzer engine, was probably not less than 14·36lb. Turning next to high-speed engines, we find that Mr. Willans obtained an economy equal to 12·74lb. of steam per indicated horse-power hour, with a triple-expansion, condensing, vertical Willans engine. Details of the trials by which this result was obtained will be found in the Papers by Mr. Willans, to which reference has already been made. The engine was supplied with steam at 170lb. on the gauge, was run at 375 revolutions per minute, was not jacketed, and developed the normal power of 500 H.P. As the mechanical efficiency of this engine was slightly over 90 per cent., the consumption of steam per brake horse-power hour did not atttain a higher figure than 14·15lb. A comparison between this result and the previous one is sufficient to show the importance of reckoning engine friction in economy trials. With a Willans compound, unjacketed, condensing engine, of large power, a consumption of 14·87lb. per indicated horse-power hour equal to 16·52lb. per brake horse-power hour has been attained; and the same engine, working without a condenser, was found to consume 18·25lb. per indicated horse-power hour, or about 20·31b. per brake horse-power hour. The average of results from trials of single-cylinder steam engines, of moderate power, will probably show a consumption of not less than about 20lb. or 22lb. per indicated horse-power hour, when condensing, and of about 25lb. when working without a condenser, steam of moderately high pressure being supplied. The consumption of these engines, per brake horse-power hour, varies between wide limits, owing to the great range in engine friction; but a consumption of 25lb. or 26lb. per brake horse-power hour, when condensing, and 30lb. to 32lb. per brake horse-power hour, when non-condensing, probably does not depart very widely from the average figure, in the case of well-made engines of moderate power. With very small engines, the economy is by no means so satisfactory, even at the most economical load; and, owing to the very low mechanical efficiency of these engines, the consumption per brake horse-power hour is especially bad.

Performance During Reduced Load Trials.—Fortunately, our knowledge of the behaviour of the steam engine at any given fraction of full load is more exact than our knowledge of the behaviour of the boiler under similar circumstances. Still, there is a great deal yet to be investigated, chiefly as to the effect of diversity of type upon the economy at reduced loads. In the case of only one type of engine—namely, the vertical balanced, single-acting engine, with regulation by the throttle valve—can it be said that the variation of steam consumption with varying load has been exactly determined. Thanks to the careful researches of Mr. Willans, we do know how an engine of this type behaves, and our information is so complete as to justify the application of the term "Willans law" to the particular case. But we do not know, at any rate with the same degree of exactitude, what the corresponding law is for other types of engines, such as the horizontal engine with regulation by an automatic cut-off. We only know that the Willans law does *not* apply to such types of steam engine, and that in some other manner the consumption per horse-power rises as the load falls. Until we know the law of each common type of engine, the controversy as to the relative merits of throttle and cut-off regulation, and many other important questions, must remain open.

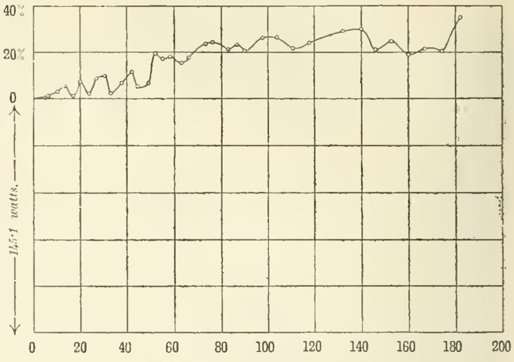
(To be continued.)

INCREASE OF OPEN-CIRCUIT LOSS IN TRANSFORMERS WITH TIME.

G. W. PARTRIDGE, A.M.I.C.E.

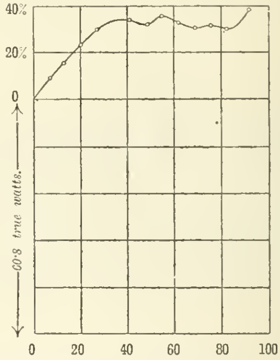
As far as I am aware, the results shown by the accompanying curves, which give the percentage increase in open circuit in transformers after they have been working for a certain time, have never before been published. The matter is one that will interest those who have to use transformers to any extent, and is of especial importance to transformer-makers, who are frequently called upon to guarantee the performance of their plant for a specified period.

A great number of experiments show that the increase of waste of power is due to a molecular change or fatigue in the iron, and not to dampness or deterioration in insulation, as might easily be supposed at first sight Were this the case, the power factor would increase as the insulation decreased; but throughout the observations the power factor remained substantially constant.



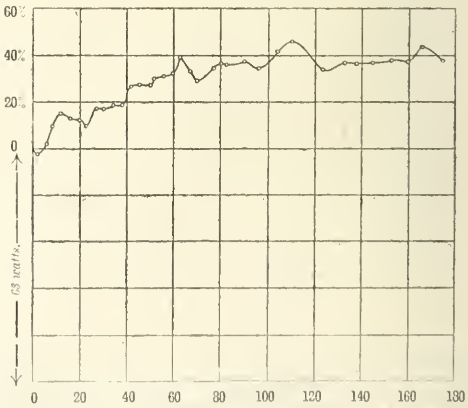
No. of days transformer has run on magnetising circuit, commencing 145·1 true watts original loss

FIG. 1.



No. of days transformer has run on magnetising circuit, commencing with 60·8 true watts original loss.

FIG. 2.



No. of days transformer has run on magnetising circuit, commencing with 63 true watts original loss.

FIG. 3.

To show beyond all doubt that no increase of loss took place owing to exposure of the coils to the atmosphere of the test room, two precisely similar transformers were taken. One was carefully sealed in its case and run continuously for four months, the other, which had its case removed, was only magnetised for the purpose of the measurements which were taken on both transformers every three days. The power taken by the former showed the usual increase, while that taken by the latter remained constant. When, however, the second transformer was run continuously, the same falling-off in efficiency was observed as shown in Curve 2.

Curves 1 and 2 were taken from similar 750-watt transformers, which were kept in the test-room for the purpose; Curve 3 was taken from a 15,000-watt transformer doing regular and varying work in a sub-station.

NOTE ON MR. PARTRIDGE'S PAPER.

BY PROF. J. A. EWING.

Mr. Partridge's observations on the "increase of open-circuit loss in transformers with time" have so much interest and apparent importance, both on the physical and on the engineering side, that one feels a strong wish to have fuller particulars than his short Paper gives. It would be interesting, for example, to know in what way the losses were measured, what was the value of B in each case, and also what was the difference in the conditions of the experiments of Figs. 1 and 2 which should make the results so different in these two curves, although both were taken from similar 750-watt transformers. That there must have been some material difference in the conditions is clear from the fact that the figures stated for the original open-circuit loss are widely different in the two. Again, as regards the curves, the rise in Fig. 2 is steady for the first month, after which a nearly stable state appears to be reached, while the rise in Fig. 1 is subject to a nearly periodic fluctuation of large amplitude, and the curve goes on rising for at least two months.

The observations apparently point to a real change in the magnetic qualities of the iron, resulting from repetition of the magnetising process. It would be interesting to get direct evidence of this by subjecting a sample of iron whose magnetic quality has been carefully tested to periodic reversals for a month or more, as in a transformer, and then to examine its magnetic quality again, testing particularly whether the area of the $B\ H$ cycle is altered by this exposure of the iron to many reversals. It is well known that when a piece of iron is first magnetised by a moderate force, the value of B reached on applying a given H is greater than the value reached after a double reversal, and the limits of B continue to contract appreciably during some scores at least of reversals of H. I have given a conjectural reason for this in discussing the molecular theory, and have, in fact, reproduced the phenomenon in a model with little magnets. It would now seem that some such progressive change goes on during millions of cycles, and results also in an enlargement of the area relatively to the value of B.

This effect, if its existence is confirmed, has an interesting correspondence with what is known as to the cumulative influence of repeated strains on the mechanical qualities of metals. Wöhler's experiments, though their interpretation is open to some question, are generally held to indicate a progressive deterioration of strength as a result of many applications and reversals of even a very moderate amount of load, and Lord Kelvin has shown by experiments on the torsional oscillations of vibrators hung from long wires that the rate at which the damping out of the vibration takes place through imperfect elasticity is augmented when the wires are kept twisting and untwisting day after day. There is a progressive fatigue of elasticity; in other words, the hysteresis of strain with respect to stress becomes increased by repetitions of straining. This is precisely what we are now told happens in regard to magnetism.

Lord Kelvin also found that this fatigue tended to disappear during an interval of rest. His wires were kept vibrating every lawful day; but they had a rest on Sunday, and on Monday they were found to have recovered something of the elasticity they had been losing during the previous week. It is natural to look for a similar restoration of magnetic quality through rest, after fatigue has been produced by many reversals of magnetism. This, if it is found, will be an interesting addition to the already cogent reasons that make it desirable to cut a transformer out of circuit when it is not doing useful work.

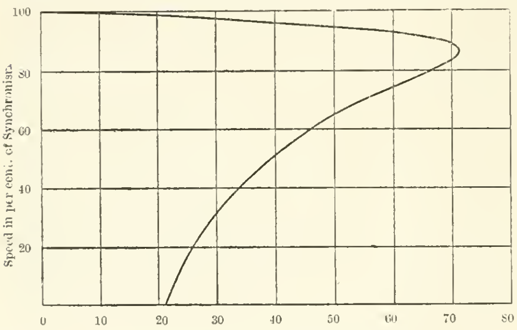
THE ELECTRIC TRACTION DISCUSSION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The following is an abstract of the discussion which took place at the Institution of Electrical Engineers on the Papers of Mr. H. D. Wilkinson, Messrs. R. W. Blackwell and P. Dawson, and Mr. C. S. Du Riche Preller. Speakers who have returned their proofs revised have an asterisk placed against their names:—

Dr. N. S. KEITH gave a brief description of a steep grade plant in California, the Passadena and Mount Wilson Railroad. The line ran from Passadena and would eventually end on the top of Mount Wilson, some 13 to 15 miles away, at an elevation above the sea of 7.000ft. The line was completed a year ago last July to the top of Echo Mountain, 3,500ft. above Passadena. For a distance of four or five miles the grade was a very uniform one of about 7½ per cent. It then went up to a grade which necessitated an ascent, as far as he remembered, of 1,600ft. in 3,000ft. This ascent was made by a cable run by a 75-H.P. electric motor placed on the summit of the rise. There were two cars fixed upon at equal distances in the cable, so that when one ran up the other ran down, and they thus balanced. The 75-H.P. motor received its current from two sources. At a small town half-way between this severe rise and Passadena there were two 60-H.P. gas engines. At various localities in the mountains above were placed dynamos driven by Pelton water-wheels. It was contemplated, and would be carried out by the time the line was completed to the top of Mount Wilson, to derive a quantity of water from the other side of the mountain. Some 400ft. below the summit of the mountain there was a small stream flowing. It was in contemplation to pump this water for 400ft. by electrical power, allowing it to fall on the western slope of the mountains, where it had a descent of 7,000ft.; 200ft. or 300ft. in excess of the 400ft. would ensure sufficient power to run the pump and motor, leaving then some 4,200ft. or 4,300ft. fall for power purposes.

*Mr. MARK ROBINSON said he believed that these Papers came at a most opportune time. Electric traction was certainly going to be a matter of a magnitude very few of them were able to gauge. He thought they would all allow that the country which could teach them most on electric traction was America. It should be very gratifying to them that not only did their American friends lay their experience and knowledge open to Mr. Wilkinson as an individual, but also avowedly placed them at his service for the purpose of laying the results before this institution. Mr. Blackwell's and Mr. Dawson's Paper struck him as being very restrained and very free from self-seeking. Their display of apparatus seemed to his colleague and himself so interesting that, having friends in France at present engaged on a large traction scheme, they thought they could do them no better turn than to ask them to come over and be present at that meeting and see that collection of apparatus. If anything would tempt him to indulge in criticism or to trespass upon the province of the expert it would be some of the statements in Dr. Preller's Paper, certainly one with regard to high-speed engines for electric tramway work; but he would not touch upon that now, for that discussion, to be of any use, ought to have taken place several years ago.

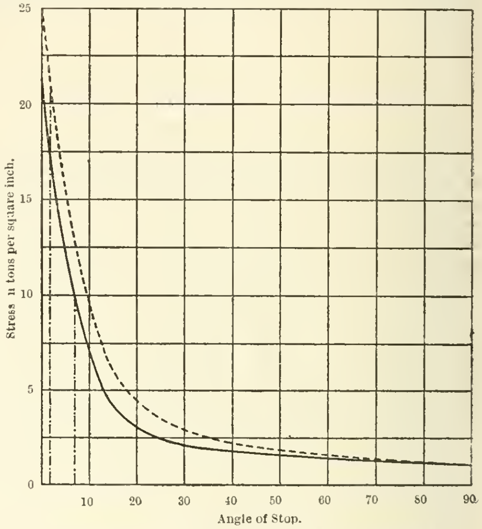
*Mr. H. F. PARSHALL said the subject of earth returns had been touched on in all the Papers. The troubles now so common in the United States might have been largely avoided had these return circuits been put in according to principles that were thoroughly well understood. The extent to which the rails might be utilised as a return circuit depended on how well they were electrically connected together. Ordinary fishplates were of no use in accomplishing this. The rail bond must carry the whole current from rail to rail. The contact between the bond and rail had been almost universally a pressure contact. Experience with polished copper pressure contacts was that a current density of 300 amperes per square inch for currents up to 500 amperes should not be exceeded. For greater currents so high a density was not permissible, since the contact surfaces could not be fitted so well together. With iron contacts, especially when liable to corrosion, 50 amperes per square inch was as high as was safe in most cases. In other words, if 1.000 amperes per square inch was taken to be the mean current density permissible in the bonds, the contact should be 20 times the section of the bond. Supplementary conductors should be located so that the current density in the bonds was kept within this limit. In the case of very large currents, the permanency of the earth circuits was best insured by electrically welding all the joints together. As Mr. Wilkinson touched on the amount of power taken by electric cars, some further data might be appreciated. A fair value for the amount of energy taken by ordinary cars of from 8,000 to 10,000lb., making schedule time from eight to twelve miles per hour, was one Board of Trade unit per car mile. The current taken in starting the car was from 40 to 50 amperes with the series parallel controller. This current corresponded to 1,600 to 2,000lb. horizontal effort at the periphery of a 33in. wheel, and accelerates the car under ordinary conditions about 2ft. per second. The energy taken per car mile remained fairly constant through a wide range of speed, which pointed to the economy of as high tramway speeds as safety permitted. The practice in the United States of running the cars at from four to six miles per hour in the crowded streets, and twelve to fifteen miles per hour in the outskirts seemed to the speaker to be reasonable, since accidents generally occurred in the slow speed districts. He submitted curves showing the speed, torque and efficiency (including loss in gearing) of a good modern American tramway motor designed for series parallel control. If this motor were adjusted to English practice the torque would be increased 50 per cent., and the starting current for the same conditions diminished to two-thirds of that quoted for American practice. Regarding the application of alternating currents to tramways, he might say the properties of the induction motor were not such that it compared favourably with continuous-current motors for ordinary tramway work. He submitted a torque curve (reproduced herewith) of a well-designed three-phase induction motor, which should be compared, as to form, with the torque curves of the continuous-current motors. The indirect application of alternating currents to drive commutating dynamos for the operation of tramways was being successfully carried out, and had the advantages of avoiding long earth returns and heavy feeders. Regarding the experience in the United States with direct-connected railway dynamos, the results had been most gratifying. No mechanical troubles had been experienced, either with dynamos or engines, and the safety and economy gained were even more marked than on direct-connected lighting dynamos.



Torque curve for 15-H.P. 3-Phase Induction Motor.

As an example of the service such plant had been put to, he would quote the Intramural Road at the Chicago Exposition. There were 14 trains of 67 tons each. Scheduled time, including stops, 10 miles per hour, each train taking on an average 42 kilowatts, but frequently more than 250 kilowatts; so that the fluctuation of load on the 750-kilowatts 100-revolutions engine and dynamo was regularly between 400 and 1,500 kilowatts. This, together with occasional short circuits, threw on the plant great strains. Still, there was no trouble from any source, and after the apparatus was taken apart at the end of the Exposition, it was found to be in perfect condition.

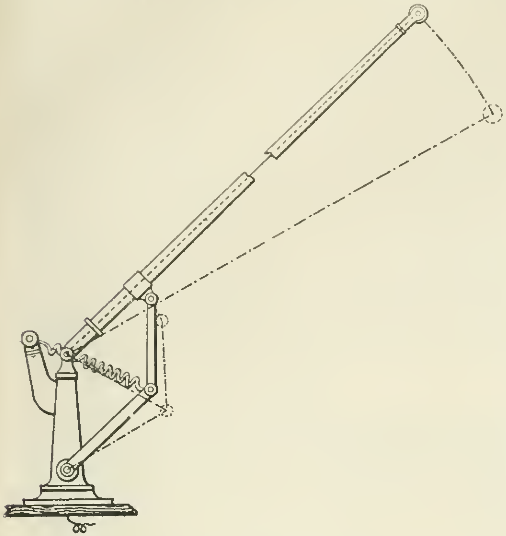
* Capt. SANKEY remarked Mr. Wilkinson said in his additional Paper that "an overload or short circuit, when driving by belt, put a sudden brake on the periphery of the flywheel and a strain on the spokes." No doubt that was true ; but he hardly thought that the stresses so produced would lead to accident, because the energy in the flywheel was discharged directly into the belt, and not through the spokes. But the case of an engine driving a dynamo direct was somewhat different. In that case the energy in the flywheel had to be discharged through the spokes, because the rim tended to get ahead of the boss, and so produce shearing and bending stresses at the boss, which might break the spokes. That stresses of this nature might be a serious question in the flywheels of slow speed sets there could be no doubt, or that they might lead to accident. At the same time there was no such risk with the small disc flywheels of high-speed direct-driven sets. It was often said that if a short circuit should take place the engine of a direct-coupled set would suffer damage A moment's consideration, he thought, would convince them that it was not the engine but the armature of the dynamo that would suffer damage, because the engine was protected, so to speak, by the flywheel. But to put the matter beyond doubt he had had some calculations made, which were embodied in the diagram given. The problem had been worked out for a single-acting engine of 200 H.P. running at 350 revolutions a minute, and it had been considered that the short circuit commenced at the moment when the pistons were at their highest speed. It was evident that the greater the angle of stop (that was the angle described by the crank shaft in the moment of short circuit) the less would be the stress, and if that angle was nothing, that is, if the stop were absolutely instantaneous, the stress was somewhat over 20 tons per square inch. The stress, however, dropped very rapidly ; even at 10deg. it was not much more than 7 tons, and at 90deg. it was only 1 ton, which was not much more than the normal stress produced by inertia in the crank shaft in the ordinary running of the engine. The ordinary stresses were about a ton and a-half. If they allowed 10 tons for these short-circuit inertia stresses it still left a very ample margin up to the elastic limit ; that was to say, the stress was a long way below the elastic limit. It was thus seen that even an angle of stop of about 7deg. would do no harm to the crankshaft. That corresponded to a stop which would take place in $\frac{1}{150}$th of a second, and he would leave them to judge whether such short-circuits were possible. The same problem had been worked out for a double-acting engine of the same power running at 100 revolutions with the cranks set at right angles. This was more favourable to the double-acting engine. The crank-shaft was of proportionate strength, and the stroke adjusted so as to give the same piston speed, so as to make all the conditions the same except the revolutions. The result was the dotted line, which was nearly the same as the other. They would observe that if this engine stopped in $\frac{1}{150}$th of a second the angle would be only 2deg., and the stress on the shaft would be over 20 tons per square inch. Nevertheless, there could be no doubt that either of those engines would be perfectly safe against any short-circuit that might possibly occur in practice, more especially if they did take into account, which they had every right to do, the protecting action of the flywheel. Therefore, it came to this: that in direct-driven sets the only trouble was likely to be in the armature, and it was evident they had only to make the shaft and the windings sufficiently strong to stand the stresses, and such a direct-driven set was perfectly safe against any short-circuit, a theoretical deduction which was confirmed by what Mr. Parshall had told them had happened at the Exhibition at Chicago.



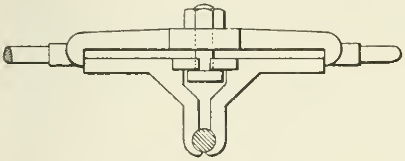
Torsional Stress in Crank Shaft due to Sudden Stoppage by Short-circuiting.

* Mr. M. HOLROYD SMITH said English electrical engineers owed their best thanks to American financiers, for they had demonstrated to the world that which English electrical engineers were only able to scheme and dream of, because the British purse strings had been drawn too tight. The history given in the Papers read showed there was a danger in hastening too rapidly. The conclusions arrived at in Mr. Wilkinson's Paper had long ago been enunciated and advocated in England—viz., that until a storage battery very different from any yet in use had been evolved they could be economically used for traction work ; that the direct system paid ; that the cheapest method was overhead conductors ; that they could be constructed so as to be reasonably safe, and not offensive even to an artistic eye ; that underground conduits were better than overhead lines where the traffic warranted their cost ; that the proper way was to put underground conduits in the busy thoroughfares of large towns, and overhead conductors in the suburban districts, and country lines. It was certainly gratifying to those in this country who had long advocated these views to find that the practical experience of the Americans had led them to the same conclusions. Referring to Fig. 12, of Mr. Wilkinson's Paper (see *The Electrician*, October 19th, p. 728) illustrating a channel system laid in Chicago it was to him a very interesting arrangement : for it was constantly reappearing under varying names. He was also interested in the description of the two-wire system ; the American experience again demonstrated the truth of English predictions. Messrs. Blackwell and Dawson set an example well worth following ; namely, they do not content themselves nor attempt to content the Institution with abstract figures. They showed how it was done. They brought a host of most carefully worked out details for examination, illustrating how thoroughly the Americans had threshed the subject out. He believed he was correct in saying that Sprague was the originator of the fishing-rod device, and the thanks of the electrical world were due to Sprague. It would be noticed that all the fishing-rods exhibited and

described were for use on cars with no roof seats: they would be quite inapplicable to cars with roof seats. He would therefore like to describe how he employed a fishing-rod on the car he ran at Bradford up a gradient of 1 in 11 to demonstrate the possibility of economically mounting steep gradients by electricity. [The speaker here described his trolley-pole, a sketch of which is given herewith. He also described a clamping "ear" and trolley-wheel devised by himself, sketches of which are also herewith.]

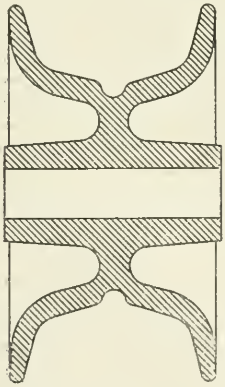


Holroyd Smith Trolley.

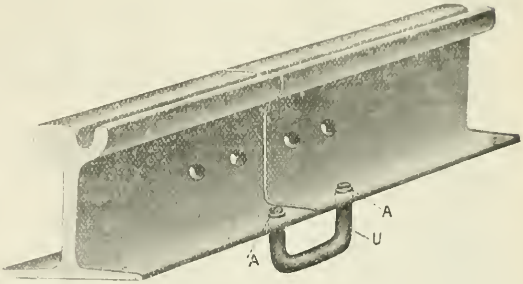


Holroyd Smith Overhead Wire Clip.

The authors of both Papers had paid much attention to rail bonds. One described, and to which the understood preference had been given, was very similar to the one he devised and employed when constructing the Blackpool line, more than ten years ago. In repairing the line this spring some of these were exposed, and found in excellent condition. He might also say that the rails are, and were at the outset, connected with the negative terminal of the dynamo by insulated copper cable of ample dimensions. It was well known that the chief difficulty with a tramway was the rail joints. Though the plan of welding was very attractive, he was at present sceptical as to the result. He had long advocated a double-tread rail and car wheels with centre flange, and he was glad to know that the plan had been adopted in Budapest, which was decidedly the best example of electric tramway with which he was acquainted. The double tread lent itself to easier running through points and crossings, and he wished to show the construction of rail that practically got over the joint difficulty and lent itself very easily to efficient bonding. It was an exceedingly simple arrangement, with one set of rails for both sides (*see* sketch).



Holroyd Smith Trolley Wheel.



Double-tread Rail.

The discussion was then adjourned.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, December 7th.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel. The following Paper will be read and discussed: "Water Works and Appliances," by William Mallock.

MONDAY, December 10th.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

6:30 p.m. Council Meeting at the Palatine Hotel, Manchester.

7:30 p.m. Annual General Meeting. Election of President, Vice-Presidents, Officers and Council for 1895. The following Paper will be read:—"On the Commercial Possibilities of Accumulators for Tramcar Traction as a Municipal Undertaking," by A. H. Gibbings, Member.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture: "Modern Developments in Explosives," by Prof. Vivian B. Lewes.

TUESDAY, December 11th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper will be read:—"Colliery Surface-Works," by Edward B. Wain.

WEDNESDAY, December 12th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read:—"Manufacture of Salt," by Thomas Ward.

THURSDAY, December 13th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. Council Meeting.

8 p.m. Annual General Meeting. Annual Report, Election of Council and Officers for 1895. Discussion on Electric Traction.

FRIDAY, December 14th.

PHYSICAL SOCIETY.

5 p.m. The following Papers will be read:—(1) "Students' Apparatus for Finding the Mechanical Equivalent of Heat," by Prof. W. E. Ayrton and H. C. Haycroft; (2) "Glow Lamps and Testing Instruments," by Prof. W. E. Ayrton and E. A. Medley.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. The following Papers will be read:—(1) "Some Experiments on the Heat-Losses to the Cylinder Walls of a Steam Engine," by S. Henry Barraclough and Lionel S. Marks B.Sc.

⁂ Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

The Electrician.

(The Oldest Electrical Journal, 1861—1878.

◆

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NOTICE.

With this week's number of "THE ELECTRICIAN" is issued (Gratis) three Photographic Views of Rooms in the Board of Trade Electrical Standards Laboratory. Complaints of non-receipt should be promptly addressed to the Publisher.

MUNICIPAL ENTERPRISE.

To hope in these days to stand between the public and some fad or other upon which it may perchance have set its great palpitating heart is scarcely less absurd than to expect to sweep back the flowing tide with a broom. And the hopelessness of the task is not rendered less when the movement happens to be one which has something to recommend it and much to excuse it; that is to say, when it contains just that lucky mixture of good and evil which nerves its supporters and unnerves its opponents. It is, however, some satisfaction merely to place an opinion on record, even at the imminent risk of allusive remarks about CASSANDRA, whose fate, it should be recollected, was not to prophesy falsely, but to never be believed.

Reflections of this kind cannot, we think, fail to arise in the minds of those anti-municipalists who chance to catch sight of the article on "Municipal Enterprise," which appeared in *The Times* of Friday last. No one would care to utterly condemn municipalisation on the strength of two isolated facts, especially when time may put quite another complexion on, at least one of them, and no one proposes to do so. A man convinced against his will is of the same opinion still; but where arguments fail to convert, facts may be relied on to succeed. The arguments in favour of the municipalisation of all manner of things which were until quite lately generally considered outside the range of parochial politics, have hitherto failed to convince many of us, so that a few facts would be extremely handy; but, as Lord FARRER pointed out to the Royal Statistical Society last month, no one knows accurately the comparative cost and efficiency of municipal and private undertakings. Electric lighting is the latest province annexed, and before committing the ratepayers of this and future generations to a more or less speculative business, one could have wished for proof, by means of a comprehensive and competent survey of available statistics, of the superiority from a purely £ s. d. point of view of the parochial management, say, of gas undertakings. When such proof is called for, however, there is usually a disposition to magnify the indirect gains accruing from municipalisation; against which it is surely permissible to set the indirect losses due to jobbery, and the absence of the bracing effects of competition. Thanks to the existence of an admirable system of central control, and to what one might in a moment of pride term natural national character, the most rabid opponent of municipalisation must fain admit that the probability of reckless finance and corruption is not so great here as elsewhere. Nevertheless, there have been ugly eruptions clearly indicative of the presence beneath ground of all the materials necessary for the reproduction on this side of the ocean of time-honoured transatlantic methods. Again, it may be plausibly argued that public-spirited emulation may be expected to prove a sufficient substitute for competition. We hope so. But facts and figures relating to what has been done in the past might, when duly correlated and analysed, afford a rational sanction for such a sanguine anticipation. As it is, the present tendency towards State meddling and municipal management appear to the dyspeptic to open up some remarkably fine democratic vistas—of heavy taxation and high rates.

The sphere of operations proper to a town council is, one would have thought, wide enough, in all conscience, even when narrowed to fit the small mind of the average ratepayer of, say, ten years ago. The construction and maintenance of roads, sewers, and public buildings; the care of the public health and of private property, by efficient house sanitation, water supply, police and street lighting might well suffice to fill up the leisure hours of well-to-do citizens. But Ossa must be piled on Pelion. Gas works and tramways must be bought and managed, an electric supply must be provided, municipal lodging houses and municipal music have become prime necessaries, and the culmination of it all is to be seen in the lending of £5,000,000 by one Corporation to one huge bankrupt concern and the sinking of over £1,000,000 by another municipality, ruling over some 112,000 souls, in an abortive attempt to make a port where nature never meant one to be. The electrical analogue of the Manchester municipal canal and the Preston municipal docks would have been for the London County Council to have undertaken the electric supply of all London from Deptford. What this premature colossus has come to we all see to-day, and the *quidnunes* are many who can quite truthfully say, "I told you so." But until the event decided the question—for a time—the arguments *for* were quite as cogent as the croakings *against* were alarming. Indeed, taking one consideration with another, as the poet says, an ambitious County Council would have been amply justified in saddling the ratepayers of the metropolis with what, even in private, personally interested, competent hands, has turned out so far a £850,000 failure. The dissipation of capital, *The Times* notwithstanding, is in any case to be deplored, when, however—as in the case of Deptford—hard-headed, wealthy individuals lose their money, at any rate no injustice is done. On the other hand, when a municipality steps outside the straight path of parochial utility, and by a majority, may be, of one, involves the credit not only of *all* of its constituents then existing but of many future thousands in purely-commercial, largely-speculative ventures, such as gas vending or electricity vending, a "magnificent sample of municipal enterprise" may very well become a piece of injustice. A taxpayer who objects to pay for the defence of his country in danger, or a ratepayer who will have nothing to do with drainage, good roads or a police force may have excellent reasons ready to hand; but to such abnormal individuals, the "majority-of-one" argument may be applied without much violence to natural justice. It is, however, quite another story when, whether he likes it or no, very vulgar, almost improper, fractions of a shilling in the pound are clapped on to the rates to aid local busybodies to set up business in gas, electricity or other similar condiments of modern urban life. And the mere fact that a venture of this nature frequently pays, does not alter the principle for which we contend, although, of course, a municipal milk supply which should reduce the rates by a handsome amount would not, as ratepayers are constituted, lead to many searchings of heart connected with such academic questions as the expediency or propriety of the undertaking.

PHENOMENON OBSERVED WITH BROKEN MAGNETS.

BY WILLIAM B. BURNIE.

These experiments have been performed in the laboratory of the Central Technical College, since the publication of the article on "A Curious Magnetic Phenomenon" in *The Electrician* of November 23, p. 104; and they are a continuation and, it is thought, an explanation of the observations there described.

Mr. Lloyd, when mapping the fields of various broken permanent magnets with iron filings, found, in addition to the disturbance of the filings at the fracture, a disturbance somewhat similar symmetrically situated with regard to the general shape of the magnet. He, however, performed his experiments with magnets which had been previously broken, whereas I commenced with an *unbroken* bar magnet and mapped its field, with the intention of subsequently breaking it. After magnetising the bar between the poles of a powerful electro-magnet to remove irregular magnetisation the result given in Fig. 1 was obtained. About one-third from each end (at A or B) we see a curved mark very similar to the image obtained by Mr. Lloyd. The field was next taken in a plane at right angles to the plane of Fig. 1, and the result is given in Fig. 2. From this we see that the curved images at A and B are caused by two feeble consequent poles at these points. The following methods of magnetisation were tried with a view of destroying these consequent poles.

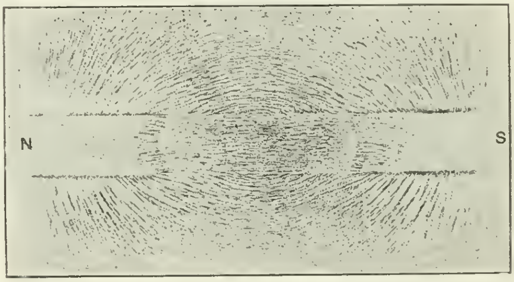


Fig. 1.

1. The bar had its magnetism reversed between the poles of the electromagnet previously used to magnetise it.
2. It was magnetised in a solenoid, the magnetic circuit being completed with iron, length of solenoid 13in., length of magnet 12in., number of turns 240, current 50 amperes.
3. Its magnetism was completely reversed with the same solenoid.
4. It was demagnetised by successive reversals with the same solenoid, and remagnetised with a small solenoid placed in the middle of its length. Length of solenoid 4in., number of turns 130, current 60 amperes.
5. Its magnetism was reversed in the small solenoid.

After each of these magnetisings the field was mapped as before, and in every case a result was obtained similar to that shown by the curves in Fig. 1. It was thus evident that the effect was not due to the method employed to magnetise the bar, but to the material of the magnet not being perfectly homogeneous. The same experiments were then tried with a number of bar magnets of different lengths; and with all those which were as long as the one previously used the effect was the same; but it was much less marked with shorter magnets. In some cases, too, the curves were rather less symmetrical than those reproduced.

A number of pieces of magnet steel were then tempered to various degrees of hardness, and attempts made to scratch the bar magnet with them at different points in its length. All the pieces of steel would scratch the bar magnet at any point in its central portion up to about one-quarter of an inch within the consequent poles at A and B; but outside these consequent poles none of the pieces of steel would produce any mark. Hence the ends of the bar magnet were harder than the centre, and there was a rapid change in hardness at the consequent poles. After this the face of the magnet was cleaned with emery; and it could be seen that there was a slight change in texture at the consequent poles, the surface outside them being dappled, while the part inside was of a more uniform character. Whether the change in hardness were due to change in temper or variation in composition, the mechanical effect would be the same—namely, to make the magnet liable to fracture at the consequent poles either through brittleness or internal strains—and the magnetic effect would be to make the ends induce the observed consequent poles in the more permeable central position.

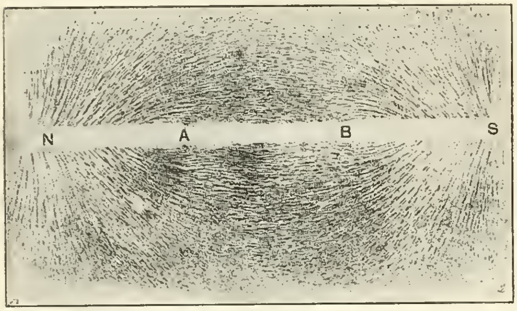


Fig. 2.

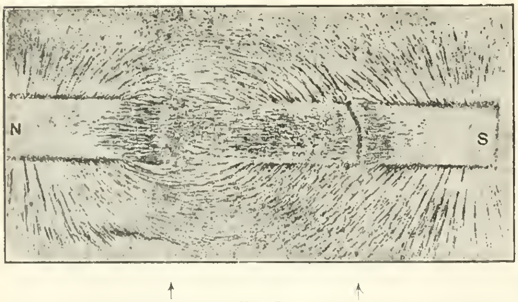


Fig. 3.

Singular evidence of mechanical weakness at the consequent poles was obtained in the attempts which were made to break the magnet.

By the kindness of Prof. Unwin, the magnet N S was supported as shown and a downward pressure of 20 tons applied at C, corresponding with a maximum stress of 100 tons per square inch. The magnet, however, did not break; and it was gently tapped in the hope that the jar would aid the pressure. The magnet instantly broke, *not* at C, but at B, one of the consequent poles. The field of the broken magnet was then plotted, and Fig. 3 gives the result. This diagram is very similar to the one obtained by Mr. Lloyd, although we now know that the apparent reflection is not, in this case, a result of the break.

The small piece B S of the magnet was next broken by blows from a sledge hammer. The metal was placed on a 2in. span, and struck in the middle; but many blows were given before one succeeded in breaking it. This is remarkable in comparison with the ease with which the magnet broke at the consequent pole. The field was then mapped for the magnet with the broken pieces placed in position, and no reflection of the cracks was obtained, but only the original consequent pole curve. I consider that the results obtained justify the following conclusions:—

1. That in many bar magnets there are consequent poles due to variations in the hardness of the steel which cannot be removed by the most careful magnetisation.
2. That, owing to the variations in hardness, the points where the consequent poles occur are much more liable to fracture than any other parts of the magnet.
3. That, as a result of this, it is at one of the consequent poles that a bar magnet usually breaks.
4. That these consequent poles are usually fairly symmetrically situated with regard to the general shape of the magnet.
5. That the magnets used by Mr. Lloyd had been previously broken at one of the consequent poles; and that the apparent image obtained was due to another pole symmetrically situated relatively to the break.
6. That Mr. Lloyd did not detect the existence of these symmetrically placed consequent poles when he mapped the field with an unbroken magnet, because the length of the magnet he employed was somewhat small; and with small magnets the effect is slight and easily missed.

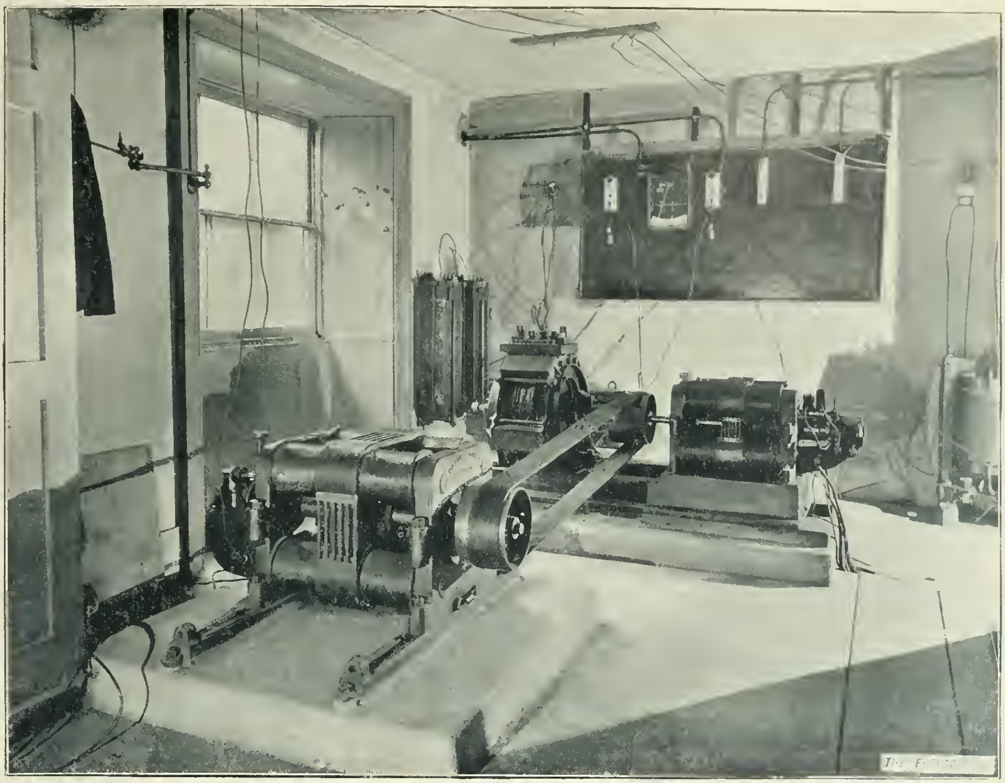
We thus see that Mr. Lloyd's conclusion is generally true; viz., that, if a broken magnet be powerfully magnetised and its field mapped with iron filings, the filings will not merely mark out the line of fracture, but will also indicate an apparent image symmetrically placed relatively with the fracture. But my experiments show that this apparent image is not due to the fracture but to the fact that there are lines of mechanical weakness in a magnet symmetrically shaped and symmetrically situated, and that the tendency of a magnet to break along one of these lines is very great compared with its tendency to break anywhere else

In conclusion, I must acknowledge my indebtedness to Prof. Ayrton, under whose directions the investigation was undertaken, for his supervision and advice during the course of the experiments.

THE BOARD OF TRADE ELECTRICAL STANDARDS LABORATORY.

The photographic views of the Board of Trade Electrical Standards Department, which we publish to-day, give a good idea of the three largest rooms of this laboratory. The laboratory and the more important instruments and standards were described in our last volume in our issues of October 5th and October 12th.

In the view of the Standards Room, the multicellular voltmeter for 100 volts (illustrated in elevation and plan, Vol. XXXIII., p. 694) is seen on the left in the foreground. On the right, placed on a high stone pedestal is the auxiliary current balance which acts to the Standard of electric current as the finder to an astronomical telescope. A pair of wires are seen running from this up to the ceiling, and down again to the Standard (described on pp. 665, 666, Vol. XXXIII.). In the background on the extreme left, the end of one of the largest current balances is seen, and the smaller balances enumerated in our description of this room are seen on the slate shelves. The concentric Ferranti mains, with the massive connections to the outer conductors, are clearly shown. Over the window in which the 5·30 ampere balance is placed two glow lamps may be seen. These are connected in series, and through them a current of about 0·8 ampere is kept continuously passing through the Ampere Standard, the lamps being dull-red hot.



Dynamo Room.

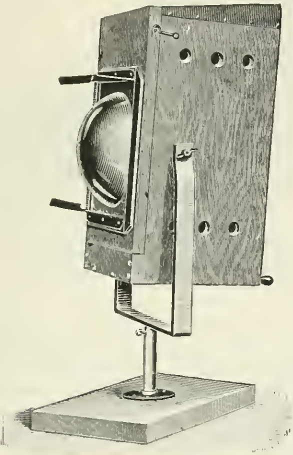
Verification Room.

The dynamo room and verification room require less comment. The plant in the former has been fully described, and the meters in the latter form no part of the permanent equipment, but are merely deposited there for examination.

This laboratory differs altogether from one which is arranged for purposes of research, for commercial work, or for education. The apparatus is provided for the accomplishment of work which is rarely attempted elsewhere; and now that the labours of the staff on the comparison of the three Standards has been completed, these important instruments will be seldom used, and verification will be carried out by means of the sub-standards.

A STAGE ARC LAMP.

The use of limelight for theatrical purposes is rapidly disappearing, where electric supply can be obtained, and arc lamps of special construction are being used instead. The ordinary automatic lamp is unsuitable for many reasons, and with one or two exceptions has not been used for stage lighting. The hand-fed lamps which were at first used for this work were very badly designed. They were clumsy to handle, were constantly breaking down, and hardly competed with a good "lime." Even now there is room for improvement in one respect; namely, running two lamps in series on 100 volts. Stage lamps are used in two ways, being placed either in the flies or proscenium, or on "perches." In the former case they are more or less fixtures; but in the latter they are set with each scene, and are generally mounted on steps. A man is, as a rule, in attendance on each lamp. The cost of a lime light is about 3s. per performance, and includes man, gas, and limes. The cost of an arc is about 2s. per man, the carbons a penny or two, and the current, at 6d. per unit, 3½d. an hour when two lamps are run in series. The total cost per lamp per performance does not differ much, but the arcs give half as much light again as the lime lights, and, if it were wanted, double the light could be easily obtained; but distribution is necessary, and one big arc could not replace two limes on this account. The cost light for light is nearly half that of limelight. The feed is given by hand, the carbons are screwed together until the arc hisses, and are then run back half a turn of the screw; they are then safe for five minutes or so. The arrangement of lens and reflector and hanging of the whole on a framework are points of considerable importance in these miniature projectors. The stage lamp which we illustrate is made by the General Electric Company, of London and Manchester. We have been indebted to this Company for the loan of three of these lamps in connection with the photographs of the Board of Trade Laboratory, of which reproductions are issued as a supplement to the present number. Several firms of photographers had declared that a good photograph of the Standards Room was impossible, since magnesium could not be used where so much glass and polished metal was included. The lamps were run from the laboratory accumulators, and were arranged to cast as few shadows as possible.

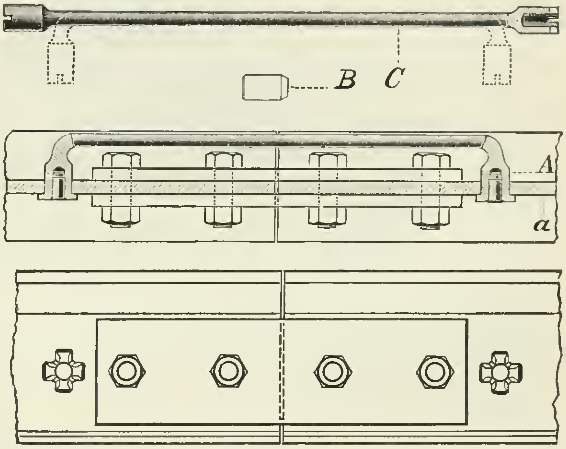


THE "CHICAGO" RAIL BOND.

A problem of paramount importance in electric railway engineering is the prevention of electrolysis, caused by electrolytic action of the heavy ground current of electric railways.

In the early stages of electric railways, the American expert made all his estimates and calculations with the utmost accuracy and scientific precision for the overhead half of the circuit, and spared neither money, time, labour nor copper to bring that half up to the highest standard of perfection; but the practical results which he aimed to attain—namely, a low percentage of loss or drop upon the line, and economical consumption of coal at the power-house—was seldom, if ever, realised, because he neglected to complete the metallic circuit.

If the metal of the rails is to be used for completing the metallic circuit, the rails must be properly bonded, and to properly bond the rails, both electrically and mechanically, accurate estimates for the number and size of the rail bonds used at the joints must be made, so that the total cross-sectional area of the rail bond will exceed the cross-sectional area of the overhead half of the circuit at any given point on the line of railway.

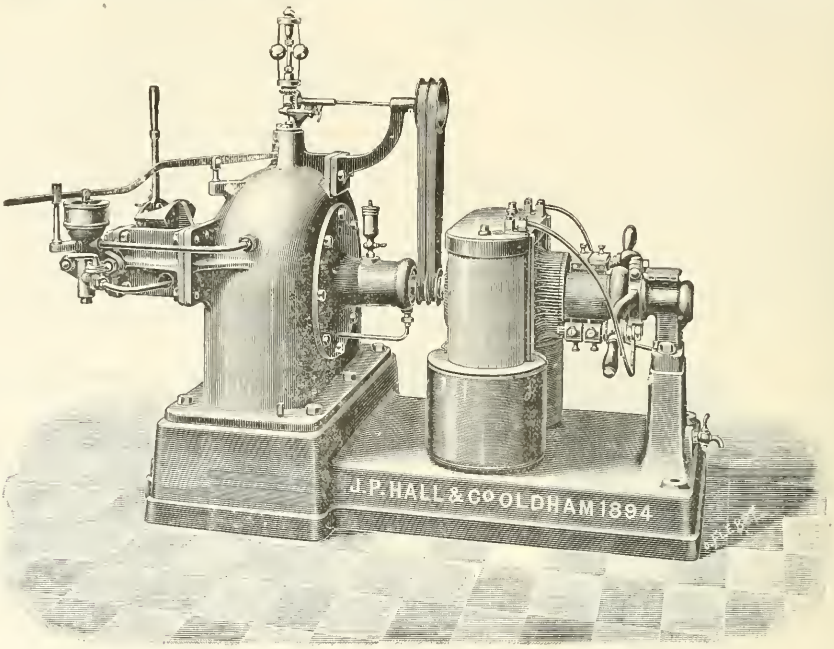


In this connection we illustrate the "Chicago" rail bond, referred to in the Paper recently read before the Institution of Electrical Engineers by Messrs. Blackwell and Dawson, and there exhibited as a typical rail-bond of best American manufacture. The rail-bond C is a copper rod composed of one solid piece of rolled copper, having thimble-shaped terminals, which are bent at right angles to the bond. The thimble-shaped terminals A are inserted into holes through the web of the rail *a* and the slitted end of the terminal A is clinched over on the rail with a hammer and punch; this holds it from drawing back out of the hole. The drift pin B, which is larger than the opening in the thimble-shaped terminal, is then driven into the terminal, expanding it and wedging it into solid contact with the surface of the hole through the web of the rail, making a good solid joint.

Electric Traction in France.—The Bellecour-St. Fons and the Venissieux steam tramways at Lyons are to be converted into electric lines on the Thomson-Houston overhead conductor system.

COMBINED DYNAMO AND TURBINE.

The dynamo is constructed for an output of 50 amperes at 80 volts at 750 revolutions per minute, and is of the usual type manufactured by Messrs. J. P. Hall and Co., of Oldham, the bed being prolonged to carry the turbine. The armature is of the Gramme wire-wound type, capable of carrying the full load with only a slight increase of temperature. The commutator segments are of hard drawn copper, insulated with mica. The brushes are of carbon, and the machine is so constructed that the lead of the brushes may remain the same without sparking for all loads. The magnets are of wrought iron let into the bed, and are shunt wound for charging accumulators or lighting direct. The electrical efficiency is about 86·33 per cent.



The turbine is of the Girard type, with wheel 10in. internal diameter carried on the end of the armature shaft, and is designed to give 6 B.H.P. when passing 36 cubic feet per minute at an effective head of 120ft. The guide ports are four in number, and are closed one after the other by a balanced regulating slide, the splindle of which passes through the bend, admitting the water to the guide, and which is regulated by a lever from an hydraulic cylinder, to either end of which water is admitted by a small balanced valve acted upon by the governor, with which the speed can be adjusted while running. By means of a tap, the water to the hydraulic cylinder can be shut off, and the slide worked by hand. The arrangement works almost silently.

BOLOMETRIC INVESTIGATIONS.[*]

BY O. LUMMER AND F. KURLBAUM.

1. On the Construction of a Surface Bolometer.

Introduction.—Although the bolometer has been generally known for more than ten years, there are not many physicists who have occupied themselves with it. Several circumstances may be made to account for this. For one thing the physicist is obliged to construct for himself the apparatus required for bolometry, and not only the bolometer, but a suitable galvanometer also; and he can hardly avoid the impression, on the other hand, that this region is one of the most difficult in experimental physics. This impression is not weakened by a perusal of the literature of the subject, and a study of the results hitherto attained with the bolometer. We see that Langley and others after him claim to have measured a rise of temperature of a hundred thousandth of a degree. So we must relinquish at once the attempt to surpass what has already been attained. It does not depend so much upon the magnitude of the deflection as upon the percentage of accuracy with which a given radiation can be measured. In general, the particulars of the sensitiveness hitherto attained are not precise enough, inasmuch as they only give the amount of deflection of the galvanometer, but not the *rise of temperature* produced in the bolometer by the radiation measured. This quantity, which determines the excellence of the bolometer, permits of the comparison of the various constructions among themselves. We shall treat this in detail further on.

Apart from the general experiments on the radiation of flames, and measurements of radiation in the visible and invisible portions of the solar spectrum, a special purpose was set for our bolometric investigations. The bolometer was to enter the service of photometry.

In the absence of a physical unit of light, glow lamps are at present used as comparison standards in photometry, and the practical standards are compared with each other through them. The glow lamps are fed by the current from a battery of accumulators whose strength is kept constant by accurately-regulated resistances.[*] To determine the changes of emission due to molecular changes in the carbon threads of the glow lamp several glow lamps are mutually compared, some of which are used often, and some very rarely. It is just this determination which was to be controlled by the bolometer by comparing the *total radiations* of the various glow lamps. A further application of the bolometer was then to consist in the reduction of the radiation of a source of light to that of a constant source of heat, so as to obtain in this manner a "unit of radiation."

In order to carry out such experiments it was necessary to have an extraordinarily sensitive bolometer, which permitted of its various branches being simultaneously illuminated from different quarters. The amount of the requisite accuracy of the bolometer measurement is given by the fact that a bolometric comparison is of no value in photometry unless we can *bolometre* the light from two glow lamps, excluding the dark heat radiation, with the same percentage accuracy as that by which they can be *photometred.* The photometers of the Reichsanstalt give, with ten readings, a mean error of about ¼ per cent. Thus it had to be our object to construct a bolometer which would satisfy these strict conditions with respect to sensitiveness, constancy, and mode of use. We believe we have attained our object since we succeeded in finding a method of construction for relatively simple linear and surface bolometers, which answer all requirements. In this Paper we restrict ourselves to the examination of the conditions for a sensitive bolometer, and the description of the mode of construction of our bolometer, giving the experiences gathered in the case of a surface bolometer in the first instance.

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[*] *Wied. Annalen*, Vol. XLVI., p. 204, 1892.

[*] O. Lummer and E. Brodhun: "Photometric Investigations," *Zeitschrift für Instrumentenkunde*, 10. p. 119, 1890.

Conditions for a Sensitive Bolometer.—The bolometric principle, that of measuring the intensity of radiation by the change of resistance produced by the radiation in a thin metallic conductor, was not first employed by Langley, as might be concluded from his dissertations,[*] but was announced and practically tested thirty years earlier by Svanberg.[†] But to Langley is due the credit of having at once brought the bolometer to a high degree of perfection, and having given to it a manifold application, so that a series of excellent bolometric investigations was initiated by his activity.

The sensitiveness of a bolometric measuring apparatus is conditioned by the bolometer proper, and by the galvanometer used. By the bolometer we shall here imply only the resistance to be irradiated. In order approximately to define the sensitiveness of a galvanometer for our purposes we shall assume that an astatic galvanometer is given with four coils and a constant winding space. Let the four coils be connected in series, and have a resistance of 1 ohm, let the current be 10^{-6} amperes, the distance between scale and mirror 1m., and one scale division 1mm. Let the magnetic system be arranged for a period of 10 seconds, and so that after the first deflection a well-defined return may be seen. The last supposition seems to be very arbitrary, but such a period fulfils almost all bolometric requirements.

Let sensitiveness be defined as the number of millimetres of deflection produced at make or break of the current, and let the sensitiveness of the galvanometer under the above conditions be called the normal sensitiveness. Since, with a constant winding space, the sensitiveness of a galvanometer is, within wide limits, approximately proportional to the number of turns; *i.e.*, proportional to the square root of its resistance, as long as the sheath of the wire does not occupy a large space, a figure for the sensitiveness in other units may be easily, and with sufficient accuracy for comparison, be reduced to the normal sensitiveness.

By the mere statement of the sensitiveness nothing is, of course, implied concerning the possible accuracy of the measurements. This accuracy depends upon the constancy of the zero position of the magnetic system, and upon the quality of the optical contrivance for reading the scale. But the accuracy is determined if, in addition to the sensitiveness, the mean divergence of several observed deflections is known. Accuracy may be defined as the ratio of the amount of deflection to this divergence, and we must in each case determine empirically when this ratio reaches a maximum, and must regulate the sensitiveness of the bolometer accordingly.

Since a bolometric measurement amounts to a measurement of a change of resistance in the Wheatstone Bridge,[‡] the general rules of the Wheatstone Bridge are applicable; *i.e.*, the relation between the resistances is most favourable when the same resistances are put in all the four branches and in the galvanometer.

The following, then, are the conditions for a sensitive bolometer:—

Make as large as possible:—

1. The main current.
2. The temperature coefficient of the bolometer metal.
3. The irradiated portion of the bolometer branch.
4. The resistance of the bolometer.
5. The absorption coefficient of the irradiated surface.
6. The irradiated surface.

Make as small as possible:—

7. The power of the total surface to giving off heat by radiation or conduction.
8. The thermal capacity of the bolometer.
    (*a*) The volume of the bolometer.
    (*b*) Its specific gravity.
    (*c*) Its specific heat.

If the metal for the bolometer is prescribed, we may write instead of the last condition—

8. Let the thickness of the metal be as small as possible.

The above conditions are those resulting from simple contemplation. We must now touch upon the points which crop up in practical work with the bolometer and which are decisive for its construction. We at once encounter a defect hitherto observed in all bolometers; viz., that the scale is constantly shifting and that a variation of the current produces a considerable displacement of the zero. The cause for all these phenomena must be sought for in the heating of the bolometer branches by the current, which is very considerable since the density of the current in the bolometer is very great. Now, if the four branches of the bolometer were perfectly equal in every respect, in resistance, sectional area, surface, &c., the changes produced by the heating of the resistances would have no effect, as the change would be the same in all the branches. As long as this is not the case the constant wandering of the scale will occur, which often lasts a quarter of an hour after the current is flowing. For the same reason a change in the current also produces a displacement of the zero.

These phenomena have given rise to the supposition that the temperature coefficients of the bolometer branches differed. We must admit that the thin wires, or sheets of the same piece of metal, may have different temperature coefficients, but nobody appears to have essayed a proof. But with the bolometers at our disposal, which had no perfectly equal branches, we have been able to prove that the temperature coefficient of the branches was the same. For if with one bridge wire the four branches were adjusted for a certain current intensity, the same adjustment held for a different room temperature, but not for a different current intensity. But the differences in the room temperature were much larger than the heating of the bolometer by the current. We therefore find the cause for the movements of the scale not in an inequality of the temperature coefficients, but in that of the temperatures themselves. Thus, an inequality in the sectional areas of the resistances will be attended by unequal heating. If two equal resistances are made of the same material, the *quantity of heat* generated in them by the current will be the same. But if the one resistance consists of thick wire, the other of thin, the momentary heating of the thin wire is greater on account of its smaller capacity for heat; but for a stronger current the difference between the two resistances will increase. The thinner the wires or sheets employed for the bolometer, the larger will be the percentage differences of sectional area. Herein lies a sufficient explanation of the slow wandering of the scale on making current, and of its sudden displacement on changing the current. But these defects can be avoided by making the resistances perfectly equal in every respect (condition 9).

As regards the irregular oscillations of the scale, they are due to the heating of the air surrounding the bolometer. This air, rising with more or less irregular motions along the bolometer, places the different portions of it in contact with warmer or colder air, and thus produces changes of resistance. This defect will be the smaller the more regular the course of the air currents, so that it is well to make a convenient path for them (condition 10).

To avoid the air currents by making the main current feeble is against condition 1, which requires the current to be as strong as possible.

Since the current heating, which causes the air currents, depends upon the current strength and the resistance, it appears as if by a suitable choice of the dimensions of the resistance the air currents might be diminished. To obtain an approximate measure of it, we will compare them in each case with the amount of heat generated in the unit of time in the bolometer. $P=(I'_2)^2 W C$, where I'_2 is the current traversing the bolometer, W its resistance, and C its electrothermal constant. The "available current" is to be the strongest current which does not produce disturbing air currents. . . .

From these four simple cases all the changes in the resistance and the available current may be selected and combined. The result is that no advantage can be gained with respect to air currents by changing the specific resistance or the thickness of the strip, since $I\sqrt{W}$ becomes constant (I = available current).

In changing the length of the strip we encounter the advantage already noticed—that, with a resistance n times as great, we obtain a deflection $\sqrt{n}$ times as great, so that we must place as many strips as possible side by side, and let them be traversed by the current in series. A similar result is obtained by letting the current traverse n strips in parallel, or by taking a strip n times as broad. But the two cases are very different from a decisive standpoint. In the first case we have

$$I_1 = I_0 \text{ and } W_1 = nW_0\,;$$

in the second,

$$I_2 = \sqrt{n}\, I_0, \text{ and } W_2 = \frac{W_0}{n}.$$

In the first case a feeble current traverses high resistances; in the second a strong current low resistances. But from a practical point of view the first case is incomporably the more advantageous. How high the resistance is to be cannot be numerically defined; but its amount must be determined empirically for given conditions. In our bolometers every branch has a resistance of about 60 ohms and consists of 12 strips.

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[*] S. P. Langley: "The Actinic Balance," *American Journal of Science*, Series III., 21, p. 187, 1881.

[†] A. F. Svanberg, On the measurement of the resistance to the conduction of electric currents, and on a galvanic differential thermometer, *Pogg. Ann.*, LXXXIV., p. 411, 1851.

[‡] The Wheatstone Bridge is preferable to the differential galvanometer, since in it the galvanometer is not traversed by any current.

The lengthening of the strip is limited by the size of the surface which can be irradiated. Therein lies the ratio of the sensitiveness of a surface bolometer to that of a linear bolometer. A linear bolometer is one by means of which the radiation in a narrow portion of the spectrum, or the radiation of a spectrum line, is measured. Hence the size of the surface to be irradiated is prescribed, whereas for a surface bolometer there exists no such narrow limitation, measuring as it does the total radiation of a source of heat. The sensitiveness of the two bolometers varies, then, under identical conditions, as the square root of their surfaces. The condition (4), according to which the resistance is to be as high as possible, is, therefore, specialised by this consideration owing to the resistance having to be increased as much as possible by letting the current traverse many strips in series (condition 11).

Finally, we must discuss the question in what time the irradiated bolometer is to attain its maximum temperature. For the observation of the deflections it is, of course, desirable that this time should not exceed the time required for a large deflection, so that the full effect of the radiation may produce the deflection. If we wish to observe simultaneously the radiation from two sources of light—by the zero method—it is also desirable that the bolometer should rapidly follow the radiation, so that even the smallest oscillations in the intensity of radiation should show forth. But the demand involved in both cases is fulfilled as soon as condition 8 is fulfilled, which was put forward in order to make the heating of the bolometer as great as possible.

The three new conditions which are given by practice with the bolometer are therefore :—

9. All the four branches must be as equal in every respect as possible.
10. The air currents about the bolometer must have a regular course.
11. The bolometer must consist of many long thin strips.

While the former conditions all related to the amount of deflection, the new ones relate to the constancy of equilibrium of the galvanometer, *i.e.*, its position of rest in so far as it depends upon the bolometer. The sensitiveness of the galvanometer was previously supposed to be very high, and its zero excellent. Upon the equilibrium of the galvanometer, therefore, depends the mean divergence of the readings, and hence the accuracy of the measurements. But the accuracy is the only quantity we are here dealing with, and was defined as the ratio of the deflection to the mean divergence of several observations. For the construction of our bolometer, the above were taken as the 11 standard conditions.

(*To be continued.*)

THE ELECTRICAL TRADES' SECTION.

A meeting of the Electrical Trades' Section of the London Chamber of Commerce was held last Friday at the offices, Botolph House, Eastcheap, Mr. E. Garcke presiding, to consider—1, the attitude of the London County Council in regard to placing transformer chambers in the streets; 2, a notice of motion by Mr. Sydney Morse as to the methods adopted in the courts of hearing actions involving electrical questions; and 3, "any other matters."

The minutes of the previous meeting having been confirmed,

The CHAIRMAN explained that, although in the interval the entire section had not been called together, numerous meetings of special committees had been held. He also reported, in regard to the question of electric road traction, that the syndicate which was promoting the matter hoped to have very shortly a vehicle in the streets which would make a demonstration of what was possible to be done.

The attention of the section was then directed by the Chairman and Mr. Percy Sellon to certain objections raised by the London County Council and other local authorities in London to the placing of transformer chambers in the public streets, in regard to which a meeting was recently held at the Board of Trade, at which the London County Council and the local authorities of Islington, Hampstead, St. Luke's, Wandsworth, and Kensington, as well as the County of London Company were represented. Briefly, the objections of the London County Council to transformer chambers were that they were a serious obstruction in the roadway, which might interfere with future gas, water, and sewer pipes, &c., and that they constituted a grave public danger. On these grounds the Board of Trade were urged by the County Council to compel electric lighting companies to place their transformer chambers on private property. It transpired that in view of the importance of the matter Sir Courtenay Boyle had postponed its further consideration until the 13th inst., when it was arranged that the parties interested should attend at the Board of Trade and appear by counsel or by expert evidence in support of their contentions. In view of the great importance of the inquiry to all undertakings in connection with which electric supply companies use transformers, it was suggested that the matter was one for associated action, having regard to the interests involved, and for this reason the Chamber were asked to consider it.

In the discussion which followed,

Mr. MORSE and Mr. SELLON gave further explanations, the former being of opinion that the question of public safety was the one to which the Board of Trade attached the greatest importance; and he, therefore, urged those who were interested to come forward with such evidence as would convince the Board that there was no real danger. Otherwise, he had no doubt that the Board would legislate. Mr. Morse also regarded the streets as really safer than private property for the placing of transformers, and he pointed out that where explosions had taken place they had occurred at junction boxes.

Major FLOOD PAGE, Mr. FERRANTI, and Mr. CECIL BULL also took part in the discussion, and eventually the following resolution was passed :—"That as the Section is unanimously of opinion that transformer chambers in the streets will not be dangerous to the safety of the public, and can be constructed so as not to form any serious obstacles to the future use of the streets for other necessary purposes, representations be made to the Board of Trade to this effect; that the chairmen of the contracting and supply companies be asked to attend the inquiry on December 13th, to support the views of the Section; and that a memorandum of the subject be prepared for their information."

In regard to the local rating of electric supply companies,

The CHAIRMAN said they would remember that a small Committee was appointed with respect to the local rating of supply companies. They had gone very carefully into the matter, and they now proposed to issue a circular to the various supply companies with a view of directing their attention to the matter before the next quinquennial valuation. He then read the draft circular, from which it appeared that inquiries had shown the Committee the very severe manner in which electric lighting companies were likely to be affected by the incidence of local rates. It appeared to the Committee that the rating authorities were becoming alive to the fact that electric lighting companies, whose capital was not always obtained from the locality, might be made to contribute large sums in the way of rates, and thus lighten the burden of capitalists residing in the district in which the electric lighting stations were situate. Several instances in illustration of this state of things had been brought to the notice of the Committee; but the most striking case of all was, perhaps, that of the St. James and Pall Mall Electric Supply Company, whose assessment was fixed in 1891 at £1,800 gross and £1,375 rateable. This assessment was raised by the Vestry in 1893 to £10,000 gross and £9,720 rateable. Upon appeal it was reduced by the assessment committee to £7,000 rateable, and an understanding was come to that it should be adjusted when the accounts for the year were published, no steps in the meanwhile to be taken by either side. Notwithstanding this arrangement, however, the Company's assessment was further raised in the present year to £12,011 gross and £9,609 rateable. This was appealed against, but the appeal proved unsuccessful, the decision being confirmed. In view of the number of cases brought before the Committee, the supply companies were invited to communicate with the Secretary of the Chamber wherever they had reason to be dissatisfied with the assessment, with a view to concerted action being taken to protect the interests of supply companies generally in the matter.

The draft circular was approved by the meeting.

Mr. MORSE afterwards brought forward his notice of motion regarding the methods adopted in the courts of hearing actions in which electrical questions are involved.

A discussion followed on the subject, and eventually it was decided to defer its consideration and any action in the matter until copies of the rules which the Lord Chief Justice has prepared for the constitution of a new commercial court are obtainable.

It was subsequently agreed to hold meetings of the Section on the first Friday in each month, beginning with next January.

ELECTRIC LIGHTING AND TRACTION NOTICES.

The time for giving official notice in the *London Gazette* of private Bills to be presented to Parliament next Session, and of application to the Board of Trade for Provisional Orders, expired on Friday last.

From the following list of notices it will be seen that there are 32 electric lighting notices and 13 traction notices. Below are given the figures since 1891 :—

	1891.	1892.	1893.	1894.
Lighting	34	20	32	32
Traction	15	15	17	13

Of the total of 32 lighting notices, 15 are given by local authorities. The lighting notices are for the most part "small beer"; in many cases they are merely applications for an extension of areas already worked, or for Provisional Orders to replace existing Licences. The traction notices, with the exception of that of the Mersey Railway Company, also do not appear very important, and may mean much electric work or none, according as fate, finance, the British public, and the Board of Trade may ordain.

Electric Lighting Notices.

The Metropolis.

Districts.	Names of Applicants.
Battersea (London, S.W.) ...	County of London and Brush Provincial Electric Lighting Company (Limited).
Parish of St. Mary Abbotts, Kensington (part of).	Notting Hill Electric Lighting Company (Limited).
St. Mary, Newington (London, S.E.) ...	County of London and Brush Provincial Electric Lighting Company (Limited).
St. Olave's District (London, S.E.)	County of London and Brush Provincial Electric Lighting Company (Limited).
Strand District (Lond., W.C.)	Charing Cross and Strand Electricity Supply Corporation (Limited).

The Provinces.

Alderley Edge (Cheshire) ...	Local Board.
Bath	City of Bath Electric Lighting and Engineering Company (Limited).
Bootle	Corporation.
Brechin	Scottish House-to-House Electricity Company (Limited).
Carlisle	Corporation.
Devonport	County of London and Brush Provincial Electric Lighting Company (Limited).
Great Crosby (Lancs.)	Holloway Electricity Supply Company (Limited).
Leigh (Lancs.)...	Local Board.
Liverpool and Toxteth Park.	Liverpool Electric Supply Company (Limited).
Llandudno	Improvement Commissioners.
Luton	Corporation.
Margate	Municipal Electric Light and Power Corporation (Ltd.).
Montrose.........	Scottish House-to-House Electricity Company (Limited).
Motherwell......	Police Commissioners.
Pontypool	Pontypool Electric Light and Power Company (Limited).
Prescott, Huyton and Roby, Rainhill, Eccleston and Whiston	British Insulated Wire Company (Limited).
Radcliffe	Local Board.
Salisbury..... ...	Salisbury Electric Light Supply Company (Limited).
Southampton ...	Southampton Electric Light and Power Company (Ltd.).
St. George (Gloucester.)	Local Board.
Stirling	Police Commissioners.
Swindon (New Town)	Local Board.
Walthamstow ...	Local Board.
Winchester	Corporation.
Windermere and District	Windermere and District Electricity Supply Company (Limited).
Windsor and Eton	Windsor Corporation.
Worthing	Corporation.

Traction Notices.

Names of Applicants.	Powers Sought.
London, Deptford and Greenwich Tramways Company (Limited)	Construction of tramways. Use of electric or other motive power.
London United Tramways (Limited)	Construction of tramways. Use of electric or other motive power.
Aldershot and Farnborough Tramways	Construction of tramways. Use of electric or other motive power.
Carlisle and District Tramways Company (Ltd.)	Construction of tramways. Use of electric or other motive power.
City of Gloucester Tramways Company (Ltd.)	Construction of tramways. Use of electric or other motive power.
Great Northern and City Railway Company	Extension of time.
Great Yarmouth Tramways	Construction of tramways. Use of electric or other motive power, other than steam.
Hartlepool Tramways	Construction of tramways. Use of electric or other motive power.
Leeds Corporation	Construction of tramways. Use of electric or other motive power.
Mersey Railway Company	Use of electric motive power.
South Shields Corporation	Construction of tramways. Use of electric or other motive power.
Stone, Darenth, and Swanley Tramroads & Thames Jetty Company	Construction of tramways. Use of electric or other motive power.
Wigan and District Tramways Company (Ltd.)	Construction of tramways. Use of electric or other motive power.

BOARD OF TRADE CONFERENCE ON LIGHT RAILWAYS.

The conference of local authorities, railway experts, and others interested in the provision of light railways, convened by the Board of Trade, was held yesterday at Richmond-terrace, Mr. Bryce, President of the Board of Trade, occupied the chair. He was accompanied by Mr. Herbert Gardner, President of the Board of Agriculture; Mr. Shaw-Lefevre, President of the Local Government Board; Mr. Burt, M.P., Parliamentary Secretary of the Board of Trade; Sir Courtenay Boyle, K.C.B., Permanent Secretary; Mr. F. J. S. Hopwood, C.M.G., Assistant-Secretary Railway Department; Mr. Garnham Roper, private secretary; Major Cardew, of the Electrical Department; Gen. Hutchinson, Major Marindin, Major Yorke, and Major Anderson, Railway and Tramway Inspectors of the Board. Among those present were the Duke of Sutherland, Lord Farrer, Lord Kelvin, Sir Jacob Wilson, Sir Julian Danvers, Sir Alexander Rendel, Mr. W. M. Acworth, Sir Richard Sankey, Sir A. Rollit, M.P., Sir Bernhard Samuelson, M.P., Sir A. Hickman, M.P., and Mr. F. Corbett, representing the Association of Chambers of Commerce; Mr. Channing, M.P., Mr. Jeffreys, M.P., and Mr. R. H. Rew, representing the Associated Chambers of Agriculture; Mr. Alderman Brownswood, Mr. Harcourt Clare, and Mr. G. C. Kent, representing the Municipal Corporations Association; Sir E. Carbutt and Mr. E. Garcke, the London Chamber of Commerce; Rev. Fleming Williams, Mr. Bruce, and Mr. Beechcroft, the London County Council; Sir John Hibbert, K.C.B., M.P., Lord Thring, Lord Edmond Fitzmaurice, and Mr. Henry Hobhouse, M.P., the County Councils Association; Sir Jas. Whitehead and Mr. Tomlinson, M.P., the Mansion House Association on Railway and Canal Rates; Lord Claud Hamilton, Mr. J. C. Bolton, and Mr. W. L Jackson, M.P., the Railway Companies' Association; Mr. Carruthers Wain, the Tramways Institute; Sir Benjamin Baker and Sir Douglas Fox, the Institute of Civil Engineers; Mr. Alexander Siemens and Major-Gen. Webber, C.B., the Institution of Electrical Engineers; Earl Cathcart, Mr. W. Frankish, and Mr. E. Clarke, the Royal Agricultural Society; Mr. R. W. Eddison, the Traction Engine Owners and Users' Association; Mr. A. Cross, M.P., the Scottish Chamber of Agriculture; Mr. E. P. Squarey and Mr. C. Oakley, the Surveyors' Institution, &c.

Mr. Bryce, in opening the proceedings, said he was glad to see those present in their representative capacity. The motives which induced the Board to call the Conference were chiefly these: There had been of late years a very severe depression in our agricultural industry, with which no one could help feeling deep sympathy, and which led them to look around to see if any remedy or palliative methods could be adopted, by providing more abundant means of communicating through the rural districts. In many foreign countries, notably Belgium, Italy, and France, there had been a large development of rural communication upon a cheaper plan than had been adopted in the trunk lines, and he had been much struck when travelling in France and Italy soon after his accession to his present office with the extent to which those cheap lines, in districts without any great population, stimulated both passenger and freight traffic, and supplied the people in a way which was found to be a great satisfaction, and held out a hope of being remunerative to those who constructed the lines. In our own country, during the 50 years since which most of our trunk lines had been built, comparatively little had been done of late years in extending the facilities of locomotion in the less populous country districts. It was true that the work of construction had gone on, and that the total mileage since 1868 had increased by 40 per cent.; but when they looked at the great progress which applied science had made within the last forty or fifty years they could but feel that it had not done as much as might have been expected to provide minor means of locomotion for the conveyance of produce. Some feeling had been expressed that the Board of Trade was a little reluctant to enter upon a new policy, and perhaps was a little indifferent to what was required; but he assured them that neither on the part of the Board or of the permanent officials, in whose hands the railway policy lay, was there any indifference or want of desire to do all that public opinion demanded. They were restricted in their railway policy in some points by statutes, and in many other points by usage which public opinion had sanctioned, and public opinion required them to maintain high standards of safety and public convenience; they could not without the authorisation of Parliament and the support of public opinion undertake to sanction any lower standard. That was the reason the Board had asked the representatives of public opinion to come into council with them and give their views as to the extent to which public opinion would support the Board in proposing to relax its requirements and varying its policy. The first question was whether railways were needed in our rural districts, and could they be made to pay, so as to reduce the cost of transportation, especially of farming produce, and enable the British farmer to better compete with other countries? It could not have failed to strike them as singular that so many dairy products should be imported from Denmark (hear, hear), and if the cost of transportation was an element in enabling the foreign producer to compete with us, it was an element which this country ought to try and extinguish. Another side of the problem related to urban populations. Was it possible to relieve the congestion of great cities by providing better transportation of workmen to their work from suburban areas, or enabling industries now conducted in cities to be transferred to suburban or rural districts? The solution of that problem would have beneficial results, not only upon industry, but upon the health and well-being of the country (hear, hear). He believed railways would certainly be made if they could be made more cheaply, and the question which would present itself to them would be mainly a question of money. Could they not reduce the cost of the present system of obtaining the Act and of making and working the line? The English railways were the best in the world as regards speed, safety, convenience and comfort; but they were also the costliest in the world, and if they continued to maintain what was considered necessary for the normal lines they could not very much reduce the cost. They might have on the light railways to drop something in speed, in safety, in comfort, and convenience. The percentage of accidents was very much lower in England than in the United States, because the English lines were required to be fenced and provided with adequate platforms; they had to maintain an elaborate system of signalling, with interlocking signals, and to work the lines on the block system, with continuous brakes; the substitution of bridges for subways for level crossings; and where there was a level crossing a man had to be maintained to look after the gate. All those points might, in a sense, be regarded as luxuries, for, though they were important, railways could be worked without them. If they were content to dispense with some of those luxuries they could have cheaper railways. It would, however, be hard to reduce the cost of construction of a normal railway below an average of £10,000 a mile; but a light railway could be constructed at a cost which had been variously estimated at from £2,000 to £4,000 a mile, though he thought it would be difficult to reduce it so low as £2,000. If they took all the railways of the United Kingdom, counting in all the elements of expense, the cost had been not less than £50,000 a mile. If they were to dispense with many of those requirements accidents might be more frequent; but the adoption of low rates of speed, and the rural population becoming accustomed to the absence of those safeguards, would greatly diminish the risk. But that was a point upon which the Board of Trade must follow, and not attempt to lead public opinion. If more accidents were to happen complaints would immediately be raised against the Board of Trade and its officers, and he reminded them that some years ago a coroner's jury returned a verdict of manslaughter against the inspecting officer of the Board in allowing a railway to be opened for traffic. They would not be justified in dispensing with those requirements without the distinct authorisation of the legislature, and local authorities must make up their minds whether they would face those risks if they wanted the benefits of cheap railroads. The cost of obtaining the Act might be reduced by giving County Councils or other local authorities power to enable a company to take land compulsorily. The main heads to which the debate must be directed were these: (1) Whether the need for cheap railways, which had been expressed in many counties, was a real one, and whether a considerable traffic might be expected to make the undertakings remunerative to promoters and shareholders; (2) if that question were answered in the affirmative that would open the way to the discussion of the technical questions as to the gauge and the motive power to be employed, but it would not be well to spend much time in discussing those points. Those were matters which should be left to the particular localities. There were cases such as hilly counties, or where the line was not likely to be wanted as a through line or made part of a through system where a narrower gauge might be laid down, and there was also the question whether they would make use of the roads, and what was the width of the roads, or whether the line was to be a cross-country one; (3) the question of the requirements with which the Board of Trade might properly dispense; (4) when these questions of requirements had been dealt with it would be necessary to consider their application to two classes of cases. In the case of sparsely-peopled districts, somewhat later requirements should be adopted; but in the suburban districts the requirements would have to be of a somewhat higher order. (5) Then would arise questions of a political or economical order as to local authorities having power to take land compulsorily, the compensation to be paid for such land, whether the local authority should have power to make the railroad, or assist in making it. Whether power should be given to them to own and work or to lease the line and guarantee a dividend, and whether after a certain time they should have power to acquire the lines made by others. Lastly, there was a group of miscellaneous questions such as the relation the light railways should bear to existing railroads, whether there should be rules imposed with regard to through booking, and whether the present system of maximum rates should be adopted or not. Those were points of very great importance, and depended largely on the attitude which was taken up by the existing railroads. He hoped they would recognise the great advantages which such lines would be, that they would serve as feeders and develop traffic which did not now exist, and that if properly used they would assist in the prosperity and dividend-paying power of the present lines. As far as his present information went he believed the existing railroads regarded the movement with friendliness. One question which it would be unnecessary to consider, and which he should regard as lying outside the scope of their deliberations, was that which related to anything in the nature of aid from the Treasury. That was a question which he entertained a very strong opinion upon, and on which he believed the mind of Parliament was absolutely settled. The objections to such a policy in a country like this in the present state of our revenue, in view of the competition which would arise in many parts of the country if such State aid were granted, and the painful results which had followed where it had been adopted in some of our Colonies, and in parts of America, were such as to convince them that it should not be attempted. In conclusion, he said that if they found reason to suppose that public opinion was ready for a forward move, and would support the Board if it endeavoured to take a step in advance in providing additional facilities, there would be on the part of the Board of Trade no want of earnestness and activity in promoting an object of such considerable public importance (applause).

A detailed report of the proceedings will appear in our next issue.

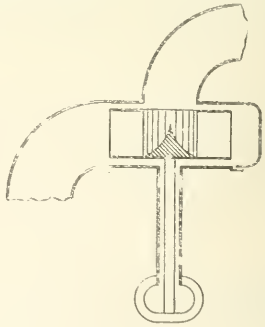
CORRESPONDENCE.

SCAVENGING ARRANGEMENT FOR GAS ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your editorial remarks upon the Paper by Mr. Atkinson, you said, "We should especially wish to see the 65ft. exhaust pipe abolished."

May I ask you some little space in your esteemed journal for a suggestion in that respect.



If a small ventilator or turbine be placed in the exhaust pipe, then in the first part of the exhaust stroke it will be put in motion like a turbine, while after the middle of the exhaust stroke it will, by its inertia, act as a ventilator. It may be arranged somewhat as indicated in the diagram, with a vertical spindle projecting downwards so as to remain cool, and the ventilator made of a not too easily oxidisable alloy, such as aluminium bronze.

As the apparatus has to bear nearly no strain, I think it will not give any trouble in working. It may even be more efficient than a 65ft. exhaust pipe, because of the friction of the gases in such a long pipe.—Yours, &c.,

The Hague, Dec. 3, 1894. C. L. R. E. MENGES.

BREAKDOWN AT MADRID.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There have been several reports recently in the electrical journals of the repeated breakdown of the electric light supply in a portion of Madrid, and I find that many persons are under the impression that the "Electricity Supply Company for Spain" is referred to.

As the above Company is fully equipped with English plant, manufactured by my company, Messrs. John Fowler and Co. of Leeds, and the Electric Construction Company, of Wolverhampton, I think it only fair in the interest of all to ask you to correct this impression in your valuable paper. The English Company has not broken down, but has continued to supply light without intermission, although, during the progress of the 50 per cent. addition to its plant last year, the machinery supplied in 1890 was often loaded quite 10 per cent. above its normal capacity, in consequence of the rapid increase of business.

The plant which has failed is that of a company financed by a German syndicate. It was manufactured in Belgium and Germany, and is on the low-tension continuous current system.
—Yours, &c., P. A. Latham,
Secretary of the Leeds and London Electrical
Engineering Company (Limited).

December 6, 1894.

LEGAL INTELLIGENCE.

Alabaster and Others v. Harness and the Medical Battery Company (Limited).

In the Court of Appeal on Wednesday, before the Master of the Rolls, Lord Justice Lopes, and Lord Justice Rigby, an appeal from the judgment of Mr. Justice Hawkins was heard. The original action was one of "maintenance" brought by the plaintiffs against C. B. Harness and the Medical Battery Company (Limited), of which Harness was the managing director, to recover a sum of £596 in respect of costs incurred by the plaintiffs in an action of libel brought against them by Dr. Herbert Tibbits, which costs remained unpaid. The plaintiffs had for years attacked the "electrical" belts sold by the Medical Battery Company, conclusively proving that they were frauds upon the public. Tibbits was one of the so-called experts employed by Harness and his company to report upon the belts, with the view of showing that they were not myths, but were useful and valuable appliances. Tibbits wrote a favourable and commendatory report of the belts, and in September, 1892, the plaintiffs published an article attacking Tibbits, because he had reported favourably upon the belts. In October, 1892, Tibbits brought an action for libel against the plaintiffs, who pleaded justification and fair comment, and the action was tried before Mr. Justice Mathew and a jury, who found that the article was a fair comment upon a matter of public interest, and judgment was therefore entered for the plaintiffs. It was admitted that Harness found the money for Tibbits to carry on the action; but it was alleged that he had, or reasonably and *bonâ fide* believed that he had, a common interest with Dr. Tibbits in the result of that action. At the trial Mr. Justice Hawkins held that Harness had no common interest, nor reasonably and *bonâ fide* believed that he had, and gave judgment for the plaintiffs, and against this the defendant (Harness) now appealed.

The MASTER of the ROLLS, in his judgment against the defendant, said he was of opinion that this was a case in which the Court were bound to hold that Harness had been guilty of maintenance. The law of maintenance had been discussed in a number of authorities, and had recently been exhaustively considered by Lord Coleridge in the case of "Bradlaugh v. Newdegate." The law of maintenance did not seem to involve any question of general principles of right and wrong. If it were not for the specific law which had been laid down he could not see that there was anything wrong in one man helping another in litigation, though he could see that it was against public policy to allow this to be done. At any rate the law was clear that anyone who interfered in another's litigation to the extent of making himself answerable for the expenses did that which was illegal It was clear that Harness had instigated this action, that it was, in fact, really his action, though brought in the name of Tibbits, and, therefore, the appeal must be dismissed. An opinion in which Mr. Justice Lopes and Mr. Justice Rigby concurred.

South v. Perry and Co.

This was an action in the Westminster (London) County Court, before Judge Lumley Smith, Q.C., to recover £7. 10s. as commission for introducing a customer to the defendants for an electric pendant.

The plaintiff, Mr. H. South, had some work to do for a customer who desired to have a certain kind of pendant, and Mr. South went to the defendants, who stated that they allowed 10 per cent. commission on all business done through them. After some delay the plaintiff's customer had a pendant from the defendants, but the commission had not been paid. The defendant, Mr. Bartlett, who trades as Perry and Co., said he was not aware that the person to whom they supplied the pendant was a customer of plaintiff's, and he had for years been a customer of Perry and Co. They removed the original pendant and replaced it with a glass one, which cost £84.

His Honour was of opinion that the sale was brought about by Mr. South's introduction, and there would be judgment for the plaintiff for £7, with costs.

Frank Suter and Co. v. L. Phillips and Co.

In the City of London Court, the plaintiffs, a firm of electrical engineers, claimed the sum of £90 from the defendants, trading in Newgate-street, London, E.C., for supplying electrical appliances to their premises. Judgment had been entered for the plaintiffs on the claim for the reduced sum of £70; but the defendants raised a novel counterclaim for £62. 10s. for advertising the plaintiffs' business on a board.

The defendants' case on their counterclaim was that they agreed to exhibit in front of their premises a board descriptive of the plaintiffs' business on condition that they were paid £2. 10s. a month. It was exhibited for over two years; and they therefore asked to be paid in accordance with the agreement which they set up, the amount being very small considering that they paid a rent of £1,500 a year for the premises.

The answer to the counterclaim was that no agreement was ever entered into by the plaintiffs to pay the defendants any sum of money for their board being up. It was only put up as a usual trade custom because they were doing work on the defendants' premises, and the board was taken down when the installation was completed. There was, too, an understanding that the defendants were to have a commission of 5 per cent. on all the work they could introduce to the plaintiffs, but no work had been introduced.

After a full hearing, the jury found for the plaintiffs, and judgment was given accordingly.

AN ELECTRIC LIGHT COMPANY FINED UNDER THE PUBLIC HEALTH ACT.—A case of much interest was decided at Lancaster on Saturday. The Morecambe Electric Light and Power Company (Limited) were summoned by the Morecambe Local Board for causing an effluvium injurious to health in connection with their works on November 5th. The case for the prosecution was that defendants had been for a long time creating a nuisance in the neighbourhood of their works at Morecambe. Dr. Waterson, medical officer, on the instructions of the Board, made investigations, and the smell on the night in question he said was particularly bad, and could be detected in every house in the neighbourhood. He had attended several people in the locality, who complained of sickness, loss of appetite, dizziness, and sleeplessness, all produced, he considered, by the smell from the works. On one occasion he was called to attend one of the workmen at the electricity station, whom he found laid on his back suffering from the gas. Several neighbours who had been long resident in that locality confirmed the story of the prosecution. The defence was that the objection was against the establishment of a manufactory in the neighbourhood, and not because of any real grievance. The smells alleged had all been traced to the sewers, and the Local Board had compelled each owner to provide fresh traps to the drains. The gas produced was lighter than air and must therefore ascend, and not enter the houses through the drains. The Bench held that the nuisance was fully proved; but in consideration of the Company offering to abate the nuisance, only inflicted a fine of £1 and costs. In the event of any further nuisance, the attention of the Local Government Board would be called to the matter.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices:—*

Laboratory Notes and Forms.—With the above title, we have in the press a set of Elementary (now ready) and Advanced Exercises (ready shortly) for use by Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

The 1894 Edition of "The Electrician" Electrical Trades' Directory and Handbook contains 1,000 closely-printed pages, and several new and useful features have been added. The price of this edition of the Directory and Handbook is now 4s. post free; abroad 5s. **The 1895 edition is in active preparation,** and subscription and advertisement orders should now be sent in.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is just out, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

Tenders Invited.—The Corporation of Hanley require tenders for the supply and erection of electric lighting plant under contracts Nos. 10 and 11, particulars of which are given in our advertisement columns. Tenders have to be sent in to Mr. Arthur Challinor, town clerk, not later than January 5th next.

——— The Corporation of the City of Melbourne invite tenders for the supply, delivery, and erection of alternating current dynamos, exciters, switchboard, transformers, instruments, &c. Specifications and conditions of contract may be seen at the offices of *The Electrician*, and tenders have to reach Mr. John Clayton, Town Clerk, Town Hall, Melbourne (Australia), not later than 11 a.m. on Tuesday, January 22nd next.

Tenders Accepted.—The Vestry of St. Pancras, London, N.W., have accepted the tender of the W. T. Henley Company for feeders and mains at £17,104. 16s. 3d., and for the extensions to the Cobden sub-station buildings the tender of Mr. J. Steed at £208. 16s. 9d.

———— The tender of Messrs. Bacon and Curtis has been accepted by the trustees of the Wesleyan Chapel, Bournemouth, for the fitting up of the chapel and attached schoolrooms for the electric light, for the sum of £84.

———— For the electric lighting of the stoneyard of the Hampstead Vestry 24 tenders were received, ranging from £250 to £68. 12s. 3d., and for the Vestry Hall lighting eight tenders were sent in, ranging from £296. 15s. (Messrs. B. Verity and Sons' tender) to £418. 10s. Verity's tender was accepted.

———— The Sunderland Town Council have accepted the following tenders :—Messrs. S. Z. de Ferranti and Co. for electricity meters ; Messrs. Poole and White for fuse boxes ; Messrs. McKenzie Brothers, Edinburgh, for arc lamp pillars ; and Messrs. H. Todd and Son for furnishing the electrical engineer's office.

Tenders Received.—The Gas Committee of the Aberdeen Town Council have received seven tenders for the supply of two new engines and dynamos required for the electric light extensions. The highest tender was £3,800. The tenders have been submitted to Prof. A. B. W. Kennedy for consideration.

Sale by Auction.——The date of the sale by auction by Messrs. Wheatley Kirk, Price and Goulty at the Deptford Central Lighting Station, Stowage Wharf, Deptford, S.E., of a quantity of surplus plant and stock, for the London Electric Supply Corporation (Limited), has now been fixed for December 19th, at 10 for 11 o'clock. The lots include a large variety of plant and material.

Plant for Sale.—The Brighton and Hove Electric Light Company (Limited), announce for sale the whole of their plant, machinery, and stock, at Brighton, including engines, boilers, dynamos, converters, meters, cables, instruments, and apparatus, &c. Some further particulars are given in our advertisement columns, and all information can be obtained of Mr. G. C. Sneath, 44. Gresham street, London, E.C.

Liquidation.—In the case of the South Staffordshire Tramways Co., Mr. Buckley, Q.C., who appeared in support of the petition of Messrs. W. Smallman and others, trade creditors, for a compulsory order to wind up the Company, said that in May, 1893, Mr. Justice Kekewich heard a debenture-holders' action, and appointed receivers and managers. On November 21st last he discharged the order as to managers, and appointed Mr. Sully sole receiver. This put the receipt of the takings in the hands of the Directors, and they now had filed an affidavit which practically confessed insolvency. Mr. Theobald, for the Electric Construction Company, who had supplied the electrical plant, &c., said his Company had only received 6d. out of 9d. per mile agreed, and there was still a large sum due. He supported the petition. Mr. Swinfen Eady, Q.C., opposed the petition on behalf of the Company. Mr. Justice Williams said the debts of the petitioners were small trade debts, and he did not see why the Directors should not pay them now they had the management of the Company in their own hands. The tramway was going on, and money coming in daily. He should, however, require to hear more about the petition, because he was not satisfied it was a *bonâ fide* trade creditors' petition. In the result, the petition was adjourned for a week.

Appointment.—Mr. Charles H. Yeaman has been appointed by the Cardiff Corporation superintendent at the electric lighting works.

Appointment Vacant.—The Manchester Corporation require for their electric works an assistant at a salary of £2. 10s. per week. Applications must be sent in by the 15th inst. Some further particulars are given in our advertisement columns.

Dissolutions of Partnership.—The partnership between Messrs. Judd and Haswell, electrical and general engineers, Watling street Works, Leicester, has been dissolved.

———— Messrs. Lowrie and Jackson, consulting engineers and electricians, 59 and 60, Chancery-lane, London, W.C., have dissolved partnership.

Removal of Offices.—Owing to increase of business the Nalder and Harrison Construction Syndicate (Limited) have transferred their offices to 47, Victoria-street, London, S.W., to which address it is desired all communications should in future be sent. The works remain at Trafalgar House, where the space hitherto used for offices has been converted into additional workshops. The Syndicate have opened a branch office at 33, Old Broad-street, E.C.

Agency.—Messrs. F. Butzke and Co., of Berlin, have appointed Mr. G. Straus representative for their manufactures for Great Britain. Messrs. Butzke's specialities include all kinds of telegraph and telephone apparatus and accessories.

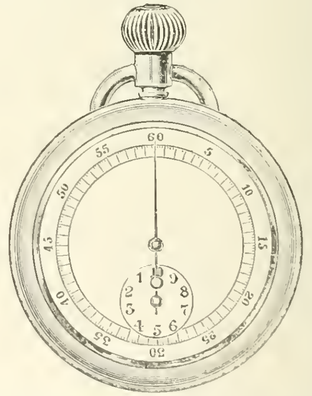
The Lime Street Telephone Exchange.—The National Telephone Company announce that any subscriber to their metropolitan system can obtain a permit to view the new Lime-street Exchange recently opened, by applying to the metropolitan manager, Mr. A. Calder, 58 and 59, London-wall, E.C.

The "Stentor" Telephone.—The International Electric Company, of 55, Red Cross-street, Barbican, E.C., send particulars of the "Stentor" telephone, which is claimed to be both cheap and of best quality. The telephone is well made, and is neat in appearance and simple in construction. It is provided with a very sensitive granular microphone, which can be worked for short distances on one cell. Included in the printed particulars issued by the Company are a number of diagrams of circuits.

Telegraph Insulators for Russia.—A recent decision of the Russian Customs Department is to the effect that all porcelain telegraph insulators fastened to iron hooks imported into the country are to be cleared under Section 153, the duty being from 1·40 to 2·20 roubles gold per pood, according to weight.

Wiring and Fittings Regulations.—Mr. C. H. Wordingham electrical engineer to the Manchester Corporation, has compiled a set of regulations for wiring and fittings, which are issued in a handy form for consumers on the Corporation's lighting mains. We find that the charge for meters is below that charged in London, a 5-ampere meter being charged at 3s. 6d. per quarter, increasing for a 150-ampere meter to 6s. 6d. per quarter. In the conditions of supply notice is given that the Corporation will pay interest at the rate of 4 per cent. per annum on every sum of 10s. deposited as security for payment of electric current accounts for every six months during which the amount remains with the Corporation.

Chronograph.—Mr. R. W. Paul is introducing a stop-watch for the use of students and general experimenters who require a simple and cheap means for timing to one-fifth of a second. A good chronograph watch is liable to be injured by general work in a laboratory, and this stop-watch, which reads up to 10 minutes, ought to be very useful. Both the seconds and the minute hands stop and fly back.



Aluminium Solder.—Another secret aluminium solder has been invented by M. Ludwig Oliven, and is being introduced by the British Aluminium Company. We do not believe that the supposed difficulty in soldering aluminium has been any obstacle to the introduction and popular use of this metal. We are informed that no less than eight patents were taken out for such solders during last year. One chemist and engineer of our acquaintance, who never could discover where the difficulty lay, has, we understand, at last discovered what there is to patent in his own process. The most successful aluminium solder will probably be the one which is most easy to use.

The "Commercial."—The Commercial Cable Company are justly proud of the success achieved by their new cable. In a circular to hand it is pointed out that in December, 1884, 45 seconds were required to despatch a communication from London to New York over the old Commercial cables ; whereas in October, 1894, a similar trial of speed has resulted in a message being despatched in 5 seconds.

Calendars for 1895.—The Direct United States Cable Company again issue a useful tear-off pad calendar for the coming year, upon which is printed in colours a map showing the Company's cables and connections.

Belfast.—In reply to a question, Mr. Alderman Pirrie said that the Electric Lighting Committee expected that the current would be ready to be supplied in January. They had applications for about 2,500 lamps, out of the capacity of the station for 8,000.

Birmingham.—The report of the Gas Committee, presented to the City Council on Tuesday, announced a reduction in the price of gas by 3d. per thousand, reducing the maximum price to 2s. 7d. and the minimum to 2s. 3d. per thousand for private lighting and 1s. 1d. for public lighting, no charge for meters being made by the Corporation. In moving the adoption of the Gas Committee's report, Mr. Alderman Pollock, who is evidently a gas enthusiast, concluded his remarks by stating that "he hoped the conductors of all large institutions in Birmingham, and especially of those fostered by the City Council, would think twice before satisfying the craze for electric lighting while they had at their command a light equally good, if not superior, supplied from their own works at one-fourth the cost." As Mr. Pollock's remarks were greeted with applause, it is reasonable to suppose that his fellow-councillors were convinced of the accuracy of his figures.

Bolton.—At the last meeting of the Gas and Electricity Committee of the Corporation the electrical engineer was instructed to arrange for the requisite mains to be laid for the supply of electricity to premises in Acresfield and Mawdsley-street. The engineer was also instructed to make inquiries and report as to the laying of further services by the workmen in the Committee's department. Alderman Miles and Councillor W. Cooper were requested, along with the engineer, to consider and report upon the alterations which it was desirable to make to the electric lamp on the Town Hall-square.

Brighton.—At yesterday's meeting of the Town Council the Lighting Committee submitted a report received from the Corporation's electrical engineer with reference to the extensions which he considers it will be necessary to make during the ensuing year, to the generating station and plant, in order to cope with the increasing demand for the supply of electric current throughout the borough. Mr. Wright's report states that whereas in 1891 the number of lamps connected was 5,706, in 1892 the total was 11,229, an increase of 5,523; in 1893, 17,760, an increase of 6,531; and in 1894, 28,000, an increase of 10,240; this last total being exclusive of the 10,000 lamps taken over from the Brighton and Hove Company. Assuming the rate of increase during the past year will continue, it is estimated there will be connected to the system in the winter of 1895 something like 48,000 lamps, and that in that year the sale of electricity will be about one million units, representing at present prices a revenue of about £25,000. As the present works are just sufficient to supply this winter's demand, the necessity of extensions being made during the next year will, it is remarked, be obvious. It is proposed that these extensions should be regarded as part of the general scheme for ultimately bringing up the generating capacity of the North-road central station to supply about 200,000 lamps, which is about the limit it is considered advisable to supply from that site. The extension now recommended includes the erection of new chimney shaft 200ft. high, a second boiler house, and an enlargement of the engine-room to double the present size; and the addition of six boilers, two steam dynamos, &c. This additional machinery will provide for an increase in the number of lamps supplied from the generating station from 38,000 8-c.p. lamps (22,800 alight at one time) to 62,000 8-c.p. lamps, of which 37,200 may be alight at the same time, still maintaining one-fifth of the power in reserve. It is recommended that a loan of £42,000 be obtained for a period of 40 years to defray the cost of the proposed works, the estimate including an item of £1,000 for mains for street lighting purposes.

Bristol.—As evidence of the desire of the ordinary public to become acquainted with at least the elementary principles of the electric current, it is interesting to point to the discourse of the Dean of Bristol before a large audience of the Y.M.C.A. at Bristol. The Dean did not profess to know a great deal of his subject; but in a gossipy way, illustrated by views thrown on a screen by limelight, he dealt with a variety of electrical phenomena. ——The Roman Catholic Church in Victoria-street, Bristol, is to be lighted electrically. The Guildhall will also be shortly lighted by electricity, to be followed, doubtless, by many other institutions in the city.

'Bus Lighting.—A new line of London 'busses, running between Waterloo Station and Baker-street, *via* Westminster Bridge, Charing Cross, Piccadilly, Bond-street, and Orchard-street, are to be fitted with electric lamps.

Cardiff.—At a special meeting of the Lighting and Electrical Committee of the Corporation last week, after the appointment of Mr. Yeaman to the post of superintendent at the electric lighting works, Mr. W. H. Massey explained that the recent variations in the electric light were due to experiments made by the contractors. The switching on of the current for the public lamps had been effected without his knowledge, and he strongly objected to an attempt being made to light the town before the gear was quite in order. The stoppages complained of had been partly due to certain irregularities in connection with one of the engines. The Committee ultimately decided, on Mr. Massey's recommendation, that no further experiments should be made with the street arc lamps at night until the necessary switching gear and resistance frames were ready.

Chester.—Mr. W. J. Bird Clerke, M.Inst.C.E., held a Local Government Board inquiry on Wednesday with reference to the application of the Corporation for sanction to borrow £25,000 for electric lighting purposes. There was no opposition raised to the proposal, and the result of the inquiry will be published shortly.

Church Lighting.—The new John Knox Presbyterian Church, Newcastle-on-Tyne, is to be illuminated electrically.

Club Lighting.—The Bacup Liberal Club has been fitted throughout for the electric light, the work having been carried out by Messrs. Matthews and Yates (Limited), under the superintendence of their electrical engineer, Mr. T. G. Slater.

Dover.—The local gas company have recently been invited to send in the terms upon which they are prepared to accept the renewal of the contract for lighting certain of the Dover public lamps, more particularly in connection with the substitution of incandescent gas burners for those now in use. It would appear that since the introduction of the electric light into Dover the gas company have adopted a less severe tone in dealing with the Dover Corporation, and this was strongly insisted upon by the Mayor of Dover at the meeting of the Council held last week. He pointed out that when the electric lighting company was first spoken of it was laughed at, but, when it was found that the townsmen were in earnest, the first step taken by the gas company was to lower the price of their commodity, and, that now the time comes for renewing the contracts, and they are holding out still further inducements to the Corporation. Thi being so, the Mayor asked the Council to extend a little indulgence to the new electric lighting company, as it was undoubtedly the advent of that concern which had brought the gas company to its senses. The Mayor's contention as to the past action of the gas company was challenged by several speakers; but, in the end, his proposal that the question of the renewal of the contract with the gas company for certain of the public lamps should be reserved for the next meeting of the Council was approved.

Fareham.—A Local Government Board inquiry is being held to-day (Friday) on the proposal of the Local Board to borrow £7,000, for the purpose of purchasing the local electric light company's undertaking. The inquiry commences at 11 o'clock.

Fermoy.—The Town Commissioners have received from Mr. Tomlinson, the engineer to the Bray Electric Lighting Company, a report on the subject of the introduction of the electric light for Fermoy. Mr. Tomlinson, in his report, deals fully with the question of public and private supply. He estimates that £7,000 would be required to provide a self-paying plant, the earning power of which, on the low-pressure system, he estimates would be £1,400 per annum, and the annual up-keep, including interest, £900 per annum. Taking the same capital sum, and adopting the high-pressure alternating system, he considers the possible earning power of the plant would be about £900 per annum, and the annual expenses about £1,000. Mr. Tomlinson advises the Commissioners to preface any further action in the matter by a canvass of the town, and by negotiations with the owners of the water power which is available in the district.

Fleetwood.—A Local Government Board inquiry has been held here in reference to an application by the Improvement Commissioners for power to borrow nearly £12,000 for electric lighting purposes. The application was opposed by the railway company, but was supported by the Local Tradesmen's Association.

Glasgow.—As previously announced, the street cars in this city are to be lighted electrically, and the work of placing the fittings in the new cars is progressing satisfactorily. It is expected that within the next few weeks the work will be completed, and the whole of the new cars will be supplied with the electric light. The work is being carried out by Froggatt's Electric Lighting Company, and will, when finished, consist in the equipment of 350 cars, for which a stock of 2,800 accumulators will be provided, and have all been specially made for this contract.——The Merchant's House is a large block of buildings in this city, and it has been decided to adopt electric lighting both for the public and private rooms under the superintendence of Dr. J. T. Bottomley, the wiring work being placed with Messrs. Anderson and Munro.

Hampstead (London, N.W.)—The proposal of the electric lighting Committee to light the Town Clock, at the Fire Brigade station, by electricity has been deferred for future consideration. A considerable extension of the lighting mains has been decided upon, for Daleham-gardens at a cost of £308, and from the junction of Gayton-road and High-street to the Vestry Hall at a cost of £1,050.

Hanley.—At the meeting of the Town Council, on Tuesday, correspondence was read from the Brush Company, stating that with regard to the plant and apparatus supplied to the electricity works, it was desired that the equipment of these works should give entire satisfaction, and the Company agreed to a proposal to send one of their engineers to supervise, and be responsible for, the running of the plant for a month, in order to show that it was in good working order.

Harrow.—In reference to a Trade Note which appeared in our last issue, some correction is necessary. The position of affairs at Harrow is as follows :—The Local Authority, having considered the question of electric lighting, decided to invite tenders. A specification was drawn up by Mr. W. C. C. Hawtayne, and sent to ten of the leading firms of electrical contractors. After carefully considering the tenders sent in, the Board decided that the tender of Messrs. Crompton and Co. was the most suitable, and they accepted the same provisionally. Promises of support of the Board's scheme were received from the house masters of Harrow School and others, and the Board wrote to the head master to ascertain if the governors of the school would introduce the light into the school buildings. The head master replied that the governors would be prepared to favourably consider the proposal for lighting the chapel, library, and other school buildings, provided they received from the Board full particulars as to the probable cost of the lighting. Messrs. Crompton and Co.'s tender to the Local Authority was for generating plant, mains, and street lighting, and has nothing to do with the lighting of the school buildings, as would appear from our Note.

Hospital Lighting.—The governors of the London Hospital have discussed the question of the introduction of the electric light, and have decided to take no further steps in the matter unless the Whitechapel Local Board should establish a system of supply, in which case the committee appointed to consider the subject are disposed to recommend its adoption. The same question was not so summarily dismissed some time ago by the governors of the Middlesex Hospital, who have adopted the electric light throughout their extensive range of buildings, and Lord Sandhurst, at the last meeting of the Board, spoke of the great benefits derived from the installation of the electric light two or three years ago. He said everybody knew a certain amount of cleaning was necessary in an hospital as in a private house, and owing to the use of electric light instead of gas they last year saved some hundreds of pounds in the cost of cleaning alone.

Jersey.—A meeting has been held in the Central Hall, Don-street, of the principal residents, with the view of establishing a local electric light company for Jersey. A Committee was appointed to consider the subject, aud will report to a future meeting.

Journalistic Enterprise.—Owing to the success achieved in previous years, the proprietors of the *Western Morning News* have again issued a Christmas number, consisting of no less than 48 large folio pages, in a coloured wrapper, for one penny. The proprietors and their energetic manager, Mr. Ernest Croft, are to be complimented upon the success of their venture.

Kendal.—The Electric Lighting Committee appointed to consider the subject of electric lighting for the district have recommended that the Council do not at present offer any opinion on the proposal of the Windermere and District Company for lighting the district by electricity until further information is provided. This is another case where the services of a competent lecturer can be recommended.

Lambeth (London, S.E.).—The General Purposes Committee of the Vestry have received from Mr. Fyfe, the owner of Electric-avenue, Brixton, an offer to hand over that thoroughfare to the parish. Mr. Fyfe is well known in connection with the electric lighting industry, and Electric-avenue has been brilliantly illuminated with the electric light for some years past. The terms offered by Mr. Fyfe were accepted by the Vestry, subject to slight modifications.

Lecture.—Mr. Ernest Scott, chief draughtsman of the Electric Construction Company at Wolverhampton, delivered an interesting lecture on "Electricity" in Queen-street Chapel, Wolverhampton, on Tuesday evening last. The lecturer was assisted with lantern views and diagrams, and the lecture proved a great success.

Leeds.—This is the time of year for Local Authorities to evince a special interest in the tramway question, and it is everywhere noticeable that the possibility of utilising electricity as a motive power has occupied the attention of many of the principal corporations in the country. On Wednesday the City Council of Leeds was engaged in the discussion of its tramway scheme, authorised the promotion of a Bill in the next session of Parliament for the development of the tramways of the city. The objectionable feature of the discussion was the prevailing opinion amongst the councillors that the obtaining of powers to own the tramway system does not commit the Corporation to use those powers ; but "safeguards the public interest against private enterprise.'

Liverpool.—The Managing Director of the Hall Electrical Company (Limited) writes complaining of the unreasonable delay which the firm and their clients experience in obtaining the Health Committee's permits for service lines. It would appear that in two cases referred to the Company's clients have been waiting a month for permission to have the light connected.

Mill Lighting.—The electric light has recently been introduced into Newby Mill, Rimington-by-Walton, and has proved a great success ; 75 incandescents are used.

Moss Side.—The Manchester Suburban Electric Supply Company is being formed to supply electric current in this district.

Newcastle-on-Tyne.—At the last meeting of the Town Council a special committee was appointed to consider the desirability of the Corporation undertaking the lighting of the city by electricity, and in this connection it was ordered that a special report on the subject of electricity as a motive power by a Chester firm should be printed and circulated amongst the members of the Corporation. ——The Corporation have this week endeavoured to quash the application for a Provisional Order for the establishment of cable tramways, as many of the members were disposed to anticipate some future betterment through the introduction of electricity as a motive power for the local lines, and after two divisions the motion approving cable tramways was only carried by a majority of one.

Pontefract.—Owing to the inadequate means of communication between Pontefract and Featherstone, the Pontefract Corporation have recently considered the question of supporting the movement for an electric tramway between these districts. Mr. Councillor McGowan stated at the last meeting of the Board that he had made inquiries and considered the scheme quite feasible. The plant at the Corporation's disbanded Tanshelf waterworks would provide the motive power, and there were very few difficulties to overcome. The whole question was referred to the Markets and Highways Committees for their consideration and report.

Portsmouth.—The extensive premises owned by the Royal Sailors' Home in Queen street, Portsea, have now been completely installed for the electric light. Mr. Grossmith, of Union-street, Portsmouth, has had the work in hand, under the supervision of Mr. D. S. Strang. The 342 cabins with which the building is provided have not yet been completely fitted, but this work is in hand.

Salford.—In reply to a question, Mr. Holland (Chairman of the Gas Committee) stated at the last meeting of the Town Council that householders need not expect to have the electric light this winter, as the contractors appeared to be hopelessly behind time. The Committee have fixed the charge for electric current at 7d. per unit. Mr. Alderman Dickins appeared to derive some satisfaction from the statement made, but it is more than probable that the contractors may have something to say on the subject.

Ship Lighting.—At Greenock the steamer "Beamer" is undergoing overhaul and refit, and Mr. R. S. Gilmour is adding a complete electric lighting plant for the vessel, consisting of a "Taunton" dynamo, &c. Two submarine lamps of 200 c.p. each are included in the ship's equipment, and are intended for the use of divers.

Thumb Ready Reckoner.—Mr. Henry Frowde, of the Oxford University Press, has issued a neat thumb ready reckoner for the waistcoat pocket, which contains calculations from $\frac{1}{16}$th of a penny to 19s. 9d., together with interest and discount tables, &c., &c.

The Arc Light for Photographic Purposes.—At a meeting of the Oxford Camera Club last week Mr. Hardie McLean gave an interesting demonstration to the members of the use of the arc lamp in photography. Several lamps were shown, the first being the Davenport lamp, manufactured by Mr. Steward, of the Strand, London, and which was described in a recent issue of *The Electrician* ; the next was a lamp made by Messrs. Newton and Co., of Fleet street, London ; and, finally, a pair of lamps made by Mr. Borland, of Leeds. The object of the demonstration was to show the advantages and disadvantages of the electric over the oxy-hydrogen light, and we understand that, as a result of the demonstration, the club intend in future to use the electric light on their "lantern nights." The current required for the demonstration was supplied by the Oxford Electric Company, free of charge.

Underground Telephone Cables.—For some time past the National Telephone Company have been in correspondence with the St. Saviour's (London, S.E.) Board of Works, in an endeavour to obtain permission for laying their telephone cables underground ; but, notwithstanding the increasing necessity for this permission, it has been refused.

Warminster. At a special meeting of the Local Board last week, the surveyor presented a report dealing with the sewage scheme, associated with which is a scheme for utilising water power in connection with a central station for supplying the district with electric current

WELLS (SOMERSET).—A proposal for adopting the electric light for the district was, at the last meeting of the Town Council, referred to a special committee.

WORCESTER.—At the last meeting of the City Council the Electricity Committee recommended that advertisements be issued for an electrical engineer to take charge of the electric lighting works at a salary of £200 per annum. This was approved.

COMPANIES' MEETINGS AND REPORTS.

Tramways Company of France (Limited).

An extraordinary general meeting of the shareholders of this Company was held on Monday last at the Cannon-street Hotel, London, E.C., under the presidency of Lord R. H. Browne, the Chairman of the Company. The meeting was called for the purpose of considering resolutions for the increase of the capital of the Company by the creation of 15,000 new Preference shares of £10 each, entitled to a cumulative dividend of 6 per cent. per annum, and for authorising the Directors, if they should think fit, to sell the 7,094 shares of 500f. each in the Rouen Tramways Company, belonging to the Tramways Company of France, for such sum as, after satisfying or providing for the liabilities of the latter Company, shall be equal to 30s. per share on the 14,248 issued shares of the Company.

The CHAIRMAN proposed the resolutions, and explained the reason of the course proposed, viz., the substitution of electric traction for horse-power. For some months past tramways had been very successfully worked at Havre by means of electricity, and there was in Rouen and other parts of France a strong feeling in favour of that system. If they did not adopt the electric system at Rouen they were threatened with serious opposition. It was expected that permission would be given by the authorities to use overhead wires, and the Company had made an application for an extension of the term of the concession for 26 years, making in all 50 years to run from the present time. The Directors thought this application was likely to be granted if electric traction were adopted.

After a short discussion the motion was carried.

NEW COMPANIES, STATUTORY RETURNS, &c.

FULGUR ELECTRIC LIGHTING COMPANY (LIMITED).—This Company was registered on December 1st, with a capital of £7 in £1 shares, to acquire from "Le Fulgur, Société Anonyme d'Eclairage Electrique," the patent No. 9,689 of 1891, for "An apparatus for primary batteries" for Great Britain and Ireland; to generate, produce, store, accumulate, and distribute electricity, electromotive force, or other similar agency for the purpose of lighting omnibuses, tramcars, boats, vehicles, public or private buildings, mines, ships, lighthouses, railways, &c.; to acquire the right to use or manufacture and put up telephones, telegraphs, electric bells, and other electrical apparatus, and to carry on the business of electricians, mechanical and electrical engineers and manufacturers, electric light contractors, and electrical apparatus manufacturers. The subscribers (with one share each) are: J. B. Gilbert, H. P. Herbert, W. E. Hanshaw, T. P. Gilbert, J. B. Hutchinson, J. Putney, and G. West.

NATIONAL ELECTRIC ENGINEERING COMPANY (LIMITED).—This Company was registered on November 29th, with a capital of £5.000 in £1 shares, to acquire and take over as a going concern the business of electrical engineers, carried on by Arthur C. Cockburn and Douglas C. Bate at London and Manchester, to manufacture and sell gas, electric, and scientific apparatus and instruments; to construct and fix pipes, cables, wires, accumulators, lamps, and works; and to carry on the business of gas, electrical, mechanical, metallurgical, and chemical engineers and manufacturers, electric light contractors, and suppliers of gas and electricity. The first Directors are Arthur C. Cockburn and Douglas C. Bate.

CHLORIDE ELECTRICAL STORAGE SYNDICATE (LIMITED).—The annual return of this Company, made up to August 7th, was filed on September 24th following. The Company's capital of £262,500 is divided into 110,000 "A," 140,000 "B," and 12,500 Founders' shares of £1 each. Of these, 70,000 "A," 100,000 "B," and all the Founders' shares have been taken up, of which 45,000 "A" and all the "B" and Founders' shares have been issued as fully paid. The full amount has been called and paid upon the remaining 25,000 "A" shares.

CRUTO INCANDESCENT LAMP AGENCY (LIMITED).—The statutory return of this Company, made up to October 8th, was recently filed. Out of a nominal capital of £5,000, in £1 shares, the 7 signatories' shares are the only ones taken up, and on these no calls have as yet been made.

DUTTON AND CO. (LIMITED).—The annual return of this Company was filed on November 2nd. The nominal capital of £60,000, divided into 500 Preference and 5,500 Ordinary shares of £10 each. Of these 285 Preference and 2,810 Ordinary shares have been taken up, of which 2,400 of the latter were issued as fully paid to the vendors, who have since surrendered 200 to the Company. The full amount has been called on 285 Preference and 610 Ordinary, resulting in the payment of £8,950.

EDMONDSON ELECTRICITY METER SYNDICATE (LIMITED).—An agreement, dated August 22nd, and recently filed, between Joseph Edmondson, Frederick Priestman, J.P., Edward Priestman, and Joseph Cooper (the vendors), and the Company, states that the vendors sell their interests in the inventions to the Company for £7 in cash, and £168 in 168 fully-paid shares of £1 each.

ECONOMIC ELECTRIC SPECIALTY COMPANY.—The statutory return of this Company, made up to November 17th, has been filed. The whole nominal capital of £50,000, in £1 shares, has been taken up and allotted, and of these 49,993 have been issued as fully paid. The full amount has been called and paid on the remaining 7 shares.

E. WALLACE AND CO. (LIMITED).—The statutory return of this Company, made up to October 15th, and recently filed, discloses the fact that only the 7 shares taken by the subscribers to the Memorandum of Association have been taken up out of a nominal capital of £1,000 in shares of £1 each, and on these no calls have been made.

CITY NOTES.

CASSEL GOLD EXTRACTING COMPANY (LIMITED).—The report of the Directors of this Company states that it is the intention of the Company to appeal against the recent decision of Mr. Justice Romer, and that the appeal will be heard in December or January. In Germany an action to set aside the Company's patent was raised in April last, when judgment was given entirely in the Company's favour, and here the opposition have appealed. Recently two other actions have been raised against the same patent in Germany by different parties on practically the same grounds as the first action.

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ended December 2nd were £928, as against £905 in the corresponding period of 1893, being an increase of £23. The total receipts for the half-year amount to £19,576, as against £18,275 for the corresponding period of 1893, an increase of £1,301.

COMMERCIAL CABLE COMPANY.—A quarterly dividend is declared of 1¾ per cent. on the outstanding stock of this Company, payable on January 2nd next. The transfer books will be closed from the 21st inst. to the morning of January 3rd.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of November are £3,600, as compared with £3,500 in the corresponding month of last year.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of November, 1894, amounted to £1,738, as against £2,442 in the corresponding period of last year.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the month of November, 1894, amounted to £64,095, as against £60,995 in the corresponding period last year, or an increase of £3,100.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of November amounted to £43,064, and to £40,247 in the corresponding period of 1893, being an increase of £2,817.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company for the month of November, 1894, amount to £26,400, and from January 1st to November 30, 1894, £261,000. In the corresponding months of 1892 and 1893 the amounts were £245,600 and £248,400 respectively.

GUILDFORD ELECTRICITY SUPPLY COMPANY (LIMITED).—A meeting of the founders of this Company was held at Guildford on the 26th ult.l Mr. A. F. Asher in the chair. The meeting having done some formal business, steps were taken for the issue of the prospectus and the appointment of Directors. The share capital is £20,000, and it is hoped that there will be no difficulty in raising the amount.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended the 2nd inst. amounted to £902. The amount for the corresponding week last year was £565.

RUSTON, PROCTOR AND COMPANY (LIMITED).—This Company have issued £250 000 First Mortgage Debentures at 105, bearing interest at 4¼ per cent. to January, 1900, and beyond that period 4 per cent. per annum. These debentures are redeemable in January, 1920, at par. The issue is made with the object of redeeming 5 per cent. debentures of the same amount.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a settling day in the 20,459 Six per Cent. Cumulative Preference shares, Nos. 30,001 to 50,459, and 19,375 Ordinary shares, Nos. 1 to 19.375.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have been informed by a telegram from their representative in Rio de Janeiro, dated Sunday last, that the following amendment to the Budget was presented by the Commission on Saturday. The announcement was officially published on Monday:—"The Government is authorised to purchase the Western and Brazilian Telegraph Company under the conditions of the Company's contract, and also to make the necessary credit operations for this purpose. The Bill is before the Chamber." The following telegram was received from the Company's representative in Rio de Janeiro on Wednesday:—"Urgent. 4th, 5 p.m.—Amendment to Budget presented by Commission of Public Works passed to-day in third discussion; it now forms part of Budget, which goes to Senate to-morrow." We understand that the proposed transfer has received the assent of the Senate.

This Company's traffic receipts for the week ended November 30th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,358.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the two weeks ending November 30th were £2,014, as compared with £2,357 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Nov. 28.		Price Wednesday, Dec. 5.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 5.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£1,012,880	Stock	9,0	Anglo-American	38	39	38	39	5 2 7	Jan., Apr., July, Oct.	..	..
£2,993,560	Stock	18 0	Do. Preferred	72	73	72	73	2 14 10	,, ,,	72½	72
£2,993,560	Stock	5/0	Do. Deferred	6½	7	6¼	6¾	..	..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 17 1	January and July .	..	..
130,000	£10	4/0	Brazilian Submarine	11	11½	11	11½	6 13 11	Mar., June, Oct., Dec.	11 7/16	11⅛
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	110	114	110	114	4 8 11	June and December	..	—
10,000,000	$100	$1¾	Commercial Cable Capital Stock	140	150	140	150	4 13 4	Jan., Apr., July, Oct.	150	..
16,000	10	8/0	Cuba Submarine	12½	13½	12¼	13½	5 18 6	February and August	12¾	..
6,000	10	10%	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	,, ,,	..	..
12,931	5	1/8	Direct Spanish (£4 paid)	4½	4¾	4¼	4¾	4 4 3	April and October —	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¼	9¾	9¼	9¾	5 2 7	,, ,,	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	4 3 4	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8½	8¾	8½	9	6 0 0	Jan., Apr., July, Oct.	8½	..
400,000	10	2/6	Eastern	15¾	16	15¾	16	4 1 3	,, ,,	16	15¾
70,000	10	6%	Do. 6 per Cent. Preference	16½	17	16½	17	3 10 7	,, ,,	..	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	117	120	118	121	3 6 2	May and November	120½	120
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	110	106	110	4 11 11	February & August	109½	108¼
250,000	10	2/6	Eastern Extension	15⅞	16⅜	15⅞	16⅜	4 6 10	Jan., Apr., July, Oct.	16⅜	15½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	117	121	117	121	3 6 2	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	107	103	107	4 15 3	January and July ..	—	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	103	107	4 15 3	,, ,,	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	104	107	104	107	3 15 8	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	107%	110%	107%	110%	3 12 11	May and November	103	..
180,227	10	1/3	Globe Telegraph and Trust	8¾	9	8⅝	8⅞	5 1 2	Jan., Apr., July, Oct.	8 13/16	8 11/16
180,042	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16¼	3 13 10	,, ,,	16	15¾
150,000	10	5,0	Great Northern	21¼	21¾	21½	22	3 17 3	Jan., April, and July	22	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	..	—
17,000	25	12/6	Indo-European	47	49	47	49	6 8 2	May and November	..	..
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	102	105	102	106	5 14 10	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	101	107	104	107	3 16 0	..	..	—
11,839	8	4/0	Reuter's	3	5	3	5	..	April and October —	..	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	103	108	104	109	5 11 1	,, ,,	106½	..
15,609	10	5/0	West African Telegraph	3	6	3	6	..	January and July .	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	100	103	100	103	4 18 3	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July .	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	100	105	100	105	7 12 5	June and December	..	..
88,321	10	6d.	West India and Panama xd	1	1¼	1	1¼	..	.	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	11	11½	10¾	11¼	5 6 8	May and November	11 1/16	10 15/16
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	..	..
£80,000	100	5%	* Do. 6 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 11 9	June and December	..	..
64,242	15	3/0	Western and Brazilian xd	10½	11	11	11½	..	May and November	11⅝	10¼
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	..	6¾	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	4½	5	5	5½	..	..	5 3/16	4¾
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 16 6	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 16 6	,, ,,	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	112	118	112	118	5 19 2	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 17 1	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	..	..	..
224,850	10/0	2⅜d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	..
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	7/16	9/16	7/16	9/16	..	Yearly —	..	..
484,597	5	3/4	National	5	5¼	5	5¼	4 15 3	June and December	5 3/16	5 1/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	16	15	17	3 15 0	,, ,,	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	,, ,,	16⅜	15⅝
119,234	5	3/4	Do. 5% Non-Cumulative 3rd Pref.	5⅝	6⅛	5⅝	6⅛	4 5 1	..	5⅞	5¾
1,000,000	Stock	4½%	* Do. Debenture Stock, 4½% (red.)	110	113	110	113	4 1 3	January and July —	110¼	..
58,000	5	1/0	United River Plate	2	3	2	3	.	,, ,,	..	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	88	94	88	91	5 6 6	,, ,,	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	12½	13½	13	14	..	—	14	..
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	14¾	15¼	14¾	15¼	3 18 8		15¼	14⅞
£[illegible]00,000	Stock	5%	Do. 5% Debenture Stock (red.)	131	133	131	133	3 15 2	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	..	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	4½	5½	4½	5½	3 12 9	—	5½	4½
£57,400	£100	6%	Do. 6 per Cent. Debentures, 1900	..		..		..	..	..	..
8,322	£5	..	House-to-House Electric	..		..		—	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		—	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		.		—	January and July —	..	—
45,000	£5	2/6	Liverpool Electric Supply (fully paid)	7 1/16	7 3/16	7 3/16	7 5/16	—	..	..	—
111,000	5	..	London Electric Supply	⅛	⅜	⅛	⅜	..	..	..	—
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	9½	10	10	10½	2 7 7	..	10¼	0¾
£150,000	Stock	4½%	* Do. 4½% Debs. (Bonds of £10, £20, and £40)	114½	115½	114	116	3 18 5	June and December	..	..
6,452	£10	..	Notting Hill Electric	6½	7½	6½	7½	—	..	7⅛	..
19,980	£5	2 0	St. James and Pall Mall	7½	8	7¾	8¼	.	..	7⅞	..
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8½	9	3 17 9	—	..	.
69,900	5	2/0	Westminster Electric Supply (fully paid)	7	7½	7¼	7¾	2 18 1	—	7 11/16	7¼
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅜	2⅝	2⅜	2⅝	5 14 3	..	2⅝	2 7/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2¼	2½	4 16 0	.	2 7/16	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	110	113	110	113	4 0 9	March & September	..	..
20 000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2¼	3¼	2¾	3¼	..	January and July —	..	..
12,139	6	..	Edison and Swan United	—		—		..	..	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	—	—	..
120,000	2	..	Electric Construction	⅜	⅝	⅜	⅝	—	—	..	..
12,845	2	2 9	Do. 7 per Cent. Cumulative Pref.	1¼	2	1¼	2	..	—	—	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1¼	1½	1¼	1½	..	—	1 5/16	1¼
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	¼	1½	.	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	25	26	25½	26½	4 14 1	February & August	26	25⅞
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 7 5	March & September	..	—
15,995	£10	6/4	International Okonite Ordinary	..		..		—	—	..	—
16,000	£10	..	Do. 8 per Cent. Preference	—		—		—	December and June	..	—
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	¼	—	¼	.	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	41	43	41	43	5 11 6	March and July .. —	42¼	..
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July .	..	—
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	—		—		..	..	..	—
41,098	£5	..	Do. Preference (fully paid)	—		..		..	—	..	..
£63,[illegible]70	10	10/0	W. T. Henley's Telegraph Works Ordinary	8	9	8½	9½	5 5 3	..	9	8¾
£30,000	10	..	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1%	City and South London Railway	40	42	40	42	2 7 7	May and Novembe	..	..
7,000	10	5%	Do. 5% Perpetual Preference	13¾	14¼	13¾	14¼	3 10 2	..	14¼	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	122	124	122	124	3 4 6	May and November	124	123
37,500	£10	1%	Liverpool Overhead Railway	7 15/16	8 1/16	8	8⅛	1 4 7	..	..	..
6,205	10	5%	Do. 5% Preference	13	13¼	13	13½	3 15 6	..	—	—
£125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July ..	—	—

In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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NOTES.

WE trust the Council of the Institution of Electrical Engineers will not weary of well-doing; they evidently have a constituency difficult to please. The cry that this or that section of the electrical industry is inadequately represented on Council has now become a hardy annual. It would certainly seem advisable in the interests of peace and dignity that effect should be given to the suggestion made by Mr. H. C. DONOVAN, in 1888 when the Institution reverted to the present mode of creating Council. Mr. DONOVAN's proposal was simply that some time previous to the Annual General Meeting the members generally should be invited by circular to propose names. No doubt the Council, as it is, take steps to ascertain the names of gentlemen who would be acceptable to this or that group; but "the proof of the pudding is in the eating," and the speeches at recent annual general meetings and the letters to the technical journals are a tolerably clear proof that whatever the Council's system may be it does not work well. If Mr. DONOVAN's plan were tried it might spare us these undignified annual discussions.

ON looking through the list of the proposed Council for 1895 it is impossible not to admit that, in spite of the evident traces it bears of a desire to secure "the greatest happiness of the greatest number," two sections are inadequately represented. The manufacturing interest has six representatives; telegraphy four; and there are two professors, three consulting engineers, three Royal Engineers and others, whilst there is only one central station and one telephone engineer.

NOW, a group of members may claim to be represented on Council on two grounds. The group may urge that it takes an active and prominent part in the affairs of the Institution, or it may merely point to its "big battalions" drawn up in silent array. The big battalion argument would be quite unanswerable if the question at issue were the election of a club committee. But an engineering or scientific society does not exist solely for the sake of social amenities. Members who read Papers, take part in the discussions, and assiduously attend the meetings are naturally and justly represented on the governing body of a Society to a greater extent than their mere numbers warrant. Judged by the test of activity, what becomes of the grievance of the telephone men, ventilated in our correspondence columns this week by Mr. J. T. CROWE? During the last decade two telephonic Papers, neither of them by telephonists, have been read out of a total of 103, and seven years have passed without the reading of a single such Paper. If Papers have been sent in and rejected, let the Council be called on to explain! If, on the other hand, a hundred excellent reasons can be brought forward to account for this telephonic drought, the fact still remains that a drought there has been. Indeed, so complete is the silence of some sections of the Institution that if at any future time they should sever themselves from the rest of the electrical industry, which the Fates forbid, it is difficult to see how they would notify the fact of their continued existence except by the holding of an annual dinner. However, be that as it may, some *modus vivendi* should be quickly discovered. This annual squabble, even if entirely justified each time, would be none the less to be deplored.

ONE of the chief obstacles to the introduction of electric welding to this country seems to have been the want of flexibility of the system. A smith with a hearth, anvil, half a dozen tools, a bucket of water, and a stout striker or two is ready for any job; but an electric welding machine seems, as a rule, to be capable of turning out only one example of work. In America, where a firm takes up the manufacture of an article in only one or two sizes, and offers no choice, but turns out thousand after thousand all exactly alike, electric welding is doubtless worth using; but English manufacturers are, as a rule, indisposed to lay down plant which in a year's time may become antiquated. There seems, however, to be a possible opening for electric welding in cycle construction—and for two reasons. Every part of a cycle is manufactured wholesale in large quantities, and is supplied, either finished or in the rough, to so-called cycle makers. The component parts are all modelled in *facsimile* of the designs of the leading manufacturer. The parts are stuck together by boys, blowpipes, borax, and Brunswick black. It is fair to say that some marvellous specimens of the art of brazing were shown at the recent cycle exhibitions; but most mechanical engineers distrust the process, and would prefer welding. The Benardos system would appear to be more generally applicable to thin tube work than the Thomson. The other reason is that it appears that an influential body of cycle manufacturers are endeavouring to secure and maintain a fixed type of construction. Whether they really try to suppress new inventions and discourage any improvements except those which will cheapen production does not concern us; but it must be admitted that if electric welding, which has been so successfully applied to thin tube work, could be used with advantage for cycle construction, the riders for whom the trade really exists would ultimately benefit. Though the Thomson process could be more easily applied to an invariable pattern, the Benardos system closely resembles blowpipe work, and does not entail expensive special tools.

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We recently had an opportunity of inspecting a new form of motor-gas generator, designed by Mr. B. H. Thwaite for the Motor Gas Plant Syndicate. The purpose of this invention is the production of a diluted non-luminous gaseous fuel for combustion in ordinary gas engines, the material from which the gas is produced being either coke, anthracite, or any form of solid or liquid fuel. So far as we were able to judge, the plant appears to be capable of producing a diluted gas fuel, very much in the nature of Dowson gas, from all but sulphur-containing fuels; for we did not discover any device for ridding the resultant gas of sulphurous products of combustion. In this respect, therefore, the new gas generator does not differ from any of the older patterns. In another respect, however, there is a distinct improvement upon previous appliances; namely, in the provisions for obtaining a fixed gaseous fuel from bituminous and oily fuels. The method adopted in this case is, to convert the volatile matter into carbon dioxide and steam, by complete combustion in an enclosed furnace, and then to reconvert these incombustible substances into carbon monoxide and free hydrogen by passing them through incandescent carbon in a second enclosed furnace. The trouble is that these bituminous fuels so often contain sulphur, which plays mischief with the valves and cylinder liner of the gas engine; but, for those fuels from which this objectionable element is absent, the new process seems to be a distinct improvement upon its predecessors.

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Royal Society.—The following Paper by Prof. W. C. Unwin was down for reading yesterday:—"On the Yield Point of Iron and Steel, and the Effect of repeated Straining and Annealing."

Personal.—We are glad to announce that Dr. Philip Lenard, who was the late Prof. Hertz's assistant and *privat-docent* at the University of Bonn, has recently been appointed extraordinary professor of physics in the University of Breslau.

The African Trans-Continental Telegraph.—According to intelligence from Capetown, the Portuguese are persistently obstructing the extension of the Trans-African telegraph line across Portuguese territory in the direction of Tete. The work is consequently at a standstill.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
Ceara Maranham	Nov. 25.	Dec. 9.
Amoy-Gutzlaff	Nov. 10.	—
Latakia-Cyprus	Nov. 27.	—
Lourenço Marques-Durban	Dec. 10.	—

American Critics and English Progress.—The American *Street Railway Gazette* says that "if it is the English idea to postpone the construction of electric railways until all the problems have been satisfactorily solved, the British public will continue to ride in antiquated tramcars for generations to come." Fortunately, that is wide of the "English idea."

The South Staffordshire Electric Tramway.—The following advertisement appeared in yesterday's *Birmingham Daily Post*:—

> The public is informed with regret that, in consequence of the failure of the Tramways Company to pay the contractors the agreed price of running the electric cars, although it collects the fares, the contractors have given notice to put an end to their contract, to-morrow (Friday), the 14th current.

The Livet Patents.—*Engineering* says that a private Bill is to be brought in next session to continue and confirm the Livèt patents for steam generators, which have been referred to several times in our columns. It appears the last instalment was not paid at the time it fell due, and the patent is, therefore, voided, unless reaffirmed by the passing of the proposed Bill.

Phenomenon Observed with Broken Magnets.—A Correction.—In Mr. Burnie's interesting article, p. 166, he refers to "a downward pressure of 20 tons applied at C." This reference would have been clearer had not the block illustrating Prof. Unwin's test been inadvertently omitted. The magnet bar was supported at N and A (Fig. 2); the point C, at which the pressure was applied, being midway between the points of support.

M. Popp and the Compagnie Parisienne de l'Air Comprimé.—With reference to our "Paris Notes" of the 27th ult., which were published on p. 145 of our issue of the 30th ult., M. Victor Popp writes us that he has "for the past three years been a complete stranger to the Compagnie Parisienne de l'Air Comprimé," and he therefore protests against the title of "The Popp Company" being, given even for the sake of brevity and distinctness, to the Compagnie Parisienne, &c., &c.

The Duties of Refuse Destructors.—In a Paper recently read before the Northern Society of Electrical Engineers, Mr. A. H. Gibbings remarks that in the use of refuse destructors "it is not an infrequent occurrence to have to destroy whole ship cargoes of condemned fruits, vegetables, and fish." We can imagine the inconsolable anguish of the electrician-in-charge whose ill-luck it may be to be called upon to keep steam up and the volts steady with such "fuel" as this.

Post Office Appointments.—Several appointments to postmasterships from the telegraph service are announced in this week's Post Office circular. Mr. P. Smith, telegraph superintendent at Newport (Mon.), is made postmaster of North Shields; Mr. H. Crawley, assistant-superintendent Central Telegraph Office, is to be postmaster of Macclesfield; similar vacancies at Dowlais, Tadcaster, and Bantry have also been filled by telegraphists.

Electrical Heating.—In South America, says *Electricity* of Chicago, an electric drying machine, in which air is forced through a chamber of heated plates and comes out as a hot blast, is to serve in drying wheat, the current to be generated by waste water power. Probably the most curious application now being arranged is to prevent the freezing of a clock. A large town clock in an exposed place often gets clogged with snow and ice in winter, and this is to be remedied by placing an electric hot plate on the top or side of the clock.

Errata.—The important monosyllable "not" was omitted by a printer's error in our report of Mr. Holroyd Smith's remarks at the Institution of Electrical Engineers on storage battery cars. His remarks should read as follows: "The conclusions arrived at in Mr. Wilkinson's Paper had long ago been enunciated and advocated in England—viz., that until a storage battery very different from any yet in use had been evolved they could *not* be economically used for traction work; . . ." On p. 163, right-hand column, the footline to the block should read "Holroyd Smith Rail Bond."

Northern Society of Electrical Engineers.—The following is the list of officers and Council for 1895, elected at the annual general meeting on Monday last:—President: Mr. Henry Edmund. Past President: Dr. John Hopkinson, F.R.S. Vice-Presidents: Mr. G. E. Preece and Mr. W. P. James Fawcus. Hon. Secretary: Mr. John Darney. Members of Council: Messrs. A. B. Blackburn, Thomas Browett, E. A. Claremont, S. V. Clirehugh, G. S. Corlett, E. W. Cowan, C. M. Dorman, G. W. Lowcock, E. Manville, J. H. Rider, James Taylor, and C. H. Wordingham.

An Impromptu Electric Fire Alarm.—Writing from Naples, the Rev. F. J. Smith informs us that on Thursday week, at 5:30 a.m., "the manager of a well-known hotel in Italy was awaked by the continuous ringing of an electric bell. On investigation it was found that a part of the house was on fire; namely, the linen room. The flame removed the covering of the electric bell wires, causing them to become united, this happy union gave the alarm, and the fire, after doing considerable damage, was extinguished. I have mentioned this fact as the electric wire is so often and unjustly blamed when fires occur."

A Gas Engine Station at Calais.—At the Calais electric lighting station, which is being run by two 80-horse Niel gas engines, with two cylinders each, the engines work so satisfactorily that full load can, it is said, be suddenly taken off each without the engine running away; and the engineer has been ingenious enough to make the engines practically self-starting, by getting one piston to stop in the position of compression, the other in that of explosion. Both cylinders are filled with the gas mixture; then the explosion in one cylinder gives rise to compression of gas in the other, and causes ignition at the tube, so that the cycle of operations begins.

Electric Supply for Agricultural Purposes.—Messrs. Ganz and Co. have recently completed a station of a novel character at Jaispitz, in Mähren. At a certain steam sawmill 30 H.P. is utilised to drive a dynamo, from which two sets of cables go out about 5km. in different directions, one leading to a mill and dairy and the other to a second dairy. There are three secondary stations, with two 12 H.P. and one 10 H.P. motors, the transmission being at 625 volts. Motor carts are arranged to be used as threshing machines at any point along the line where they may be required, and they draw their current by means of sliding contacts from the mains. The system is said to have great advantages over the system of steam-driven machines formerly in use in the directions of cheapness and simplicity.

American Street Railway Investments.—A useful book on this subject has been published in New York by the Street Railway Publishing Company. According to a review of it in *Electrical Engineering*, of Chicago, American financiers regard street railway investments as one of the most profitable means of employing capital. The book contains a list of more than 1,000 street railway companies, operating in some 600 cities and towns having a population of more than 50,000. Information relating to the location and arrangement of the roads in all of the more important cities is given by means of maps. In addition a concise statement is prepared showing the organisation of each company, its financial status, the principal officers and employes, together with the general important details of the plant and equipment under operation.

The Law's Delay.—In the year 1883 a serious attempt to tamper with the Marseilles-Barcelona cable of the Direct Spanish Telegraph Company was made by several Spaniards. From time to time the question of the actual guilt or innocence of the prisoners has come before the Spanish courts, and the case has been as many times adjourned from various reasons. In the meantime two of the prisoners have died, and another is too ill to be examined. The following note on the subject appeared in the *Noticiero* of the 24th ult.:—"The case against Pedro Busquets for violation of telegraphic communication was again brought before the First Section of the Provincial Court to-day. We gave a full account of this sensational case when it was first brought before the Court. It will be remembered that it was the outcome of the discovery of instruments established on the track between the cable house and the station for the purpose of tapping the telegrams transmitted by the cable. The Court had hardly assembled when it was announced that the case was again postponed. No reasons were made public."

Continuous-Current Dynamos.—The current number of *Science Progress* contains the second and concluding article of the series, by Mr. C. C. Hawkins, on "Continuous Current Dynamos." The article commences with a notice of Dr. Hopkinson's researches on armature reaction; passes on to review Mr. W. B. Sayers' practical inventions in this field of dynamo work; and, finally, discusses the growth of the dynamo in size, output, and efficiency. The part devoted to a discussion of the performance of machines in relation to their size is especially of practical interest; and in this section the author describes the practice of treble-winding armatures, and its influence upon the output and economical working of the machines. The author concludes with some remarks upon the electric transmission of power, expressing it as his opinion that, "owing to the scarcity of water power, little can be done in this direction at home, and schemes for the transmission of the energy of our coalfields to our towns by electric stations at the pit's mouth remain but imaginative dreams, far removed from practical realisation."

A Big Magnet and a Big Story. The *Western Electrician*, of Chicago, tells the following story:—"The most astonishing contrivance for warfare recently developed is Col. W. R. King's gigantic electro-magnet, of which something has been said in the newspapers within the last few days. This engineer officer of the army has constructed on the top of a fort at Willet's Point, near New York, a great horseshoe composed of two big cannon and a metal bar, with several miles of heavy insulated telegraph wire wound around the muzzles of the guns for spools. Thus has been produced the most powerful magnet in the world, a current of electricity being supplied from a dynamo. As alleged, it is capable of deranging a ship's compass at a distance of six miles, which would be useful in case hostile vessels tried to approach at night or in a fog. They would be apt to find themselves ashore unexpectedly. It has been suggested that a row of such magnets along the walls of a fort might be used to draw the small arms out of the hands of an on-coming enemy. This idea is the same as that of the 'Arabian Nights' story, in which the iron nails were pulled out of ships that ventured too near the mountain of loadstone."

Electric Haulage in a Michigan Mine.—About two years ago, says the *Electrical World*, of New York, the Pittsburg and Lake Angeline Iron Mining Company determined to put in an electric plant, after having become convinced of the economy of the step. At the surface, a power house was constructed, and a 14 by 30 Reynolds-Corliss engine erected to drive a D. 62-500-volt general electric bipolar generator. Armoured mains are taken down the mine on porcelain insulators, and connected in the usual manner to the trolley wire and track. The haulage plant proper consists of two general electric 30in. gauge locomotives, each being equipped with two motors. The locomotives are capable of exerting a draw-bar pull of 1,500lb. each, at a speed of from six to eight miles an hour. The motors are of the iron-clad waterproof type. The length of haul is somewhat short for locomotives, but is too long for profitable tramming by men, the distance averaging from 250ft. to 1,400ft. The grade is 8in. in 100ft. in favour of the loaded cars, and the curves are sharp, varying from 12ft. radius up, on account of the narrow veins. No serious delay has occurred since the plant began operation. The cost of hauling at the present rate of working, which is not up to the capacity of the locomotives, is 2 cents per ton, including oil, waste and repairs.

Electric Muffles.—From a casual observation which occurs in a recent Paper communicated to the Paris Academy of Science by G. Charpy, dealing with the allotropic changes of iron under the influence of heat, we (*Engineering and Mining Journal*) learn that an electric muffle is now a fairly common adjunct to the metallurgist's laboratory—at least, in France. The advantages of electrical resistance in bringing metals to high temperatures which are evenly distributed, and can be elevated gradually, are now recognised in many industries, and are destined to be much more widely exploited. An electric muffle at once suggests the adaptation of the principle of resistance to the "firing" of pottery. When valuable porcelain is "fired" in a kiln heated by means of fuel many expensive precautions have to be taken so as to prevent the delicate glazes and colours from being impaired by the products of combustion. Small gas kilns and muffles have found a ready sale because the products of combustion of gas are not quite so injurious to porcelain as those of fuel. Now, since a muffle can be heated to any degree of temperature possible by other methods by means of electrical resistance, and since no fumes or injurious products whatever accompany this use of electricity, it seems to be obvious that electric muffles, and even kilns, would be a success. If small gas kilns and muffles are commercially possible, and an improvement on older methods, electric pottery muffles are feasible, and would be welcomed.

The Standard Candle.—Some rather interesting proceedings took place on Monday last week before Justices Grantham and

Lawrance, when the Commercial Gas Company challenged a certain report of the chief gas examiner on the ground of its having been made without jurisdiction. It was a question of candles. Just a twelvemonth ago the metropolitan referees "prescribed" the candles to be used for testing gas in an elaborate specification, which we referred to at the time; but the Company were unable to procure candles made in accordance with it. This being the state of affairs in April last, the examiner at the Wellclose-square testing station made a test of the Commercial Company's gas with some old candles, which, the Company aver, they understood to be unsuitable for the purpose. Having used these candles, the examiner reported a deficiency of illuminating power, against which the Company appealed to the Chief Gas Examiner. Another bad report was forthcoming in May, with respect to the gas tested at the Parnell-road station, and again the Company appealed. Both these appeals were decided against them. But the Company declined to enter into the merits of the matter, and informed Dr. Williamson of their intention to raise the question of legality of the tests, on account of their having been made with candles which were not "candles" within the meaning of the Act, since they were not prescribed by the Gas Referees. Counsel for the Company told the Court that the Referees' candle specification had proved unworkable, and was withdrawn last June; but this is the first announcement to the effect that has been publicly made. The Court seemed to think that the whole affair was really due to an incompleteness in the direction in the statute; but this will be looked into when the "rule" the Company obtained is brought into Court again in the regular course.

The Royal Medal.—When awarding a Royal medal to Prof. J. J. Thomson, for his physico-chemical researches, Lord Kelvin said:

"Prof. J. J. Thomson has distinguished himself in both mathematical and experimental fields of work. His first essay on vortex rings showed power of grappling with difficult problems, and added to our knowledge concerning the encounter of rings which came within a moderate distance of one another so as to deflect each other's paths. His theoretical work in the borderland of chemistry and physics has been very interesting and suggestive. His experimental work has likewise been mainly on the borders of chemistry and physics. He has observed the large conductivity of many gases and vapours, and proved the non-conducting power of several others, founding on the conducting power of iodine vapour important speculations as to its probable chemical constitution. He has also measured the specific resistance of various electrolytes, under extremely rapid electric oscillations, by an ingenious and valuable method, based on the partial opacity of semi-conducting matter to electromagnetic waves. Recently he has worked at the discharge of electricity through rarefied gases, getting induced currents in closed circuits in sealed bulbs without electrodes, and, in especial, measuring to a first approximation the absolute velocity of the positive discharge through a long vacuum tube, proving that it was comparable with, though decidedly less than, the velocity of light. He also gave an ingenious theory of the striæ—a theory which he has since endeavoured, with some success, to extend to a large number of electrical phenomena, the whole of electric conduction and induction being regarded by him from the chemical side as a modified or incipient electrolysis, or as concerned with electrolytic chains of molecules or 'Faraday tubes.' Some of his recent mathematical work on the theory of electric oscillations in spheres and cylinders, and in dumb-bell oscillators of the kind used by Hertz, with reference to not only their oscillation-frequency but also their damping efficiency, has been of much service to experimental workers in those branches of physics. And, in general, the effective manner in which he attacks any electrical problem presenting itself, as evidenced by his book on 'Recent Researches in Electricity and Magnetism,' wherein he worthily carries on into a third volume the great treatise begun by Clerk Maxwell, is evidence of consummate ability combined with remarkable energy and power of work."

Dynamo Electric Machinery.—Judging by the following review, which appeared in a recent number of *Electrical Engineering* of Chicago, a "home" (*Anglicé*, "pirated") edition of Prof. S. P. Thompson's well-known book seems to have made its appearance in the United States:—

The appearance of this well known work from an American publishing house is naturally viewed with suspicion, particularly as it retains the very conspicuous binding which characterises the most recent edition of Messrs. E. and F. N. Spon. It is noted that the present publication is not dated, and that the well-known trade mark of the Finsbury Technical Manuals has been omitted. The preface also omits the date and closing sentence contained in the original, in which the author states the work takes its place in the series of Finsbury Technical Manuals. The present work is divided into two volumes, though bound in one, the only advantage of this arrangement apparently being that it allows the insertion of a few blank pages in the centre of the book, which may, however, pass as a rearrangement. In all other respects the present work is an exact reprint of Messrs. Spon's 1892 edition, for, in perusing the work, one finds that it contains the same number of chapters and enumerated pages, the illustrations and matter are the same, and also the arrangement with the exceptions noted. The symbols used, with one exception, are identical, and perhaps this exception, from a practical standpoint, is the most serious criticism to be made. In the symbol chosen to represent the "electromotive force of some external supply of electricity," a letter very similar to the symbol denoting the "entire electromotive force generated in an armature" has been selected; this resemblance is very liable to cause confusion. The proof of the present work has evidently been compared directly with the English edition, and has not been read with the intention of correcting any minor typographical errors which may have escaped the careful work of Messrs. Spon. It is, however, to be said in favour of the present work that a comparison made at random fails to show any errors from the standard edition, so that from an engineering standpoint the work is of equal value. The American edition sells for $6, while the English edition retails at $9; the print is clear and distinct, though slightly inferior to the English. The paper is also inferior, though heavy and substantial. Regardless of any arrangements which may or may not have been made with the author, or the authenticity of the publication, the work will be found fully as useful to the student as the more expensive edition.

The Baltimore Underground Electric Line.—The work on the electrical plant being erected to haul the trains of the Baltimore and Ohio Railroad through the Belt Line tunnel is, says the *American Engineer and Railroad Journal*, being pushed to an early completion. The locomotives are finished, and the machinery to generate the electricity is complete and ready for erection, and the power-house is well under way, and it is fully expected that before January 1, 1895, trains will be hauled through the brilliantly-lighted tunnel by powerful electric locomotives. "The locomotives consist of two trucks, each truck having two axles, and on each axle is mounted a 300-H.P. motor. The motors are gearless, and are supported on springs resting on the frames of the locomotive truck. This method of suspension leaves the wheels free to adjust themselves to the irregularities of the roadbed, and consequently tends to diminish the wear of both tracks and motors. The motor fields are of the ironclad type. The axles of the locomotive pass through the hollow shaft on which the armatures are mounted. These shafts rest on the bearings of the motor frame, and are connected to the axles by universal couplings, which allow of freedom of motion in all directions. There are four sets of brushes to each commutator. The motors are controlled by means of series parallel controllers set up in the interior of the cab. There will be ample space in the cab for the motorman's movements, and will afford him considerably better protection than that usually vouchsafed. When finished the complete locomotive will be an exceedingly massive piece of machinery, weighing at least 100 tons and of 1,200 H.P. It is fitted with air brakes, the air being compressed by a small auxiliary motor in the cab. The electrical air compressor will also operate the whistle. The regulation is such that the speed can be varied from nothing up to 35 or 40 miles per hour, and this can be increased if desired. For the work contemplated, however, 30 miles per hour will probably be the maximum. The locomotives are to be used in this way: If a freight train is to be pushed through the tunnel, the motor switches behind the train and couples to it without stopping. It then pushes it steadily from the Camden-street end of the tunnel to the portal at Mount Royal Avenue, up a grade of about eight-tenths of 1 per cent. Then the steam locomotive is also put to work, and the two of them pull the train up the steeper grade to Huntington Avenue, where the electric motor is detached. For passenger work the electric motor will be coupled to the train at the lower or Lombard-street station, and will be detached at the upper or Bolton-street station. As there will be no smoke in the tunnel, it will be possible, says our American contemporary, "to paint its interior white; and, as it will be illuminated by about 2,000 incandescent lamps, it will not be necessary to light the lamps in the cars." We do not know what length the Belt tunnel is, or what the normal speed of the passenger trains through it is likely to be; but if the tunnel and cars have anything like the respective dimensions of their counterparts in England, and if a speed of anything like 20 or 30 miles an hour is maintained, the illumination that the passengers inside the cars are likely to derive whilst passing through the "brilliantly-illuminated whitewashed" tunnel will be about comparable to that obtained when an English express train runs slowly through a well-lit station, such as York.

ELECTROMAGNETIC THEORY.—LX.*

BY OLIVER HEAVISIDE.

(Continued from page 93.)

§ **226.** If it should ever come to pass that there prevailed in this world a so-called religion in which the minor virtues of mercy, charity, meekness, resignation, and so forth, were unduly exalted at the expense of the supreme virtue of justice, and if this religion were carried into practice generally, it would be a very bad thing for the world. For such a religion would be a snivelling religion, only fit for the weakminded of both sexes; and if the strong-minded and the just allowed it to prevail, then would the liars, rogues, hypocrites, slanderers, and other wicked people have it all their own way, and the just would be crushed along with the meek and lowly. But just men are better than their religions, and in self-defence would assert the paramount importance of justice, in tacit defiance of the nominal religion in which it was made a secondary virtue. Let us above all things try to be just. Even Cambridge mathematicians deserve justice. I cannot join in any general attack upon them. I regret exceedingly not to have had a Cambridge education myself, instead of wasting several years of my life in mere drudgery, or little more. It is to Cambridge mathematicians that we are indebted for most of the mathematico-physical work done in this country. Do not most mathematical physicists hail from Cambridge? Are not Thomson and Tait, Maxwell and Rayleigh Cambridge mathematicians, to say nothing of the large crowd of other and mostly younger men whose names will suggest themselves? We must take the good with the bad, in this as in other matters; and though legitimate and serious objection may be raised to the distressing and soul-destroying style in which some Cambridge mathematicians do their work, and to the unpractical conservative tendency that exists (conserving the bad as well as the good, and resisting innovations), we should also bear in mind the great volume and value of the work done, and not unduly depreciate or make invidious comparisons. As regards their want of sympathy with less conventional men, it is not sympathy that is particularly wanted—perhaps it would be unreasonable to expect any at all. What one has a right to expect, however, is a fair field, and that the want of sympathy should be kept in a neutral state, so as not to lead to unnecessary obstruction. For even men who are not Cambridge mathematicians deserve justice, which I very much fear they do not always get, especially the meek and lowly, and those who long suffer under slight.

On this question of "Mathematics—and Mathematics," I may mention a somewhat remarkable phenomenon which has lately occurred. Orthodox mathematicians, when they cannot find the solution of a problem in a plain algebraical form, are apt to take refuge in a definite integral, and call that the solution. It is certainly one form of the solution. But it may be just as hard, or harder, to interpret than the differential equation of the problem in question, from the difficulty of evaluating the integral, and so finding out what the solution means. In such cases we might as well keep to the differential equation, and be just as wise. Now, it has come to my knowledge that a man who is not a Cambridge mathematician, and who does not pretend to be much of any sort of mathematician but who is a practical physicist, capable of discussing with proper judgment such a question as the age of the earth, a higher limit to which he finds (and with good reason) to be very likely hundreds of times greater than the most probable previous estimate (which conclusion has obviously important interest to geologists and astronomers), recently made the discovery that a certain unconventional mode of treating the mathematics of the question (explained to him by myself) conducted him immediately to the exact solution of the problem he had in hand, in a few lines in fact; whereas by the methods generally employed he might have spent days over it, without any final success beyond obtaining a definite integral of too complicated a nature to be practically discussed or obviously evaluated.

It has naturally given me much pleasure to find that the method in question, which professes to obtain the solution in plain language directly from the differential operator, and, so to speak, to evaluate the definite integral without the trouble of finding it, should receive such ready appreciation from a practical physicist. Of course, he has no prejudices of the rigorous kind; but makes use of what he finds useful, as soon as he has got to know how to go to work. It is the fact that he is a practical physicist, without mathematical pretensions, that constitutes the importance of the phenomenon. For this reason, I shall have no further hesitation in making use of the method in question occasionally in the course of the rest of this work, at least in such simple cases as the above experience shows are fairly and without much trouble within the reach of practical physicists and electricians; not mathematicians of the Cambridge or conservatory kind, who look the gift-horse in the mouth and shake their heads with solemn smile, or go from Dan to Beersheba and say that all is barren; but of the common field variety, who take the seasons as they come and go, with grateful appreciation. It is really not a question of high mathematics at all, in these diffusion problems at least, but of the substitution of simpler and more direct processes for the indirect and complicated processes of the highly cultivated mathematician with too rigorous proclivities.

§ **227.** Now Prof. John Perry has suggested to me that I should write something on the subject. Therefore, as he has made the matter of the age of the earth interesting at the present time, I give some particulars regarding simple solutions. They are not so much out of place as may appear at first, for they all represent electrical problems of interest, as we shall see later.

The main problem is: Given the earth initially at a constant temperature V_0 throughout, find its way of cooling, and, in particular, find the gradient of temperature in the earth's crust, for that is the observed datum. It can then be deduced how long it takes to arrive at its present state. In accordance with general practice, much simpler problems are substituted, and approximations made with various data. Lord Kelvin, who started this branch of inquiry in his celebrated paper on the Age of the Earth, substituted for the earth an infinite body of uniform capacity and conductivity, the same as those in the crust, with a plane boundary kept at zero temperature.

Now consider first the converse problem. The earth is initially at zero temperature, and by means of surface sources its skin is thereafter maintained at constant temperature V_0. Find the temperature gradient in the skin which results. Let V be the temperature at distance x from the plane face; the well-known characteristic of V is

$$\frac{d^2V}{dx^2} = \left(\frac{c}{k}p\right)V = q^2V, \text{ say,} \tag{1}$$

where c is the capacity per unit volume, k the conductivity, and p means the time-differentiator. Therefore,

$$V = \epsilon^{-qx}V_0 \tag{2}$$

gives V in terms of V_0. This is easily integrated, but we only want the surface gradient, say g. Thus,

$$g = -\frac{dV}{dx} = q\epsilon^{-qx}V_0. \tag{3}$$

So, between (2) and (3) we get

$$g = qV_0, \tag{4}$$

which is the solution.

To turn it to algebraical form, we have

$$q = \left(\frac{c}{k}p\right)^{\frac{1}{2}}, \quad \text{and} \quad p^{\frac{1}{2}}1 = (\pi t)^{-\frac{1}{2}}, \tag{5}$$

so that (4) is the same as

$$g = V_0\left(\frac{c}{\pi kt}\right)^{\frac{1}{2}}. \tag{6}$$

Since the final state due to our source is V_0 everywhere in the earth, it follows that in the subsidence problem, starting from a uniform temperature V_0, the gradient has the same value, only reversed in direction, so that (6) is still the required solution. This is the formula, due to Fourier, used by Lord Kelvin. Taking

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$$V_0 = 4{,}000\ \mathrm{C}, \quad g = \frac{1}{2{,}743}, \quad \frac{k}{c} = 0{\cdot}0118,$$

which are data used by Perry, we find that t is 100 million years. That is, it takes 100 million years for the gradient in the skin to fall to its present value, under the assumed circumstances. The correction necessary for the finite size of the earth, other data being the same, is not large. I find that the time requires to be reduced by $\frac{1}{25}$ part.

§ **228.** The next step, due to Perry, is to assume that the capacity and conductivity are higher in the earth than in its skin. That this will prolong the time of subsidence may not be difficult to understand; but the result is most distinctly not an obvious one in the case of a sphere, for it may be readily shown that the time of cooling may be either less or greater, according to circumstances. But we want numerical results. So take a distinct case. Let the skin be so thin that its capacity may be ignored, whilst its conductance, which is k_1/l, where k_1 is the conductivity, and l the depth, is finite. Then the current of heat inwards through the skin equals that entering the inner earth. This gives the condition that at $x=0$ we have

$$\frac{V_0 - V_1}{R} = -k\frac{dV_1}{dx} = kqV_1, \tag{7}$$

if V_0 is the temperature outside the skin, V_1 that just inside. So

$$V_1 = \frac{V_0}{1+Rkq} \tag{8}$$

is the solution for V_1 in terms of V_0 impressed. R is the resistance of unit area of the skin.

There are two ways of converting (8) to algebraical form, one convergent, the other divergent. The latter is most useful. Thus, by division,

$$V_1 = [1 - Rkq + (Rkq)^2 - (Rkq)^3 + \dots]\, V_0, \tag{9}$$

which, by the use of (5), is turned to

$$V_1 = V_0\left[1 - \left(\frac{a}{\pi t}\right)^{\frac{1}{2}}\left\{1 - \frac{a}{2t} + 1.3\left(\frac{a}{2t}\right)^2 - \dots\right\}\right], \tag{10}$$

from which the subsidence solution, due to V_0 constant all over initially, is

$$V_1 = V_0\left(\frac{a}{\pi t}\right)^{\frac{1}{2}}\left\{1 - \frac{a}{2t} + 1.3\left(\frac{a}{2t}\right)^2 - 1.3.5\left(\frac{a}{2t}\right)^3 + \dots\right\}, \tag{11}$$

Here $a = ckR^2$. The gradient is got by dividing by l, so that the first term, which is sufficient when t is big enough, is

$$g = \frac{V_0}{k_1}\left(\frac{ck}{\pi t}\right)^{\frac{1}{2}}. \tag{12}$$

So, with the same k_1 in the skin, the value of t varies as the value of ck in the earth when t is big enough, which is an important conclusion.

Now (11) is unsuitable when t is small, on account of the divergency. Then apply an alternative method to (8), viz.,

$$V_1 = \frac{V_0}{Rkq\left(1 + \frac{1}{Rkq}\right)} = \left\{\frac{1}{Rkq} - \frac{1}{(Rkq)^2} + \frac{1}{(Rkq)^3} - \dots\right\}V_0, \tag{13}$$

which by means of $p^{-n}1 = t^n/\lfloor n$, is turned to the algebraical form

$$V_1 = 2V_0\left(\frac{t}{a\pi}\right)^{\frac{1}{2}}\left(1 + \frac{2t}{3a} + \frac{1}{3.5}\left(\frac{2t}{a}\right)^2 + \frac{1}{3.5.7}\left(\frac{2t}{a}\right)^3 + \dots\right)$$
$$+ V_0(1 - \epsilon^{t/a}). \tag{14}$$

So the subsidence solution due to initial V_0 is

$$V_1 = V_0\left\{\epsilon^{t/a} - 2\left(\frac{t}{a\pi}\right)^{\frac{1}{2}}\left(1 + \frac{2t}{3a} + \frac{1}{3.5}\left(\frac{2t}{a}\right) + \dots\right)\right\}. \tag{15}$$

The equivalence of (11) and (15) is merely an example of the generalised exponential, but it is interesting to see how it arises.

The solution for the temperature at any distance x may be similarly obtained and without difficulty, but we need not consider that here.

§ **229.** Going a step further, let us examine the influence of the capacity of the skin itself. This was done by Perry immediately on receipt of the above, so far as the beginning and most important part of the solution were concerned. The skin may now be of any depth, and is treated in the same way as the inner earth, but with different constants. Let c, k, V belong to the earth, and c_1, k_1, v to the skin. Measure x in the earth from the inside of the skin, and z in the skin also from its inside. Then we have

$$V = \epsilon^{-qx}V_1, \tag{16}$$
$$v = \epsilon^{-q_1z}C + \epsilon^{q_1z}D, \tag{17}$$

where V_1 is the temperature at $x=0$ and C, D are unknown, and to be eliminated. The boundary conditions are $v = V_0$ at $z = l$, and $v = V_1$ at $z = 0$, besides continuity of current at the interface of skin and earth, or

$$k_1\frac{dv}{dz} = -k\frac{dV}{dx} \tag{18}$$

at $z=0$, $x=0$. These find C and D, and lead us by ordinary algebraical work, which need not be given, to the following expression for the gradient of temperature at the outside of the skin:—

$$g = \frac{1+sy}{1-sy}q_1V_0 \tag{19}$$

where
$$s = \frac{1-(c_1k_1/ck)^{\frac{1}{2}}}{1+(c_1k_1/ck)^{\frac{1}{2}}}, \qquad y = \epsilon^{-2q_1l}, \tag{20}$$

notice that $s=0$ when $ck = c_1k_1$. That is, the flow of heat in the skin due to applied V_0 on its outside is the same for any material inside, provided $ck = c_1k_1$, which reduces (19) to the elementary form (4) first considered.

The approximate solution involving the first power of l may be got at once from (19), and it leads to the former results when l is small. To get the complete solution, expand the fraction in (19) by division. Thus,

$$g = (1 + 2sy + 2s^2y^2 + 2s^3y^3 + \dots)q_1V_0. \tag{21}$$

Only one term needs transformation, since they are formally alike. We have

$$y^nq_1V_0 = \left(q_1 - 2nq_1^2l + \frac{4n^2q_1^3l^2}{\lfloor 2} - \dots\right)V_0, \tag{22}$$

by (20), using the ordinary exponential expansion. Integrating by (5) we obtain a series which also belongs to the exponential kind, being

$$V_0\left(\frac{c_1}{\pi k_1t}\right)^{\frac{1}{2}}\epsilon^{-c_1n^2l^2/k_1t}. \tag{23}$$

Here n has to be 0, 1, 2, 3, &c., in the successive terms of (21), so we obtain

$$g = \left(\frac{c_1}{\pi k_1t}\right)^{\frac{1}{2}}\{1 + 2sA + 2s^2A^4 + 2s^3A^9 + \dots\}, \tag{24}$$

where
$$A = \epsilon^{-c_1l^2/k_1t}$$

In fact (21) expresses the initial effect of V_0 in the first term on the right, and of an infinite series of images due to the change of medium.

Although (24) is a very neat form of solution, we may want a solution arranged in inverse powers of $t^{\frac{1}{2}}$, as in (11) for example. We may get this by picking out the coefficients properly from the expansions of A and its powers in (24). Or, from the operative equation (21) itself, which becomes

$$g = \left\{1 + \frac{2s}{1-s} - 2q_1l\,.\,2s(1 + 2s + 3s^2 + 4s^3 + \dots)\right.$$
$$+ \frac{(2q_1l)^2}{\lfloor 2}\,.\,2s(1 + 2^2s + 3^2s^2 + 4^2s^3 + \dots)$$
$$\left.- \frac{(2q_1l)^3}{\lfloor 3}\,.\,2s(1 + 2^3s + 3^3s^2 + 4^3s^3 + \dots) + \&c.\right\}q_1V_0, \tag{25}$$

when arranged in powers of q_1. Here the even powers of q_1 are ignorable, as they involve whole differentiations. So the q_1 term gives the factor of $t^{-\frac{1}{2}}$, the q_1^3 term that of $t^{-\frac{3}{2}}$, and so on. It is easily seen by inspection that the functions of s that occur in (25) are derivable in succession from one another by the operator $s(d/ds)$, the first one being $2s/(1-s)$. So they may be written finitely if we like. Or,

$$g = V_0\left(\frac{c_1}{\pi k_1t}\right)^{\frac{1}{2}}\left\{1 + \left(1 - \frac{c_1l^2}{k_1t}(s\Delta)^2 + \left(\frac{c_1l^2}{k_1t}\right)^2\frac{(s\Delta)^4}{\lfloor 2} - \dots\right)\frac{2s}{1-s}\right\} \tag{26}$$

where Δ is short for d/ds, is the complete solution, of which the first part is the same as

$$v = \frac{V_0}{k_1}\left(\frac{ck}{\pi t}\right)^{\frac{1}{2}}\left\{1-\left(1-\frac{c_1k_1}{ck}\right)\frac{ckR^2}{2t}+\dots\right\} \quad . \qquad (27)$$

where $R = l/k_1$ as before. Comparing with (11), we can see the effect of the capacity of the skin.

§ 230. The next step would be to go on to consider the case of a spherical earth, first with no surface resistance to the escape of heat, next with a resisting skin, and, thirdly, with a skin of any depth, the capacity being allowed for. But these are too complicated for the present purpose, and would frighten timid readers, and perhaps some Cambridge mathematicians as well. At the same time, I may remark that the solutions can be got through the operators in the form of Fourier series with much less work than by Fourier's way.

Prof. Perry has examined Fourier's solution for a homogeneous sphere with constant surface emissivity (equivalent to a resisting skin) and a very interesting result comes out, viz., that the plane solution gives much too big a result with the same data as regards conductivity and capacity, internal and external.

Thus, according to Perry, take the radius of the earth at 6380^5, and the depth of the skin at 40^5 centim., or 4 kilom., the initial temperature as 4000°C., the present surface gradient 1° in 2743 centim., and $c = 2{\cdot}86$, $k = {\cdot}47$, $c_1 = {\cdot}507$, $k_1 = {\cdot}00595$, so that k in the earth is 79 times that of surface rock, and k/c in the earth is 14 times that of surface rock. Then the time of subsidence to the present state is 960^8 years, or 96 times the estimate of 10^8 years given with the same data except that the earth has the same c and k throughout as in the skin, when calculated by the plane theory, or the linear diffusion of heat.

But, according to the plane theory adapted to meet the case of a plane slab of skin instead of a spherical shell, the time of subsidence would, by (12) above, be ck/c_1k_1 times as great as the estimate without the increased c and k inside, or about 4630^8 years. So the effect of having an infinite conductor with a plane face to represent the earth is to increase the time of subsidence from 960^8 to 4630^8 years. Perhaps it does not matter in very rough estimates; but it is interesting to note the difference made by the finite size of the earth, and that it lessens the time of subsidence in the ratio 463 : 96, or 4·7 to 1.

In order to ascertain whether the objection made to Perry's neglect of the capacity of the skin had any serious basis, I have worked out the corresponding formula with the capacity allowed for. There is very little difference numerically. Thus, Perry found two terms in the Fourier expansion to be necessary. But the first term is a large multiple of the second, so we may take it alone for our comparison. By the first term of Perry's formula, the time of subsidence comes to 9020^7 years. Allowing for the capacity of the skin, I find it comes to 9030^7 years. But I have not taken special pains to get the third figures right.

§ 231. Now a few remarks (which I make with much diffidence) on the practical outcome of Prof. Perry's investigations. It is known that geologists demand long ages of time for the earth's evolution in its geological aspect. Physicists, on the other hand, have offered them what geologists consider the miserable allowance of from 20 to 400 million years. Prof. Tait, I believe, offers them only 20. They want more.

There are two evident ways of getting more. The first is by not requiring so much, by allowing that the earth's evolution went on at a far more rapid pace in former times than at present, wholly apart from catastrophes. This seems to be a reasonable view. The other is Prof. Perry's way. He advances arguments to show that it is reasonable to suppose that the earth's effective capacity and conductivity, especially the latter, may be even at present much greater in the earth's interior than in its skin, so that the time of subsidence to the present skin gradient is prolonged. But it is not a mere question of the present state of the earth's interior. The state during the whole period of geological evolution has to be considered, and Prof. Perry's argument seems to me to apply with greater and greater force the further we go back in time. I presume that the earth's birth, for geological purposes, should be reckoned from the time when it became encrusted, or when the crust attained some notable thickness to give some sort of stability. Is it necessary to solidify the earth all through before beginning its life? If we allow it to solidify gradually by the natural increase of depth of its solid crust, consequent upon its cooling, it is evident that the age of the earth may possibly be much extended.

As for the origin of life upon this planet, the only reasonable view seems to me to be Topsy's theory. She was a true philosopher, and "she spekt she growed." Any other theory is of the elephant and tortoise kind, a sort of evasion, which explains nothing, whilst it increases one's difficulties. Prof. Tyndall was of Topsy's persuasion. So am I, as I firmly believe (subject to correction) in the truth of his view as to the "promise and potency" of life in so-called dead matter under the influence of the forces of nature.

(To be continued.)

THE LIFE AND INVENTIONS OF THOMAS ALVA EDISON.

There has recently appeared under this title a book, the authorship of which, in spite of the puff preliminary which whispered that much of it was autobiographical, is attributed on the title-page to W. K. L. Dickson and Antonia Dickson. This book belongs to the class of works that are produced by enthusiasts to glorify their ideal, and cannot be judged by scientific standards. As a piece of imaginative literature it has some notable qualities; as a sympathetic biography it is of intense interest; but as a narrative of scientific weight it is strangely deficient. The authors are so lost in the worship of their hero that they lose all sense of proportion and perspective. Even the most trivial of his doings and sayings are gravely set forth as though they possessed some permanent or scientific value; and the very naiveness of the narrative, which is very fine and large, makes it most entertaining reading.

Edison's early experiences in selling newspapers as a train-boy on the Grand Trunk Railway, where he printed the *Grand Trunk Herald* on board the train, are given at length, with a facsimile of one of the sheets so produced. After this came his introduction to telegraphy, with varied experiences and wanderings until the time when, at the age of 22, while engaged at Boston, he took out his first patent for an electrical vote-recorder. This is an invention which, it appears, no political party wants, as it would facilitate legislation and prevent the free play of that powerful engine of party warfare—obstruction. Incidentally we learn that a year before, while at Louisville, he had issued his first electrical treatise. If any copies of that treatise exist now they must fetch a greatly enhanced price. It was at Boston that Edison began constructive work, while still an operator on the night shift of the Western Union Telegraph Company, his first completed instrument being the stock quotation printer or "ticker," which preceded by some years the perfected Edison quadruplex telegraph system that first made him really famous. The authors do not seem to be well-informed on the subject of telegraphy, since they get rather mixed about single-current and double-current systems; and they apparently attribute to Edison the discovery of the polarised relay, and of duplex telegraphy, to which they assign the date 1872! The work of Gintl in 1853 on duplex signalling led to the improved systems of Frischer and of Siemens and Halske in 1854. Our authors say nothing of this—perhaps they never heard of Siemens and Halske. But they omit all mention of J. B. Stearns, of Boston, who in 1871 completed the solution of the problem of duplex telegraphy for land lines by compensating the capacity of the lines. Surely they must have heard of J. B. Stearns. So also, they omit all reference to other workers on duplex systems which also date from 1853. And the combination of duplex, with diplex which is known as quadruplex, they attribute without qualification or reservation to Edison, without a word of the prior suggestion to that effect of Heaviside, or any reference to the still better known system of Gerrit Smith. The standard quadruplex used throughout the Western Union Company's lines is Gerrit Smith's. Perhaps the authors never heard of Gerrit Smith or even of the Western Union Telegraph Company. With the growth of his telegraphic inventions, including an automatic transmitter somewhat resembling Wheatstone's, came money, which enabled him to set up a factory in Newark in 1873. While here he made the discovery of the effect of the current in diminishing friction between a metal point and a prepared strip of paper, which constitutes the principle of the motograph. In connection with this discovery the authors state that the Edison motographic telephone receiver proved such a signal success in England that "the system was successfully grafted upon the social, political, and commercial workings of the day." There is some mistake here; for the motographic receiver was never brought into commercial use in the United Telephone Company's exchanges; where, until the modern types of Hunning's transmitter were introduced in recent years, the Bell receiver and the Blake transmitter held their own.

The account of these years of Edison's life at Newark is pleasantly enlivened by amusing digressions, which record how he celebrated the sale of an invention by entering the workshop with a whoop, and throwing his hat into an oil pan; how he used to dispense with sleep; and how he aired his views on diet. These are as original as his views on Newton's Principia. Newton would have done better had he known less about mathematics. "The nations that eat the most kinds of food are the greatest." This text, which fills three pages, introduces the first of a tiresome series of discourses by the authors in the time-honoured style of the leaders of the *Daily Telegraph*, overflowing with references to Assyria and Babylon, Sparta and Hymettus, Shakespeare, Milton and Spenser, all fired off like fourth-of-July fireworks to dazzle the reader. The authors opine that the birth of the quadruplex telegraph was the practical outcome of Edison's strange views as to diet and sleep! During the years 1870 to 1876 it is said that 45 distinct inventions were maturing; and to escape the importunities of visitors Edison removed his laboratory and workshop to Menlo Park, twenty-four miles from New York. Several pages are given to descriptions of the tasimeter, an instrument for detecting minute effects of radiant heat, which at one time promised to be of great scientific value, and was used in 1878 in observations during the solar eclipse of that year. It has since been so entirely superseded by Langley's bolometer, that the interest in the tasimeter is now purely historical; it does not seem even to have been useful as a thermoscope. The odoroscope, a modification of this instrument, which was supposed to measure odours, has never been heard of since. Though the authors describe it, and give a picture of it, we are unaware that any scientific results have ever been given to the world by its use. The same may be said of a number of the "inventions" of which pictures are given.

Following on the description of the tasimeter comes one of the greatest blots on this book—namely, a direct accusation against Prof. Hughes of having stolen from Mr. Edison the invention of the microphone. All who know Prof. Hughes know how utterly incapable he is of any such act. Moreover, the stages of discovery by which, armed with a Bell telephone receiver, he arrived at the microphonic principle of loose contact are well known from his earliest Paper on the subject. There is not the slightest evidence that any ideas that Edison may have had at that time working in his brain were known to Hughes; and the famous telegram which Edison cabled to Count du Moncel at the time, in which he stated that he had previously sent some microphones to Mr. Preece was found to refer not to microphones at all, but to some of the lamp-black transmitters which he had devised shortly before. It is a very unworthy act to revive now a scandal which sixteen years ago was shown to be without shadow of foundation.

Chapter VIII. is devoted to two of the "inventions" of Edison, which are euphemistically described as having had "no commercial application as yet"—namely, the "megaphone" and the "aerophone." One of these simply consists of two large funnel-shaped ear trumpets, which enable the observer to listen to the cows munching grass six miles away, and the other is a device by the aid of compressed air or steam to magnify the human voice to two hundred times its ordinary loudness. According to the authors, it "not only intercepts casual and indiscreet remarks, but roars them out to the adjoining neighbourhood in a manner calculated to endanger the bulwarks of social life." We may be pretty sure that if a machine ever had actually produced such a result, the scientific world would have heard of it before now. If the invention really exists why should its only use be to swell the pages of an enthusiastic biographer?

Chapter IX. is devoted to the phonograph, the first idea of which Edison states to have been suggested to him by the accident that he pricked his finger while singing to the mouthpiece of a telephone transmitter, to the diaphragm of which a fine steel point had been attached. But the germ of the invention had really been working in his mind before. He had had much experience in automatic methods of translating telegraphic messages from one set of instruments to another: and one year before the phonograph was invented he had described "a method of reading ordinary telegraphic signals by a chisel-shaped stylus indenting a sheet of paper, enveloping a cylinder or plate along the line of a groove cut in the surface of the latter." There can be no doubt that the phonograph will take its place as one of the great scientific discoveries of the world; and that the idea that underlies it of the simple mechanical recording of sound in such a way as to enable the original sound to be reproduced from the record is one of those suggestions of masterly simplicity that stamp a really great step in scientific progress. It is impossible to underrate the value which some still further perfected phonograph may hereafter prove to have as an implement of scientific research, acoustical and linguistic, quite apart from any possible commercial uses, or from its human interest as presenting the personal voices of those who are far away or dead. The man who makes such an invention will live in scientific history when everything else he has done, or that may be fathered upon him by an admiring biographer, is forgotten. With lavish hands the writers of this book pour out their praises, and adorn their pages with illustrative blocks—cuts we must not call them, for they are surface-blocks—lavishly strewn throughout the book.

There are many anecdotes told of the inventor, which must have been narrated by himself. One of these is of some interest. It is told how Edison, shortly after making the first tinfoil phonograph, "strolled into the Smithsonian Institute at Washington and embarked on a close scrutiny of the phonautograph"—doubtless one of Koenig's instruments, made on the pattern invented by Scott in 1860—and delivered himself of the following observation: "Wise men, these were, not to see that they could put a hard point and a piece of tinfoil in front of it, and there is the phonograph." This puts me in mind of a personal incident worth mentioning. Once when I was in Koenig's laboratory in Paris, I asked him whether at the time when he and Scott were working at the recording of sounds by the phonautograph the idea had never occurred to him or to Scott to use the record for reproducing sounds. He shook his head, and replied: "No, Monsieur, the idea never came to us." To return to the book, the authors make a strange omission, when, in dealing with the modern phonographs, in which the sounds are not indented into tinfoil, but carved with a cutting tool upon the surface of a waxen cylinder, they omit all mention of the men who brought about this important step. The researches of Sumner Tainter, Graham Bell, and Chichester Bell surely deserve mention. Without them the phonograph was practically of no service, from the inherent impossibility of obtaining a perfect record by the method of indenting into metal foil. To allow the reader to suppose that the vast stride made in substituting the method of carving the vibrations upon wax was made by Edison or his assistants is a gross injustice to these three workers. In spite of all the recent improvements it still remains true that the phonograph is still mainly a splendid toy to attract crowds at penny exhibitions, and to enliven the tedium of garden parties; for these are its principal uses as yet.

After the invention of the phonograph the demands on Edison's capabilities to invent seem to have become oppressively numerous, and inventions made to order increased apace. "Thick as owls in Athenian temples they crowd about us." Why they resemble owls is not very clear, but the authors say so. And what is the thickness of an owl in an Athenian temple is also an unexplained mystery. This is intended, doubtless, as a piece of that fine writing which makes the book so comic. "Deep-eyed Mnemosyne" must be invoked in describing the phonograph, as must a whole page of heathen divinities in order to introduce the subject of incandescent illumination; while, with a touch of superfluous piety, Edison's electric lamp is declared to correspond to the "Dayspring from on high," and the chemical products in his laboratory "recall memories of the Babe of Bethlehem"!

Our authors are not always correct either on details. British readers might not recognise in "M. Ewing, of the University of Glasgow," our well-known Prof. J. A. Ewing, of Cambridge, formerly assistant to Prof. Fleeming Jenkin at Edinburgh. Dr. Gilbert's *De Magnete* now reappears as the *De Arte Magnetica* of *Sir* William Gilbert. Deleuil, the inventor of an early form of arc lamp, is described as Délénil. Kosloff is now spelled Risloff. But these are trifling compared with some of the other features of the book.

Amongst the least gracious things in the whole work is the ungenerous reference on p. 248 to Mr. Swan—himself one of the most generous of men—in which he is grudgingly described as not the inventor but the *proprietor* of the Swan incandescent light. This, to anyone who knows the inner history of the incandescent lamp, would be amusing if it were not so unblushing. We should like to hear what Mr. Frank L. Pope, the author of the fullest account that has yet been published of the history of the incandescent lamp, would say of it. It is notorious that it was Swan's success at a time when Edison's lamp experiments had led to nothing of commercial value that caused the latter to abandon his platinum and iridium lamps for the carbon which he had previously spurned. To a reporter of the *New York Sun*, in November, 1878, he said: "I use no carbon, the carbon lamp won't do. I have made repeated experiments with carbon." This was in the days when Sawyer and Mann were using carbon, and when Lane-Fox had already found out that platinum and iridium were useless as bridges of lamps. Swan's public use of carbon came shortly after—early in 1879. Then, and not till then, did Edison abandon the much-advertised overpraised platinum lamp, and "invent" (in October, 1879) the carbon lamp.

One good story, entirely to Edison's credit, and intensely characteristic of the man, we miss from the *personalia* which Mr. and Mrs. Dickson have gathered up. It is that relating to his demand for the rare earth *thorina* at a time when he was working at pyro-insulating coatings for the platinum wire lamp. This earth is found in a rare mineral, monazite, of which, he was assured by the State geologist, only a few grains existed in all the United States. Entirely undismayed, he engaged an active explorer to search for the required mineral, of which he shortly had a good supply; and crowned the incident by despatching a lump of several pounds' weight to the astonished State geologist. As it turned out, the thorina was of no service; but it happens that this very earth is now used in the manufacture of the mantles of incandescent *gas* lights. On Edison's quest for bamboo for his lamps, on the adventures of his explorers in South America and in the Far East—all profusely illustrated—we have not room to dwell. At this point the want of due sense of proportion to which we have alluded becomes almost ludicrous. One would gather from this book that the whole success of electric lighting depended on the use of bamboo; while the fact is that not a single firm in all Europe—not even the Edison-Swan Company in England—uses bamboo at all in its lamps. One would also gather that all the electric lighting in the world is done by Edison lamps supplied from Edison dynamos erected in Edison central stations—there are no others recognised in this book! Even the work of such valiant assistants as Lieut. F. J. Sprague, who worked so hard at electric motors for the Edison companies, is ignored. This is the more strange, since Mr. W. K. L. Dickson, according to his own account, was in charge of the testing department of the Goerck-street establishment in New York, and is still with Mr. Edison at the Orange laboratory, working at the kinetoscope. This apparatus, a toy as it seems to us, is described as the latest invention; but it is with very little difference the same thing as we have often seen under other names. At the Frankfort Exhibition, in 1891, there were machines practically identical with the thing now called Edison's kinetoscope; the photographs of a moving object taken in rapid succession of a score or more per second being illuminated successively by electric sparks. The kinetoscopes now being shown in London as Edison's appear to me to differ only in their pictures being a little more ambitious. If with all the resources of the Orange laboratory Mr. Edison can do nothing better than this, one begins to fear that his inventive powers are on the wane. At the present moment his fame, in public estimation, rests upon two toys, the phonograph and the kinetoscope, one purely mechanical, the other optical and photographic.

Before we leave this volume, with its amusing blunders and juvenile outbursts, we must say a word for Mr. Dickson's excellent photography. Assuming that surface blocks are a satisfactory form of illustration (and these are not, even with the smoothest of hot-pressed paper to receive their imprint), the photographic reproductions, especially of the later half of the book, are distinctly above the average.

We reserve for the last, as the gem of the whole work, the crown of its hero-worship, one sentence, which we commend to the astonished gaze of the electrical world generally. On the authority of Mr. Dickson, who claims to have had a close and friendly connection with Mr. Edison for thirteen years, we now have it stated that:—"*Mr. Edison at no time has ever advanced a claim of original discovery in connection with the electric light.*" What, then, were all the lawsuits about, and why did the Edison Company bring them?

SILVANUS P. THOMPSON.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, December 14th.

PHYSICAL SOCIETY.

5 p.m. The following Papers will be read:—(1) "Students' Apparatus for Finding the Mechanical Equivalent of Heat," by Prof. W. E. Ayrton and H. C. Haycroft; (2) "Glow Lamps and Testing Instruments," by Prof. W. E. Ayrton and E. A. Medley.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. The following Papers will be read:—(1) "Some Experiments on the Heat-Losses to the Cylinder Walls of a Steam Engine," by S. Henry Barraclough and Lionel S. Marks B.Sc.

MONDAY, December 17th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture: "Modern Developments in Explosives," by Prof. Vivian B. Lewes.

TUESDAY, December 18th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper will be discussed:—"Colliery Surface-Works," by Edward B. Wain.

WEDNESDAY, December 19th.

ROYAL METEOROLOGICAL SOCIETY.

7:30 p.m. Ordinary Meeting at 25, Great George-street, S.W.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read:—"Forestry," by Gen. J. Michael.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Ordinary Meeting at 20, Hanover-square.

\. Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

Electric Conduit-Tramway Patents.—In a Paper recently read before the American Institute of Electrical Engineers, Mr. Joseph Sachs makes the statement that of all the electric railway patents granted since the first days of the practical application of electricity, one-half have been issued for conduit railways.

The Electrician.

(The Oldest Electrical Journal, 1861—1878.

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RADIOMETRY.

In a recent issue we printed a translation of an article on a new unit of light proposed by LUMMER and KURLBAUM, and in the course of that article allusion was made to a bolometer, by means of which this unit was constructed. It will be remembered that a sheet of platinum was raised to such a degree of incandescence that the total radiation was ten times that which passed through an absorbing screen. The construction of the absorbing screen was simplified as much as possible, with the view of easy reproducibility, and, as often happens in physical researches, the simplification of one part of the apparatus called for a higher degree of sensitiveness and of complication in another part. When a standard of light is to be constructed by a differential measurement of its radiation, the question naturally arises—what photometer is good enough to adjudicate upon this vital difference—*quis custodiet ipsos custodes?* And when we find that no photometer at all, in the ordinary sense of the word, is used, but a bolometer, we may naturally ask, what is this bolometer that is fit to standardise all photometric work? The answer is to be found in our columns this week. Whether or no such an instrument is to be relied upon to discharge the responsible duties thus assigned to it we do not propose to discuss: but, granting that this is the case, why should any photometer be used at all in subsequent work with this unit of light? If we are right in supposing that Herr O. LUMMER, one of the joint inventors of the new unit, is also the joint inventor with Herr Brodhun of the most sensitive photometer that has ever been constructed, he, perhaps, is the best man to answer the question.

The only other instrument which competes with the bolometer in point of sensitiveness is Prof. Boys' radiomicrometer. The bolometer is not a new instrument; it dates from 1851, and Prof. S. P. Langley has successfully used it for many years. The new bolometer, however, possesses several new features of importance. The details of construction of this bolometer, regarded as an instrument of physical research are very interesting. The production of a continuous sheet of metal of a thickness—surely we may say thinness—of one twenty-thousandth of a millimetre is a remarkable application of Wollaston's method, and the delicacy of manipulation of the resulting film seems to equal that which is necessary for handling and working with quartz fibres. No extraordinary galvanometer or other apparatus is necessary, and the most serious source of error, in so far that it would be difficult to estimate, neutralise, or correct, seems to be changes of temperature due to air currents in the apparatus or in the room, or to reflected or other stray radiations. It is easy to discover whether a photometer room is sufficiently darkened since the eye is a tolerably good photoscope, but we have no corresponding radioscope. Cutting off all light but that which is intended to fall on a photometer is easy; but it is impossible even for Prof. Dewar to cut off, if we may use the expression, all temperature from a bolometer. The instrument is essentially a differential one, and the only hope of accuracy lies in the possibility of easy and definite reversibility. The action of apparatus for a physical, or, indeed, any other accurate measurement, may be apparently reversed for the purpose of neutralising certain unknown, or partially known, instrumental errors, but the reversal is not always effectual or simple.

The great weakness of photometry, as at present practised, is that it is not a direct measurement indicated by a pointer moving over a graduated scale; true, there is such a pointer and scale, but the former is moved according to the judgment of an observer, and not by the directive forces of an instrument. Observers may occasionally be found who can read without difficulty to about half a per cent., and their measurements may be concordant, but they cannot be accepted with the same confidence as weighings or measurements of length. But there seems to be a much wider field for the bolometer than as a mere substitute for a photometer. All energy tends to degrade into heat, and it follows that many physical measurements in which energy is directly or indirectly involved might be conducted with the aid of a bolometer. When one of the largest and best astronomical telescopes in this country was constructed no provision was specially arranged for an eyepiece, for the most valuable astromical work is done by the photographic camera. The eyepiece of the spectroscope has been supplanted by the linear bolometer and automatic photographic apparatus. The use of a shilling thermometer as a wattmeter is familiar to most of our readers, and the fact that the best mercury and glass thermometers are extremely liable to errors of a very complicated character is known to many of them. The thermometer is, indeed, a very unsatisfactory instrument. The bolometer is nothing but a highly-developed thermometer, and if the concluding section of the article by Lummer and Kurlbaum is to be taken without qualification as indicative of the accuracy and sensitiveness at which they had arrived two years ago, their instrument, with the modifications which have doubtless been subsequently introduced, seems to be well fitted for many physical measurements.

REVIEW.

American Electric Street Railways. By Killingworth Hedges. (London: E. and F. N. Spon. New York: Spon and Chamberlain. 1894.)

This is a work which may rightly be said to appeal to two distinct classes of readers—namely, to those who wish to be provided with a popular yet correct account of modern electric traction, and to those who may find it convenient to possess in a compact and well-arranged form all the principal data of the chief electric railways and tramways. The book claims to give an account of the construction and equipment, with notes as to the maintenance and initial cost, of American lines; but the author has rightly assumed that American practice is better expounded by adding full accounts of European practice than by reserving his pages exclusively to American lines. Thus, the whole of one very useful chapter is devoted to "English Electrical Tramways"; while there will also be found several well-illustrated pages giving a description of the Buda-Pesth conduit system. Again, the author has recognised that electric traction, whether in America or elsewhere, has its competitors and rivals; and he has stocked his book with much that is useful, and much more that is generally interesting, in regard to traction by steam locomotives, compressed air, horses, cable haulage, &c. Mr. Hedges assumes the attitude of an impartial teacher, rather than of an advocate of any particular system; and his attention is equally devoted to trolleys and overhead wires and to slotted conduits and their fraternity; to oil-fired and coal-fired boilers; to coupled and geared engines and dynamos; to single and double-motor trucks; to geared and direct-driving motors. Admirably illustrated with an immense number of carefully selected pictures, and bound in brilliant covers, the work should strongly appeal to popular fancy. But, even though there is a popular exterior, and though the pictures are pictures and not scale drawings, except in the minority of cases, there is a great deal in the book which ought to be of use to that fastidious person, the practical engineer; and he need not hesitate to put it on his bookshelf.

NEW FORM OF POLARISED RELAY.

BY T. H. LLOYD.

The following description of a new form of polarised relay may be of some interest to readers of *The Electrician.* B, Fig. 1, is a bobbin wound with fine silk-covered copper wire, into which

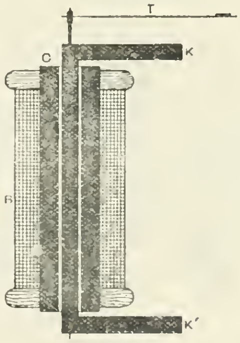


Fig. 1.

is inserted a soft and carefully annealed iron core C, through the centre of which passes a soft iron armature with extension pieces, K and K^1; the top end of armature also carries a small German silver tongue T (Fig. 1 or Fig. 2). On either side of the extension pieces is fixed a straight bar permanent magnet whose unlike poles are opposite each other (as shown in top view, Fig. 2, at N S), the play of T being limited and adjusted by two screws,

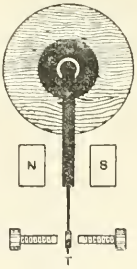


Fig. 2.

as is usual in similar instruments. Greater sensitiveness may be obtained by using two bobbins and armatures with extension pieces as AB (Fig. 3). This arrangement has an additional

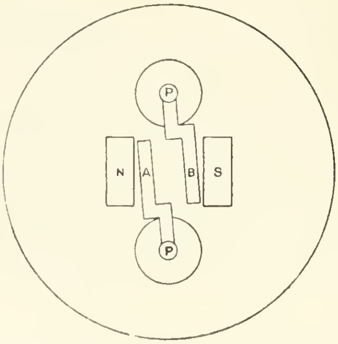


Fig. 3.

advantage, each armature being fitted with a tongue, thus, in many cases, being able to accomplish the work of two separate relays, as Fig. 4. It will be observed that only one coil is

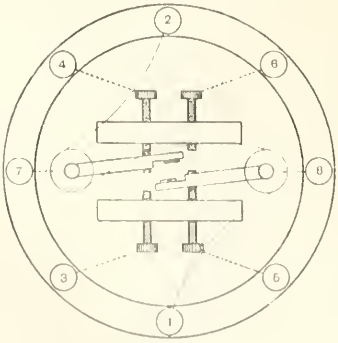
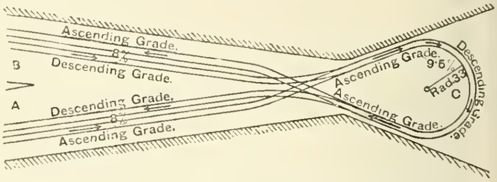


Fig. 4.

necessary, but as it surrounds the whole length of the iron armature-spindle the extension pieces are more uniformly magnetised, and when in their most sensitive position, viz., midway between N and S, respond to the weakest currents.

A STEEP GRADE CURVE.

The accompanying illustration shows a plan of a curious and ingenious steep gradient curve, designed to avoid a very steep ascent in passing round a sharp corner. A and B are two streets, each having an 8 per cent. gradient, which meet one another at an acute angle. An ordinary curve would require the cars passing from A to B to go up a grade of 9½ per cent., or more, at a very stiff radius. To avoid this the rails are laid



as shown; and it will be seen that, by this arrangement, cars passing either from A to B, or from B to A, will go round the sharp curve at C in the same direction, and always on the descending grade. The piece of line is at the junction of Glenway and Wilder Avenues at Cincinnati, U.S.A., and was constructed by the Johnson Company, of Johnstown, Pa. We are indebted for the illustration to the *Street Railway Review*, of Chicago.

TIME INCREASE OF THE OPEN CIRCUIT LOSS IN TRANSFORMERS.

BY DR. J. A. FLEMING.

Mr. Partridge's short Paper in your last issue of *The Electrician* induces me to say a word or two on the above subject rather sooner than I should otherwise have done, in order that it may not be generally inferred that such time increase in the iron loss of a transformer is a general phenomenon, or one which is a universal defect in transformers now used. The subject has been one which for a long time past has occupied my attention. In 1892 a somewhat extensive series of experiments was undertaken by me on methods of measuring transformer losses, and the results of these transformer tests were presented in a Paper to the Institution of Electrical Engineers. At that time I arranged the methods of systematic testing transformers since employed in many places, and in the course of those experiments certain discrepancies in the open circuit losses of transformers as measured at different times and in different places made their appearance, many of which at that time appeared difficult to explain.

Since then I have had the opportunity of carrying out an even more extended series of tests on the transformers of another transformer supply company, which have been conducted with extreme care and with improved methods of testing. Without attempting to describe the details of these prolonged experiments, suffice it to say that they have established two causes of variation in the measurement of open circuit transformer losses, which render it absolutely necessary to state in connection with any such measurements the *temperature* of the core, and the *form of the curve* of potential difference at the terminals of the primary circuit, before the results of measurements made at different times and off different machines can be brought into comparison, and also (which is more to the point at present) my experiments have shown that in the case of certain transformers specially tested for the purpose *no time increase in the iron loss takes place.* Curiously enough, the small period of the time trial was the same as in the experiment mentioned by Mr. Partridge: viz., four months.

The transformers used in the test were two 30-kilowatt transformers by well known makers, which at the beginning of the time test were perfectly new and had not been used for circuit work. These transformers, which we will call A and B, were tested on a *single* Mordey alternator, and were connected on to the circuits (the transformers being cold) on July

25, 1894, at 10:15 a.m. The open circuit losses were then taken and were as follows: A = 578·5 watts, B = 595 watts. As the transformers warmed up a steady *decrease* in the hysteresis losses was found, and the loss fell steadily during the next 24 hours as the transformers warmed to the following values: A = 537 watts, B = 534 watts. At this point the loss became stationary, and readings were taken at frequent intervals during the three following days. On July 27th, at 48 hours from coupling on, the losses were A = 540 watts, B = 535 watts. The losses were then observed throughout August, September, and November, and the last measurement made on November 24th, when the losses were found to be A = 539 watts, B = 552 watts.

There is, therefore, no evidence whatever in these cases of any sensible time increase in the iron loss.

It appears, however, that the iron losses may vary from 5 to 15 per cent., or perhaps more, according to the form of the curve of electromotive force at the primary terminals, and, as the temperature rise appears always to decrease the open circuit loss to a very considerable extent, we cannot institute comparisons between cases in which the same transformer has its open circuit loss measured when cold, and when detached from the circuit after a long run for the purpose of such measurement. I have found in some cases as much as 11 to 12 per cent. difference in the open circuit loss when the transformer is measured under these different circumstances. If the open circuit losses of any transformer are to be brought into comparison when made at different times, it is essential that the state of the transformer as regards temperature shall be the same, and it is also necessary that the test be made off the same alternator, and the same load on that alternator. I find that the open circuit loss, when worked off groups of alternators in parallel, is not the same as when the individual machines are employed separately.

The figures which support these statements are derived from exceedingly numerous tests made on different transformers and different machines. I should like, therefore, to point out that the increase of open-circuit loss observed in the case of the transformers referred to by Mr. Partridge is not to be taken as proving a general fact. The most close and careful tests have failed to find it in the case of these two transformers tested by me. I have been aware for some time that this rise of loss had been observed in some cases, and therefore desired to know if a test upon two new transformers with not very small open-circuit losses showed any indications of such rise. I may, perhaps, mention that Mr. Roger Smith began in my laboratory last summer to conduct a series of tests on different varieties of iron, taking the hysteresis loss for certain change of induction, and then reversing the magnetism for a few million times, and taking the cycle again. These experiments will necessarily take a long time to complete; but they may be expected to assist considerably our present meagre knowledge of the subject.

Meanwhile, opinion must be held in suspense. There is no sufficient evidence yet that the time increase is a general effect. It certainly does not occur in the case of some transformers and some circuits. The problem is to find out when it occurs and how to prevent it. It may be noted that the open circuit loss in the case of the 15-kilowatt transformer given by Mr. Partridge is under 1 per cent. of the full nominal output. This, of course, is a very low figure. The transformers used by me had 1·6 per cent. open-circuit loss.

Some of the figures obtained by me for the open-circuit losses of transformers with very different iron losses seem to indicate that relatively very small hysteresis losses in specimens of iron are not so permanent as larger ones; but the tests necessary to determine if this is the case must be continued over great lengths of time, and I do not wish to speak positively on the point at present. My only object now is to offer a word of caution against the too hasty assumption that transformer losses invariably increase with time of use.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of December 7, 1894, is an interesting record of experiments, by Mr. G. W. Partridge, on "Increase of open circuit loss in transformers with time," and a comment on the same by Prof. Ewing.

The latter has asked for direct evidence that this loss is due to alteration in the magnetic quality of the iron itself, and suggests that a sample of iron should have its magnetic quality carefully determined before and after subjection to a great many magnetic reversals. For several months past I have been experimenting on these lines, but though I have obtained results with one sample of iron which shows considerable increase in the hysteresis area after about 240,000,000 reversals, it would seem necessary to test several samples before arriving at any definite conclusion in the matter. To this end I am now testing samples of iron as used in transformers to the limits of induction obtaining in transformer practice, and I hope to be permitted to submit the results to your journal early next year.—Yours, &c.,

Whitehall Club, Westminster, Roger T. Smith.
December 10, 1894.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Manufacturers of transformers have been perfectly aware for many years that the iron loss increases with time (if the transformer is in circuit, and not if it is kept in the magazine), and also that this change is not due to dampness, as a transformer kept continuously in circuit is *per se* very well dried by the heat evolved in it. In the transformers I have had to deal with the increase of iron loss was not quite so high as in those experimented upon by Mr. Partridge, the increase mostly varying from 20 to 25 per cent. of the original value.

Artificially heating the transformer for several hours to a temperature of about 150°C. will have the same effect, the iron loss being thereby permanently raised by some 25 per cent.—Yours, &c., Otto T. Bláthy.

Budapest, December 10, 1894.

We have received a communication from Sir David Salomons to the effect that some time ago Prof. Fleming pointed out Mr. Partridge's result in a report to the City of London Electric Company, and it is referred to in the third volume of "Electric Light Installations," on page 198. This reference was written months before Mr. Partridge's letter appeared.

[The diagram relating to the performance of the 15-kilowatt transformer was accidentally numbered Fig. 1 by the author; it should have been Fig. 3. This alteration in the numbering of the curves will meet many of Prof. Ewing's queries.—Ed. *E.*]

INSTITUTION OF ELECTRICAL ENGINEERS.

The following members constitute the Council of the Institution of Electrical Engineers for the year 1895. New members of Council, or members occupying new offices on the Council have their names in italics.

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J. M. V. Money-Kent.

It was announced in the course of the reading of the annual report that the Institution Premium had been awarded to Mr. H. D. Wilkinson, for his Paper, "Notes on Electric Tramways in the United States and Canada." No other readers of Papers during 1894 were eligible for Premiums.

BOLOMETRIC INVESTIGATIONS.*

BY O. LUMMER AND F. KURLBAUM.

(Concluded from page 170.)

Defects of Previous Methods of Construction.

By the methods hitherto used it is not possible to construct a bolometer fulfilling the conditions enumerated. Not only very thin metal sheets are required, but especially a suitable way of mounting these thinnest sheet metals in a certain manner. Hitherto commercial materials were almost exclusively used, such as wires of platinum or silver and sheets of tinfoil or gold leaf. To the employment of wires we may state the general objection that the bolometer is less sensitive and more inert, owing to the unfavourable relation between surface and mass, so that the heating of the irradiated portion only takes place after some time, and the galvanometer only slowly approaches a position of rest. A bolometer made of commercial thin wires 0·06mm. thick takes about 100 seconds to come to rest. But that even the thinnest wires producible by Wollaston's method do not fulfil the highest demands may be concluded from the fact that they are hammered into sheets before use. This process has been employed by several observers. By hammering one can surely obtain sufficiently thin sheets; but it may be impossible then to produce four branches *equal in every respect*, as required by condition 9. The same objection applies to commercial gold leaf, which is much perforated and unequally thick. Commercial tinfoil, on the other hand, is not thin enough. But even if we succeeded in preparing the thinnest sheets with all the properties required, their manipulation would be exceedingly difficult and delicate; the construction of a surface bolometer of the form designed by us would certainly be impossible. An instance of the difficulty in obtaining suitable material lies in the fact that W. H. Julius became possessed of a very thin metal sheet (1/500 mm.) by taking the nickel plating off his teapot.

Thin metal sheets on non-conductors are excluded by their want of sensitiveness. since the small quantities of heat radiated pass to the non-conductor. For linear bolometers the following case might conceivably enter into consideration, which does not seem to have been tried yet. A platinised quartz fibre is drawn out to such thinness that the mass of the quartz fibre cannot deprive the metal of any considerable amount of heat. All the defects enumerated are avoided by the method of construction given in detail below, in which the branches of the bolometer are cut into suitable shapes on the dividing engine out of a double sheet of platinum and silver, and then mounted, after which the silver is dissolved off.

Method of Construction.

Sheet platinum is welded to sheet silver of about ten times the thickness, and is drawn out. Since the sheet metal becomes very hard and brittle by the drawing, it is heated from time to time in a charcoal fire, the surface skin is removed by weak acids and friction, and the drawing is repeated. After a certain strength is passed the sheet can only be further drawn out in a folded copper sheet. From the original dimensions of the sheet and from the dimensions attained on drawing, the thickness is given at any stage, and may be regulated at will. The platinum-silver sheet can easily be removed from the copper sheet as long as the platinum layer is not thinner than 0·5 μ—a thickness corresponding to the wave length of green light. On further drawing the silver is very apt to get pressed into the copper, firmly adhering to it, so that it can no longer be removed. For our bolometers we have been satisfied with giving the platinum a thickness of a little under 1μ; but considerably thinner sheets, such as 0·3μ in thickness, may be prepared and easily mounted.

Such a platinum-silver sheet is mounted with Canada balsam on a glass plate, and 12 parallel strips are then cut out with the dividing engine, 32mm. long and 1mm. broad, at intervals of 1·5mm., as shown in Fig. 1.

Thus the connection of the strips is such that the current must traverse them in succession. The platinum-silver sheet is easily removed after the operation with chloroform. A sheet thus divided is mounted by means of a colophony solution in ether upon a slate frame *c d k i* (Fig. 2).

This solution has the advantage that it at once retains the metal very firmly, but still admits of displacements, so that the required accurate position may be given afterwards. The ether evaporates completely from the colophony only on pressing a hot wire on to the metal. Both ends (*a* and *b* in Fig. 2) of the strip are soldered for metallic connection to the copper sheets *w* and *w*¹, which embrace the corners of the slate frame. The copper plates, and those portions of the platinum-silver sheet which lie on the slate frame; *i.e.*, the points *m* and *m*¹, receive a coating of Japan lacquer.

Fig. 3 shows a slate from behind, and the fitting of the rods adjoining the strips. Here are only seen the portions of the strips which were to be freed from silver. The slate frames are immersed in nitric acid, with the strips vertical. The silver is dissolved away, while the lacquer is unaffected. The bolometer may be carefully removed from the acid without tearing; but by immersion in water for removal of the acid it is easily torn, owing to the capillary forces at the surface of the water, which wet the bolometer unequally. While it is completely covered with water it does not tear even with tremors. To avoid tearing, it is necessary to let the water rise gradually along the bolometer by means of a very narrow siphon. In the case of very narrow strips, suitable for linear bolometers, it is advisable always to let the level of the water stand above the top of the bolometer; *i.e.*, to gradually replace the nitric acid by water by means of a narrow siphon, to replace the water by alcohol, and to let this flow off by a siphon. In this manner it is possible to prepare and mount in a frame very thin sheets in any shape and with great precision.

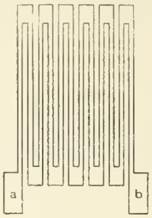

Fig. 1.

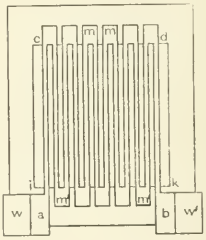

Fig. 2.

Whilst the bolometer before etching is pretty resisting and easy to manipulate, it must afterwards be protected from the slightest pressure. But it will stand strong shaking of the frame and moderate blowing very well.

The lampblacking of the bolometers was at first performed in the usual manner by a petroleum or turpentine flame. It was found that the bolometers after this process, and owing to the heating, had a decidedly lower resistance, and that four bolometer branches made as equal as possible showed pretty large differences of resistance. After many attempts with various blacking substances the following cold method was found very serviceable. It gives a perfectly even, delicate, and yet well-covering layer of lampblack, whose margin is so perfectly flush with that of the strips that a hole, say, 0·1mm. in diameter will be quite free. The petroleum burner employed consisted of a thin brass tube 1mm. in diameter, through which a wire was drawn. For protection against air currents a conical shade surmounted the

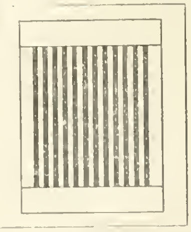

Fig. 3.

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[*] *Wied. Annalen*, Vol. XLVI., p. 204, 1892.

burner, and upon the shade was placed an overlapping glass cylinder. In this position the lamp burns without smoking, whereas by simply lifting the cylinder a smoke thread of any fineness or thickness may be produced at will. Above the cylinder is a copper plate about 12cm. in diameter, with a hole of 4mm. diameter in the centre. As the smoke thread ascends vertically in a straight line it is easy to make it pass through the hole. Here it emerges as a fine thread, and while the copper becomes very hot the heating of the body to be blackened is hardly perceptible. The bolometer strips are taken through such a smoke thread, while the other side is protected by a metal plate at a distance of 1mm. In this manner the platinum strips are gradually coated with a delicate layer of black, while the other side remains bright, and a thick layer of smoke remains on the metal plate. From the bolometers thus prepared, each of which has a resistance of about 60 ohms, four are chosen of as nearly as possible the same resistance, which form the branches of the Wheatstone bridge. The resistances need, of course, be only equal two and two, combining those into which the current divides. Fig. 4 shows diagrammatically the arrangement of the four bridge branches, which is governed by the possibility of letting two diagonally opposite branches of the bridge be irradiated simultaneously. The current coming from the battery B traverses the regulating resistance W, splits at the copper plate $K_{3,4}$, and passes through the bolometer branches 3 and 4 to $K_{1,3}$ and $K_{2,4}$, these being the terminals for the galvanometer. From these points the current passes through the bolometer branches 1 and 2. Between K_1 and K_2 is a rheochord $r\ r^1$ for the complete adjustment of the bridge. From the mercury cup C of the rheochord the current returns to the battery B.

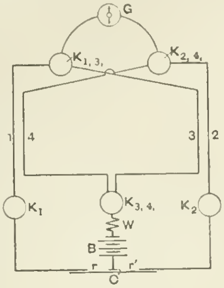

Fig. 4.

The bolometer as a complete apparatus is shown in Fig. 5 in two-fifths natural size.

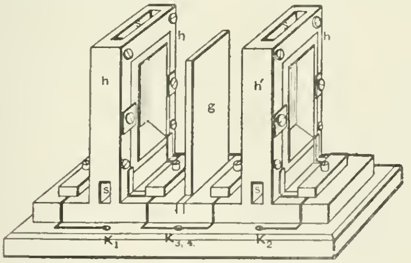

Fig. 5.

The points K_1, $K_{3,4}$, and K_2 correspond to the same points in Fig. 4, while the points $K_{1,3}$ and $K_{2,4}$ of Fig. 4 are hidden in Fig. 5. Two and two slate frames, as known from Figs. 2 and 3, are joined in the ebonite stands h and h^1 in such a manner that the sides covered with platinum strips are turned towards each other, with a distance of 3mm. between them. The strips of one frame stand behind the openings of the other, and since the strips are 1mm. broad, and the interval 1·5mm., no strip covers the other. The air between is, while being heated, freely admitted and emitted through the opening s of the ebonite stand. The stand h^1 is broken in the drawing and exposes the two slate frames. The platinum strips on both frames are also broken. Between the stands h and h^1 is placed a blackened metal plate g, which is neither to reflect nor to transmit rays. Over the whole apparatus is put a box, into which fits the bed plate of the apparatus. Two sides of the box are furnished with openings, through which the radiation is admitted. At these sides are placed tubes provided with several diaphragms, so that the air in the interior of the box does not take part in the external air currents. The connections of the bolometer with the battery and the rheochord pass through the bedplate and emerge between two wooden plates, which are not shown.

Use of the Bolometer.

The first thing is to test the bolometer with respect to the constancy of its zero position. If it remains constant during changes of the room temperature, the temperature coefficient is the same for all the four branches. This was the case in our bolometer for a variation of temperature of several degrees.

That all the four branches are equal in every respect is shown by the constancy of the zero during a variation of the main current. The current available for the most accurate measurements may in this case attain a strength of 0·04 amperes: the amount per unit sectional area is then 40 times that allowed in practice with thick resistances. That this is possible is due to the exceedingly favourable relation between the surface and the mass. As regards the inertia of the bolometer, the change of resistance due to a source of radiation is completed in less than four seconds. For when the magnetic system of the galvanometer was given a period of four seconds, it exhibited a distinct return at the end of the deflection, and oscillated about its position of rest without sensibly advancing in the direction of deflection. The slight inertia of the bolometer is also due to the fact that, apart from the very slight thickness of the strips, the portions m and m^1 (Fig. 2), which are stuck to the slate, and do not at once take part in the change of resistance, have an electrical sectional area about 70 times as great as the useful portions. For one thing, they are about ten times as thick, consisting, as they do, of platinum and silver, and then the thermal conductivity of silver is about seven times that of platinum.

Accuracy and Sensitiveness.

To test the accuracy of the measurements of radiation the following experiment was made, which supposes a pretty constant source of radiation. A small glow-lamp, fed by accumulators, and whose total radiation was about equal to that of three candles or four Hefner lamps, irradiated two branches of the bolometer, whose distance from the glow-lamp was 1m. Between the glow-lamp and the bolometer was introduced a trap-door, which alternately opened and closed a hole for the radiation. The following deflections were thus obtained :—

Zero position before opening.	Point of return after opening.	Deflection.	Difference from the mean.
		mm.	
700 5	285·8	414·7	−0 1
700·7	285·6	415 1	+0 3
700 2	285·3	414·9	+0·1
700·3	285·8	414·5	0·3
700·3	285 8	414·5	−0·3
700·2	285 5	414 7	−0·1
700·4	285 5	414·9	+0·1
700·8	286 0	414·8	0·0
700 9	286·2	414·7	−0·1
700 0	286 2	414 8	0·0
...	...	Mean 414·8	Prob. err. of res. } + 0·04
...	...	...	

In these experiments the galvanometer had a sensitiveness of $1{\cdot}5\times10^{-9}$ ampere, while its resistance amounted to 20 ohms, and the distance between mirror and scale amounted to 1·7m. The main current from the battery was 0·006 amperes; the point of return was attained after an irradiation of 8 sec.

It will be seen that the zero positions of both the galvanometer and the bolometer are good; since during the above series, which occupied about 10 minutes, the zero did not shift by a millimetre. The differences from the mean have always remained smaller than 0·1 per cent. If we calculate a probable error of the result from a series of observations, this is found to be 0·01 per cent. The elevation of temperature corresponding to the deflection is 0·15 C. A Hefner lamp at the same distance produces an elevation of 0·038°. It may be mentioned that the radiation of a Hefner lamp may be measured with the same accuracy. For the same accuracy was obtained when the main current was increased six times, and the radiation of the glow lamp reduced to such an extent that the amount of deflection remained the same: and, besides, the sensitiveness of the galvanometer was not yet fully taken advantage of in these experiments.

We have, therefore, attained the purpose mentioned in the introduction, and we believe we possess in the bolometer an apparatus which completely fulfils our requirements.

CONFERENCE AT THE BOARD OF TRADE ON TRANSFORMER CHAMBERS.

The hearing of the appeal to the Board of Trade of the County of London and Brush Provincial Electric Lighting Company (Limited), in reference to objections to the construction of transformer pits under the streets raised by the London County Council and the Wandsworth District Board of Works, took place before Sir Courtenay Boyle at 7, Whitehall-gardens yesterday (Thursday). With Sir Courtenay Boyle were Major Cardew, electrical adviser to the Board of Trade, and Mr. F. G. S. Hopwood, C.M.G., of the Railway Department. The London County Council was represented by Mr. Bassett Hopkins, and the Wandsworth District Board of Works by Mr. Earls; Mr. C. A. Cripps, Q.C., appeared for the County of London Company, and Mr. Scott, on behalf of Mr. Germaine, for the House-to-House Company.

The CHAIRMAN said there were two issues before the Board of Trade: an appeal of the Company against the objections of the local authority, and the objections of the local authority to the system of supply which the Company were carrying out. He thought it would be most convenient if the objectors to the system of supply were heard first.

Mr. CRIPPS raised the question as to the limits of the inquiry. He contended that under the Provisional Order Parliament had approved of the principle of placing transformers under the streets, which was an important matter of public policy, and what the Board of Trade was called upon to say was whether the particular method of the Company was consistent with public safety. It was beyond the jurisdiction of the Board of Trade to say whether or not transformers generally might be placed under the streets.

The CHAIRMAN said the question of going under the public street for public purposes had been determined by Parliament, but he was not certain that it had been determined that transformer chambers might be put under the streets. The right to go under the public streets for certain purposes did not convey the right to go under the streets for all purposes.

Mr. CRIPPS said it was, of course, a question of the construction of the Provisional Order.

Mr. BASSETT HOPKINS, on behalf of the London County Council, and Mr. Earle, on behalf of the Wandsworth Board of Works, having argued that it was within the scope of the powers given to the Board of Trade to decide whether any transformers should be placed under the public roads,

The CHAIRMAN said section 12 of the Provisional Order said the power to put street boxes under the streets was to be subject to the provisions of the Order, and he knew enough about the compilation of these orders to be quite certain that when application was made to Parliament for authority to put street boxes under the streets there was no idea in the minds of the Board of Trade that street boxes would be extended to mean large transforming chambers taking up an immense amount of space. He did not wish to quarrel with Mr. Cripps's interpretation of the law; but he was quite certain that he was right in holding that the Board of Trade had power under the authority given them to approve or otherwise of the uses to which street boxes were put. He was quite convinced that the Board of Trade had jurisdiction to determine the issue before them.

Mr. BASSETT HOPKINS, in opening for the objectors—the London County Council—said there were serious objections to the occupation of the subsoil for the purposes required, especially considering the apparent outlook as to the extent to which these transformer chambers might eventually be required. He believed that on the last occasion objections were put forward as to the policy of allowing these chambers to be constructed except where no alternative system could be suggested, and it was argued that it was merely a matter of relative convenience and relative expense; it was a question of using the subsoil of the streets on the one hand without expense, except that of construction and supervision, and, on the other hand, being obliged to provide themselves with places for the purposes of the transforming operation other than under the streets at a greater expense. He gathered that consideration of the convenience of a private company would not be allowed to prevail over public convenience and the well-being of the community. In accordance with the application made on the last occasion by Mr. Morse they had placed the heads of their case before the other side, and he received replies from them, and they still seriously contended that the transformer chambers would be a source of danger, or might be a source of danger. It was not necessary that they should demonstrate that they would necessarily be a source of danger; it would be sufficient to justify at any rate a postponement of sanction to these chambers if they reasonably showed that they might be a source of danger. Electric lighting was still in its early youth, and there had not been anything like enough experience of various systems of supply to justify them in coming to any final conclusion. Evidence would be put before them that the larger the spaces where explosive agencies might exist or come into existence the more disastrous the consequencies would be in the event of an explosion. Then the difficulty of ventilation under the streets was greater than elsewhere, because there was less control of all the circumstances. He did not suggest that it was impossible to ventilate, but it was difficult to do so, and without ventilation there was the risk of danger. There was the proximity of the gas and water pipes to such an extent, he was advised, that it was scarcely possible to expect to keep gas out of the chambers, and very difficult to keep water out of them, and the danger under such circumstances was very serious. Then there was risk to the persons employed in supervision. There must be frequent inspection, and persons would have to descend into the chambers, and there the question of ventilation came in again. Another consideration arising out of that was that during the period of the inspection the flaps or manhole covers must be raised and left open, thus adding to the obstructions to traffic in the streets. Taking these facts into consideration, the London County Council felt bound to exercise some supervision, and to see that the powers which had been given were not abused.

Mr. BINNIE, chief engineer of the London County Council, was the first witness called. Examined by Mr. Bassett Hopkins, he said he had had under consideration the proposals of the Company to make transformer chambers. All the notices which were sent, under the Acts and Orders of the electric lighting companies, to the County Council, in accordance with the conditions laid down by the law, came before his department. He considered that the proposed chambers were objectionable upon several grounds. First, they interfered with a certain amount of cross-sectional capacity of the streets in which they were placed. Then they were not advisable on account of the possibility of explosions occurring through accumulations of gas in the chambers; and, further, they would be at certain times, when the boxes were being entered by the servants of the Company, cause of obstruction to the public traffic, whether on the footpaths or in the streets themselves. Another objection was that they were very likely to receive a certain amount of street water. He had been looking into the question carefully, and he was of opinion that in times of much rain they would be absolutely flooded. By the plans which he put in, which showed the gas and water pipes, the sewers, and the proposed transformer chambers, it would be seen that in many cases it would be impossible to drain the transformer chambers. They were so nearly below the sewer that when the pipe connection made with the sewer got full they would be flooded from that source. Then it would be noticed that the transformer chamber in some cases went down to the channelling at the side of the footway, and in heavy rains that was always liable to become surcharged with water, and if there were to be ventilators they would certainly allow the water to enter. In two places—one in Bath-street and one in Old-street—it was proposed to put the chambers actually on the site of existing sewers. One or other would have to give place in those instances. The main drainage system which the County Council were carrying out necessitated continual development, as also did the system of storm-water relief sewers, and the multiplication of these transformer chambers must seriously interfere with the carrying out of that work. The sewers were not at a constant depth; some were 100ft. below the surface, whilst others were scarcely more than 2ft. 6in. There was also great variation in the sizes of the sewers, some being mere pipes, whilst others were between 10ft. and 11ft. in diameter. He thought, if the Company were permitted to put in their transformer chambers upon an undertaking to remove them if called upon to do so, a large expense would fall upon the public directly or indirectly. The possibility that explosion might occur was proved by the fact that there had already been several explosions from the street boxes, and as the transformer chambers would be so much larger, the danger would be greater. The junction boxes were about one cubic foot in capacity, whilst the transformer chambers would be roughly about ten cubic feet. He had seen the plans prepared to show the proposed method of ventilating the chambers. He was not satisfied that it would prove efficient. It was possible that explosions might be caused by the dropping of lighted matches through the ventilating holes. The subsoil of the Metropolis was simply black with the accumulations of gas, and the streets were at all times highly charged with gas. Where boxes or chambers were in a public thoroughfare they were undoubtedly liable to be interfered with by persons with mischievous or felonious intentions.

Cross-examined by Mr. Cripps: He took a general exception to transformer chambers under the streets, and not merely to this particular system. The plans he had put in referred particularly to Clerkenwell, where the sewers were under the control of the Clerkenwell Vestry, but they were in all cases subject to the approval of the County Council. He was not aware that the Clerkenwell Vestry raised no objection to the construction of the transformer chambers. He had not made any examination of the transformer chambers already existing in the city and elsewhere. He did not think it was possible for the Company to properly ventilate vertical pits of the kind proposed with the power they at present possessed; it might be possible to sufficiently ventilate them if they could run a shaft up the side of a house or use some mechanical means for forcing air into the chambers, but they had not the powers to do this. If the transformers were put in cellars hired for the purpose it would be much more easy to secure efficient ventilation. He did not understand that by going into a private cellar for the purpose, the Company would escape supervision by the proper authorities.

Dr. JOHN HOPKINSON, examined by Mr. Bassett Hopkins, said almost everyone who had had to do with the laying of conductors underground, whether in pipes or not, and having connecting boxes in the system, had a more or less painful experience. There had been more than one explosion in Manchester, and several in London. If the cover of the box or chamber were made very tight, the force of the explosion was greater. It was usual to pack the large covers round with spun yarn and something of the nature of cement, and that would hold the cover down with considerable force, so that they would not lift until the full energy of the explosion developed. It was certainly not so easy to ventilate a space under the streets as it was a space elsewhere. He did not think the ventilation shown in the drawing put in by the Company would be adequate. At Manchester the transformers were placed in cellars which were hired for the purpose. The transformers in that case, however, were not of the same class; they were small machines. The lighting was carried out in Manchester by the Corporation. The system in use in Manchester was the continuous-current five-wire system, and they worked at a tension of 400 volts. The transformers were used for equalising the pressure between one section and another. He thought very frequent inspection would be necessary in the case of underground transformer chambers, possibly as frequently as twice a day; and the men certainly would not care to have the covers shut down whilst they were inside, so that they might fairly assume that the covers would be up a great deal. The chambers might at a little additional cost to the undertakers be placed on private ground; or they might be dispensed with altogether, and another system adopted which would be quite as economical for the undertakers. It was simply a question of convenience and cost. It would be cheaper, of course, to put the transformers under the streets, but he did not think the profit would go to the consumers, nor did he see why it should.

Cross-examined by Mr. Cripps: At Manchester they had two stations. He had seen the County of London Company's plans, and understood they were proposing to form a chamber 6ft. square. They would almost certainly get gas in such a chamber. A grid was provided, but it did not follow that the gas would rise and pass out through that grid. His experience in the past had been in connection with junction boxes. The question of ventilation was not nearly so serious in the case of a cellar, for it could be much more readily carried out. It was possible, of course, to put the transformers into a cellar, and then build it up and approach it from the top, and the same question as to ventilation would then arise, but that was scarcely a natural thing to do.

By the Chairman: His chief objections to the chambers proposed was upon the grounds of ventilation and size; the larger the chamber the greater the danger if an explosion did occur. There might be danger of short-circuiting if the earth became moistened.

By Major Cardew: At Manchester the transformers were moving machinery, with commutators and brushes, and there was almost a certainty of small sparks at the brushes. He did not know the conditions with regard to access to the cellars at Manchester, whether or not they had to pass through other people's premises.

Mr. JAMES ENRIGHT was called and examined by Mr. Bassett Hopkins. He deposed to being electrical engineer and physicist at St. Mary's College; also a science graduate, and a member of the Physical Society. He had conducted a good many experiments in connection with electric lighting, and as a result of his experience he held the opinion that transformer chambers under the public pavements were a source of great danger, by reason of a possible accumulation of gas, which accumulation was almost sure to arise. The walls of these chambers might be made air-tight to-day, and to-morrow a heavy van might pass over the transformer chamber and cause the walls to crack, and through the apertures gas would creep in very easily and readily, even, indeed, if the gas was not already in the soil, which all experience in London showed it to be. Moreover, the gas would come into these chambers from the culverts if the cables were laid in earth, as was the case inmany places. Further, the Witness averred that it was well known that hydrogen would leak in without there being any cracks at all. Judging from evidence, it had been found difficult for electrical engineers to keep culverts gastight. Mr. David Cook, of the Electric Lighting Company, declared it to be difficult in the City. But road subsidence was the chief source of danger by allowing an accumulation of gas. In some cases it had occurred that the concrete basement on which the pavements originally rested had been drawn away, leaving a chasm underneath, in which space the gas would accumulate. The larger the transformer chambers were made the more dangerous it would be in the event of an explosion occurring. There was also a danger possible to arise from the presence of moisture. In illustration of this point, the witness cited a recent accident which occurred from this cause at Hampstead. In such a case as this a person passing along the pavement might receive a shock.

Mr. HOPKINS: Do you believe in the possibility of electrolysis? A.—Yes: if water gets into the chamber by reason of floods. In the case of coal gas, Witness said, it would be detected by smell; but the hydrogen generated from electrolysis would not be apparent to an inspector in the same way. Further replying to Mr. Hopkins, the Witness said that insulated wire being heated would give off gas. That opinion Witness held by reason of reading the evidence of the accident at Cannon-street, in which case he very much doubted if the accident was due to coal gas. It having occurred to the Witness's mind that insulating material being heated might give off gas, he procured some, and found that at a moderate temperature a combustible gas was given off. To the Chairman Witness named india-rubber as one material so tested, and in reply to Mr. Hopkins he said he had tried a good many coatings. Even paper would give off an explosive gas under certain conditions. Witness had tried most of the materials commonly used, and he found that there was no difficulty in getting from them a gas which would burn freely at the mouth of the tube, which, of course, was an explosive gas.

The CHAIRMAN: What was the gas? A.—Of course, it would be some hydro-carbon, but that he would not speak for. It was sufficient for his purpose that the gas would burn freely, and was therefore explosive.

Mr. HOPKINS was proceeding to question the Witness with regard to his observations of recent explosions, when

Mr. CRIPPS interposed with the question whether Witness was speaking from personal experience of those explosions, and thereby drew from Witness the admission that they were accounts of explosions which had been reported in the technical papers. The point was not proceeded with.

Examination continued: WITNESS certainly did not consider these transformer chambers were necessary in the streets for the proper and efficient working of an electric lighting system; on the contrary, he believed they would be much more convenient for the Company's servants if they were placed elsewhere. Judging from his own experience in one of the chambers, it was a very uncomfortable position—the chamber being 6ft. by 7½ft. high. That chamber was opposite the Finchley-road railway station. Witness then went into details how his descent was made. There was apparently no ventilation provided for, though the cover was perforated; there were no pipes or tubes. The fact of the manhole cover being perforated of course rendered the space liable to be flooded. Even ordinary rainwater would penetrate. There were "safes" provided to take the water, but these might get over full. Going to the question of high-tension leads in transformer chambers under the streets, Witness did not consider them a safe thing. The current might be taken up by a streak of water on the walls, and a person walking overhead would under certain unfortunate conditions receive a shock. At the first view one might say that those conditions were very impropable, but remembering the circumstances that have taken place it was not so. An insulating material was found burning, and a man who went to put it out with a bar of iron in his hand was killed. Besides that the accident in the City proved that by curious coincidences and the electricity running along the line of least resistance the animal was killed. Mr. Hopkins, at the suggestion of the Chairman, brought the Witness back to the Chambers, and in reply to examination, Witness said that a cellar with a lateral opening would be safer and more convenient for the Company's servants, and for everyone.

Cross-examined by Mr. Cripps the WITNESS said he had never been engaged in experiment making in a large way. He considered that there was a danger of electrolysis in an alternating system. Being pressed for his own experience, Witness said he had not made experiments for it himself, but he would refer to Dr. Hopkinson. Going to the question of subsidence or cracking, Witness said he had seen the plan showing the proposed strength of construction, notwithstanding which he thought it was possible that the chambers might be knocked about by the traffic. Witness would not suggest any method of further strengthening them. He had frequently seen such work damaged by street traffic. Referring to the Hampstead accident, Mr. Cripps drew from Witness the explanation that that case was an installation by the Local Authority, and that the transformer station was placed by that Local Authority under a public footway.

Mr. GUNYON was called, and, examined by Mr. Hopkins, said he was assistant engineer to the London County Council, and superintendent of the electric meter-testing department and electric work generally. In fact, he had charge of the duties of the Council under the Acts relating to electric lighting. He agreed with former witnesses in regard to the inadvisability of putting the transformer chambers under public thoroughfares, both from an engineering and a drainage point of view; also, they were an obstruction to traffic. Further, they were a source of danger, mainly on account of gas leakages. Witness did not think it could be expected to keep them water-tight. Witness referred to a leakage in Rosebery-avenue, notwithstanding the stability of the construction. That was not a bad leakage; but it was a persistent one. The structure there was in gault brickwork and lias lime.

Sir BENJAMIN BAKER, being examined by Mr. Bassett Hopkins, said there was greater and greater difficulty as years went by in occupying the subsoil with new things. In each session of Parliament opposition increased, and there was greater reluctance to cede any existing rights in subsoil. For this reason all recent applicants for underground railways had been driven lower down, below the sewers and other pipes; whereas if these had been kept up to the level of the proposed transformer chambers hundreds of thousands of pounds would not need to have been expended. During his 20 years' experience at the Parliamentary bar he had been cross-examined severely for the mere suggestion of making a temporary shaft in a public street. If Parliament would allow such interference as would be caused by these transformer chambers, then the problem of light railways for London would be solved, because they could be made cheaply. He thought that if Parliament had contemplated such interference with the subsoil as was asked in this case some reference would have been found in one clause of the Act. The right to build the transformer chambers was a large concession, and worth a lot of money.

Mr. CRISP'S cross examination was only very brief.

This closed the case for the London County Council.

Mr. EARLS, for the Wandsworth Local Board, said that to a large extent he could adopt the evidence given for the London County Council. His Local Board (which was the Local Authority for the district) had no objection to the introduction of the electric lighting; on the contrary, they were likely to become the largest customer in the district. But they believed that there were reasonable possibilities of danger from the transformer chambers being fixed in public streets. Mr. Earls, enlarging his argument, said that his Board were not only opposed to the chambers being made in main streets, but also in back streets, because, although situated in a back street, the chamber would be dangerous, and it would also be an obstruction when street improvements were carried out. But beyond these points, the scientific adviser of the Board objected to the particular form which it was suggested that these chambers should take.

In reply to the Chairman, Mr. EARLS said his Board did not feel called upon to offer any alternative suggestions.

Prof. HENRY ROBINSON was then called to give evidence in support of Mr. Earls' opening.

Mr. CRIPPS, cross-examining the Witness, thanked him for his strictures of the proposed construction, and drew from him that his experience had been limited to low tension.

The Court adjourned to Thursday, Dec. 20, at 10:30 o'clock a.m.

BOOKS RECEIVED.

"A Treatise on Industrial Photometry, with Special Application to Electric Lighting." By A. Palaz. Authorised translation from the French by G. W. and M. R. Patterson. (London: Sampson Low, Marston and Co.)

"Electro-Plater's Handbook. By G. E. Bonney. Second edition. Price 3s. (London: Whittaker and Co. 1894.)

"Theory of Electricity." By L. Cumming. Fourth edition. Price 8s. 6d. (London: Macmillan and Co. 1894.)

THE BOARD OF TRADE CONFERENCE ON LIGHT RAILWAYS.

The following is a continuation of the proceedings of the Board of Trade Conference, the opening of which we reported last week. Speakers whose remarks are prefaced by an asterisk have returned their proofs revised :—

Replying to Lord Cathcart, the PRESIDENT of the Board of Trade said his observations on the subject of state aid had reference to contributions from the Treasury.

Lord CATHCART asked would the Conference be at liberty to discuss the policy of the Government in recent years in reference to light railways in Ireland ?

The PRESIDENT of the Board of Trade thought it would be impossible to introduce that subject without touching upon a political element, upon which differences of feeling would be found to exist, and he, therefore, believed it was desirable that the question should be avoided as far as possible.

*Lord E. FITZMAURICE, speaking on behalf of the County Council Association, and being connected with a county which had suffered very severely from agricultural depression, welcomed the movement that had been set on foot for the establishment of light railways. An important question was what were to be the relations between the great existing railways, and those small companies which would be called into existence under this scheme ? If facilities were not afforded by the great companies for getting the traffic of the light railways on to the main lines—if difficulties were placed in the way of the weaker companies in the matter of transferring the produce from one line to the other—everyone knew that it would mean ruin to the light railways. That was a vital point ; and one of the first things the Board of Trade ought to do was by arrangement, or by legislation, or by an extension of the powers of the Railway Commissioners to afford security to those who embarked money in light railways that their investments would not be thrown away by the opposition of the great companies. The Irish Light Railway Acts were directed with a view of co-operation between the existing companies and the smaller lines, and where these conditions had been secured it was found that the light railways were achieving satisfactory results. He did not think the county councils would care to accept the responsibility of guaranteeing lines of this character.

Mr. HENRY HOBHOUSE, M.P., said agriculturists and ratepayers generally were anxious that greater facilities should be given for the conveyance of farm produce to the best markets. He thought power to acquire land compulsorily for railway purposes ought not to be attended with anything like the expensive procedure at present necessary. That was a matter which might be left to such a tribunal as the county councils, subject to the confirmation of the Board of Trade. The agricultural county councils, especially in large counties, would not be in a position to work light railways themselves, nor did he think they would be willing to guarantee these railways. They could not get a large county to levy a rate for such railways. It must be levied by the district that was benefited by the new line. But of vital importance to the practicability of these schemes was the simplification of the Board of Trade regulations in agricultural districts. He thought that when these lines were made the locality should be assured that no unreasonable rates would be charged for a certain number of years.

*Lord CATHCART, representing the Royal Agricultural Society, said the question of light railways was, from an agricultural point of view, a difficult one to deal with in a few words. In agriculture they must have horses, was it to be supposed that by the introduction of light railways the expense of horses would be lessened ? He did not think so. He questioned whether agriculture alone could pay for a light railway ; where they did exist they were, generally speaking, maintained by a considerable passenger and tourist traffic as well. As regards the Board requirements, he was in favour—consistently with public safety—of absolute freedom. He regarded compulsory powers as the rock they would split, so far as this scheme was concerned, unless there was a sufficient power of appeal. He was not speaking for the landlords alone, but for the tenant farmers, the clergymen, and the small holders : they could not have compulsory powers throughout the country, destroying everybody's comfort and satisfaction. They must have some sufficient court of appeal : as regards the suggestion that the procedure should be cheaper, he would only say that cheap law was not always the best law. With regard to getting facilities for connections with the great lines, he did not apprehend any difficulty. The Royal Agricultural Society of England viewed these proceedings with the greatest possible interest, and trusted that the Conference would be productive of good results.

Mr. HUMPHREYS-OWEN, M.P., said the first difficulty that beset the scheme was that of raising capital for these lines. The only solution he saw was to give power to the local authorities to guarantee. He was quite aware how difficult it would be to induce the county councils to give a guarantee for a particular district. The way would be to give power to a certain majority of owners of a district to adopt the Act, and to have the rate collected deducted from the tenant in the same way as the income and property tax was at present collected. It would be practically impossible to adopt the ordinary gauge without greatly increasing the cost, and, on the whole, he thought independent lines would be preferable. He advocated a relaxation of the Board of Trade regulations, and, as regards the compulsory acquisition of land, he thought landowners would be willing to submit that question to a local tribunal after a full public inquiry had been held. He considered that light railways could be made to pay if the conditions at present insisted upon by the Board of Trade were relaxed. In his district there was a railway ten miles in length independently worked and earning £7 per mile per week, but very nearly the whole of those earnings were swallowed up in working expenses—in fact, 90 per cent.

Mr. CHANNING, M.P., speaking on behalf of the Central Associated Chambers of Agriculture, regarded the present conference as the highest proof of the public spirit of the Board of Trade in endeavouring to deal with the complicated question of agricultural depression. Those light railways were of immense advantage to agriculturists, and he saw no reason why, if this scheme succeeded, there should not be short lines connecting almost every important farm with the main lines of the country. Speaking for the country ratepayers, he might say that no weighty or expensive system of guarantee which would be likely to involve large contributions would in the present condition of agriculture be absolutely undesirable. They must ascertain by commission what would be the actual money cost of working these railways, and lay it before the public before the line was started, and then they would have as near an approach to uniformity of system as could be obtained. He thought it would be a great disaster in agricultural districts if experimental companies and engineers were to be allowed to lay down railways with apparently favourable prospects which would afterwards ruin the county rates. In Belgium and other continental countries the lines depended upon the produce from small farms which was constantly flowing in. In England there were no small farms worth mentioning, and that was a matter that would have to be taken into consideration before anything was done that might lead to rash and reckless schemes.

*Mr. JEFFREYS, M.P., thought the country generally would object to spend the ratepayers' money on such a system of light railways. The money should come from private enterprise or from the Imperial Exchequer, as was done in Ireland. If the country districts could obtain these light railways at somebody else's expense it would be a great advantage.

Mr. STOREY, M.P., said the Parliamentary Committee who went into this matter last year were perfectly satisfied that light railways would be a very great advantage to many parts of the country. The question was how was the money to be got ? The President of the Board of Trade had told them that they must not expect it to come from the State, and gentlemen representing the county councils told them that they could not have it out of the rates. That showed the financial difficulty in the way of having light railways at all. If railways were shown to be beneficial to the country at large that would be a reason for asking the Government to do something for them ; and if railways were a source of benefit to particular districts or particular counties that would also be a reason why the county councils should aid them. The local authorities should have extended powers. They ought to have power to refuse consent to any projected light railway in their county unless it was, as the result of a public inquiry, deemed to be satisfactory. The county councils ought to have much fuller powers as regards the compulsory acquisition of land, and they ought to have power to pledge the rates in order to secure the creation of light railways.

The Duke of SUTHERLAND thought the big railway companies throughout the country ought to be encouraged by the Board of Trade to work these light lines. The people of the Highlands had shown great interest in these light railway schemes, and had proved their earnestness in the matter by subscribing for shares—even the poorest class of people investing their money with a view of developing the schemes that had been brought forward. They did not seek legislative powers, but subscribed what they could and worked the railways under the rules of the Board of Trade. In the Highlands the question of gauge was not one of difficulty. Different localities required different gauges, and all they required was to have railways of the cheapest description in their midst.

Mr. CLARE, Town Clerk of Liverpool, representing the Association of Municipal Corporations, advocated the cheapening of the cost of acquiring land compulsorily. To connect the country districts with the main systems of railways might perhaps assist the farmers to a small extent, but not to any substantial extent, because what killed the trade of the country, large in quantity and small in value, was the terminal charges. Any scheme to be satisfactory must be one which did not involve the taking of land to any great extent, the construction of stations and terminal charges. He advocated the extension of tramways into the country as likely to be of immense advantage to the agriculturists, as well as the food-consuming community in large towns.

Rev. FLEMING WILLIAMS, speaking for the London County Council, welcomed the proposed light railway schemes. A difficult question which the County Council had been endeavouring and not unsuccessfully to grapple with was how to rehouse the people whom they had to displace when any large improvement had to be effected. Increased railway facilities was one of the main objects which was to be attained.

Sir A. ROLLIT, M.P., said the London Chamber of Commerce was in favour of light railways with slow speed. He did not share the opinion of some of the speakers that the county authorities would hold aloof from this movement. To him the only possible difficulty to be overcome would be to obtain the co-operation of the State and the local authorities to stimulate private enterprise. He referred to America, where the railways ran through the streets ; there it had been found that the public very quickly learned to take care of themselves. There was, too, the case of Ostend, and of Huddersfield, where a line was worked by steam.

Mr. C. DODD, M.P. (Essex) said in his county they were prepared in those districts which wanted the lines to run their fair share of the risk occasioned by them. They thought the lines could be made better with the assistance of the existing railway companies.

Sir A. HICKMAN, M.P., thought the Board of Trade a more satisfactory tribunal than the county councils. The objection that the Board of Trade returns were not published might be obviated by publishing them. In regard to the question as to whether it would be necessary to have platforms made, in his district there were steam tramways, running through densely-populated districts, which were practically railway trains.

They stopped in all sorts of places to take up or put down passengers, and no platforms were necessary. He thought it would be best to leave the making of the lines to private enterprise.

Mr. BEACHCROFT, L.C.C., said the London County Council believed that a system of light railways going hand in hand with the existing suburban system would be the best. The cost was the difficulty; but he thought something in the nature of betterment might meet the demands of the case. They wanted to move in this matter by rapid strides.

Major RASCH, M.P. (South-east Essex), said what was wanted in his part of the country was not light railways, but steam trams, which were very much cheaper. If they used rails about 66 tons weight to the mile, it would certainly not cost more than £1,400 a mile. If the Treasury would guarantee 2 per cent. there would be very little difficulty in raising the capital. Supposing 8.000 miles of tramway were constructed in England, that would only mean a charge on the Treasury of £250,000 a year

Lord CLAUD HAMILTON (Great Eastern Railway) said he was authorised on behalf of the Railway Association to say that they viewed with favour the general principle of light railways by means of subsidiary lines. Beyond that they would not expect the railway companies to go at present, as they wished to have something presented to them in a more concrete and definite form before they pledged themselves. They would give every assistance in their power in any inquiry which should be held. Speaking as Chairman of the Great Eastern Railway, he would say they had a light railway and a tramway which partook partly of the character of a light railway, and they had gone to Parliament to acquire powers to make a goods tramway. The light railway was a 3-ft. gauge, and of course on their junctions with it all goods had to be transhipped. Roughly speaking, they allowed about 6d. a ton for transhipment. That railway was both for goods and passengers, and did not cover its debenture interest. The tramway, which was partly tram and partly light railway, ran for 6¼ miles through the very flat and favourable country of Cambridgeshire. It was on the ordinary gauge, and on 50lb. rails; there were no stations, and no signals beyond the stations at the junctions with their main line, and at the terminus of the line. The tram took up passengers at any point. Along the tramway were goods yards, and they found it was only necessary to keep one goods porter to each of those yards. There were no clerks, and the porter who received the goods sent forward the consignment note to Wisbech, the junction with the Great Eastern line, where all the necessary clerical work was done. He was glad to say the working and revenue of the line was not, on the whole, unfavourable. They had had, however, to submit to some requirements of the Board of Trade which they considered unnecessary. They were limited to a speed of eight miles an hour, and were at the same time compelled to furnish their carriages and engines with Westinghouse brakes. They were also compelled throughout the length of the line to put an inner guard inside the rails, which they thought was absolutely unnecessary, except on those portions of the line where it crossed the road. On the passenger traffic there was a decided financial loss; on goods a small profit. But when they took the profit derived from goods and coals passing on and off this line on to the Great Eastern Railway there was sufficient profit to justify further experiments. They had gone to Parliament for a short line on the condition that the farmers and landed proprietors should let them have the land they required at its agricultural value, which in the majority of cases was agreed to. There would be goods stations wherever the roads and farms converged, and a main line engine could be sent down on notification, and so avoid keeping a special engine ready. Under those conditions they believed a small profit could be made, while the line would prove a great benefit to the farmers and inhabitants.

*Mr. J. C. BOLTON (Chairman of the Caledonian Railway) said these railways would probably be worked at somewhat lower rates than those charged on the main lines, and, therefore, it would be necessary if they wished to obtain money for them that any bargain come to should be kept, and that directly they were made an attempt should not be made to reduce their power of earning. He was satisfied that if they had light railways at all they must have them of the standard gauge. He should think rails of something like 25lb. to the yard would be heavy enough for the purpose. The railway companies, so far as he was aware, looked with great sympathy upon this proposal, and would be desirous of lending any aid in their power to carry out the object in view, always remembering that they must act in the interests of their shareholders.

Lord CLAUD HAMILTON said the cost of the Wisbech Tramway, including crossing places and stations, was £7,290 per mile; but excluding these it was only £5,000 a mile.

After an adjournment of an hour,

The Duke of SUTHERLAND moved that the following gentlemen be appionted to form a committee to inquire into the question of light railways:—Sir M. Hicks-Beach, Sir B. Samuelsen, Sir A. Hickman, Mr. W. Jackson, Mr. Beachcroft, Lord Claud Hamilton, Lord Cathcart, Sir C. Boyle, Mr. Hopwood, Lord Thring, Mr. W. Meik, Mr. H. Hobhouse, Mr. Acworth, Mr. Storey, Mr. Humphreys-Owen, Sir B. Baker, Sir A. Rendel, Sir A. Clark, Mr. A. Siemens, Lord E. Fitzmaurice, Mr. Stephen Sellon, Mr. Channing, Sir A. Rollit, Mr. Carruthers Wain, Col. Makins, and himself.

The resolution was agreed to, and the Committee will meet at once, so as to be able to present their report before the end of January.

Mr. BRYCE said some weeks ago one of their inspecting officers was sent to the Continent to obtain facts and make a report. The report on Belgium had been distributed to them.*

Mr. JACKSON, M.P., spoke as to his experience of the light railways in Ireland, and said the conclusion he had come to was that wherever they could conveniently make arrangements for the light railway to be worked in connection with or by the adjoining railway, it would result both in economy and in the better development of the district. He believed he was justified in saying that there were many cases where if a line were constructed by an independent company it would mean an absolute loss to the promoters, whereas if constructed by an important railway company, even if a slight loss resulted, the capacity of the line to feed the trunk line would be compensation. In Ireland there were lines which the railway companies had undertaken to work for £4 per mile per week. The principle underlying Mr. Balfour's scheme had been if possible to avoid laying any charge upon the district. If they were going to have what was practically a goods tramway in a district, they would not want all the costly service which was necessary for the maintenance of the public safety in the case of trunk lines. In some districts where there was an ample water supply it might even be possible that they might have electric motors which would provide a very cheap means of conveyance. As much latitude as to type and style should be allowed as possible. He thought the gauges of the light and trunk railways should be the same so that trucks might be run from one on to the other, and he did not think the additional land which would be required for a line of 4ft. 8½in. gauge, instead of a 3ft. gauge, would make much difference to the cost. There were tramways in Ireland which were laid partly on the public roads, but there was very little saving by using the public road.

General SANKEY said he would be glad to lay any details as to the construction and working of the narrow gauge railways in Ireland before the Committee. The extension of this gauge had been greater in Ireland than in any other part of the British Isles. The railways varied very much. The country, of course, was extremely poor through which the lines passed. The Board of Trade had been good enough to relax some of their regulations.

*Sir E. H. CARBUTT (London Chamber of Commerce) thought the Board of Trade had not always endeavoured to help those who were finding money for private enterprises which would be an advantage to the public, and instanced the case of a previous President of the Board, who, he said, had thoroughly strangled electric lighting, and there was no doubt that that strangulation had done a great amount of harm. If the Board could make it cheaper for the railway companies to obtain their Acts they would find more people ready to subscribe for these enterprises. His Chamber thought some powers ought to be conferred on the Board of Trade in regard to the sanctioning of the acquisition of land for such enterprises as light railways. They had heard that some of the county councils objected to the spending of money for these lines; but all they asked was that the county councils should inquire into the matter, and that then the railway should be made by private or joint enterprise. He did not see any objection to using the public roads. In America he had travelled at the rate of 14 miles an hour in the streets. If tramways in this country were to be made to pay we should have to run them very much quicker than at the rate of eight miles an hour, and his Chamber thought they ought to be run at from 20 to 25 miles an hour in the fields, and from 10 to 12 miles an hour on the roads.

*Mr. GARCKE, speaking on behalf of the same body as the previous speaker, said the question of light railways was inseparably associated with the facility of Parliamentary procedure, the modifying of existing regulations and the obtaining of lands compulsorily. The latter, to his mind, was the most important point, and until it was settled it would be impossible to proceed with the development of light railways. With regard to the compulsory purchase of land, the precedent the Chamber of Commerce had had before them was the Local Government Act of last year, section 9 of which provided for the acquisition of lands compulsorily where the Parish Council failed to obtain the lands by arrangement for the purposes authorised. It was there provided that in the case of the Parish Council failing to obtain the land by agreement they could apply to the County Council who were, after due public inquiry, empowered to put into effect the Lands Clauses Act for the compulsory acquisition of the lands without further Parliamentary sanction. It seemed to him that the risk of promoting these lines would be very great and the expenses of obtaining capital very great, and it was of the utmost importance that if they were to be developed by private enterprise that special protection should be given to capitalists who found the necessary funds. This was a matter that he would press upon the Committee to consider in connection with the development of the scheme. There was no doubt very great advantages of an indirect character would result from light railways, but few of those advantages would confer benefit on the capitalists who developed the lines. It would be necessary, therefore, to give capitalists special inducements, and either the State or the municipalities must be prepared to assist by a contribution towards the cost of construction or by a guarantee of interest.

*Sir DOUGLAS FOX said the simplification of the obtaining of powers to construct light railways appeared to be the foundation of this subject. Of course he and his colleagues had the greatest respect for the present procedure; but it was undoubtedly expensive, especially as they were obliged to go before two tribunals. He thought where light railways were confined to a particular county the question might be dealt with by the county authority, subject to the approval of the Board of Trade; but in cases where more than one county was concerned it might be necessary to come to the central authority. The Committee about to sit ought not to lose sight of the question of speed that ought to be allowed. The Act of 1868 was rendered inoperative by its permitting a speed of 25 miles per hour, for which there were many regulations necessary, which would not be required if the speed was only 12 miles. That to his mind would be sufficient for all practical purposes. It had been suggested that these light railways might be laid along the public roads. This, no doubt, if practicable, would be of great advantage to agriculturists, because it would supply an outlet for their traffic at their very doors. In Italy many of the light railways were so constructed, but then the roads in Italy were wide and well suited for the purpose. He thought that in Essex and other flat counties such an experiment might be possible; but he did not consider that they could hope to any great extent to lay railways along the public roads in this country. He thought it was unsatisfactory to have gauges of different kinds scattered all over the country. But it would be impossible to construct railways of the ordinary gauge in this country that would pay the shareholders, because of the restrictions put upon them by the Board of Trade. He pointed out that a narrower gauge enabled a totally different and more economical system to be introduced. The great question was how the money was to be found. Unless constructed by the large companies, it would be many years before most of these feeders would return the money expended on them, while at the same time they would confer lasting benefit upon the districts through which they would pass. The only way to succeed in introducing this system was to put upon the local authorities the obligation to repay the shareholders for the benefit conferred upon the districts by these light railways. Under conditions such as he had suggested, whether worked by electricity or locomotive power, he believed there was a great future for light railways in this country.

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* This report will appear in our next issue.

*Mr. ARTHUR PAIN, who has had large experience in the construction of light railways, referred to the Southwell line, which had been worked on a 3ft. gauge with such satisfactory results that the Great Eastern were now making overtures to purchase it. His experience led him to the conclusion that unless the parliamentary costs and the cost of obtaining land, as well as the cost of working, were reduced, light railways could not be expected to pay.

*Mr. W. M. ACWORTH said that legislation on all the matters suggested that day would take up the time of Parliament for many years to come. The Chairman in his speech had suggested that they might get something next session, and he trusted that the efforts of the Committee would be directed to securing that end. What they did want was not to create 10,000 miles of light railways at once, but to make it possible in those cases where all the circumstances were favourable, to try the experiment of light railways immediately. As regards the question of procedure, if they had a Joint Committee of both Houses, which was more or less a permanent body, and if, further, the House fees were abolished or greatly reduced—and all this could be done by mere changes in Standing Orders—much would be gained immediately in economy both of money and time. Then let the Board of Trade, with the advice of the newly-appointed Committee, frame a new and much relaxed code of regulations for the construction and working of light railways—and he was glad to gather from the opening speech of the President that the Department was favourably disposed to this idea—and we should see forthwith some light railways, at least, come into existence—enough, probably, to give us practical experience to go upon in further developments of the subject.

Mr. CORBETT, representing the Associated Chambers of Commerce, recommended short lines for local purposes, and said it ought to be made possible to secure such lines without the necessity of application to Parliament. The present regulations were quite appropriate to the existing railways, but would require to be modified considerably in relation to light railways.

After a few remarks from Mr. CARRUTHERS WAIN, Mr. YEANS, and Mr. SQUAREY,

The PRESIDENT of the Board of Trade declared the conference closed. He recognised with great satisfaction that the tone of the subject was generally sympathetic towards the project, and in many cases hopeful, and particularly he was glad to learn that the existing railway companies looked upon the movement with sympathy. He suggested that the Committee when it had concluded its labours should forward their report to them, and he would then take an early opportunity of calling them together again, when it would be open to them to pass such resolutions as might be a guide to him in the direction of securing legislation.

A vote of thanks to the President of the Board of Trade terminated the proceedings.

CORRESPONDENCE.

THE COUNCIL OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Twelve months ago you opened your columns to the grievances of certain sections of the electrical world against the Council of the Institution of Electrical Engineers, and even supported our claim for the inclusion of representatives of the cable, telephone and railway engineering professions on the Council. Not many persons, however, know the sequel of that agitation, and I propose to throw some light on its subsequent course.

A small committee was formed, consisting of Messrs. Ansell and Crowe for the cables, Messrs. Leonard and Houghton for the railway telegraphs, and Messrs. Calder and Fletcher for the telephones. I was made secretary, and after sundry meetings and communings, the Council granted us an interview. As we fully anticipated, they frankly admitted the justice of our complaints and the reasonableness of our claims, and promised at the next opportunity to redress the "balance of power" by including representatives of each section, asking us at the same time to suggest, for the information of the Council, the names of those gentlemen whom we should like to see nominated. Mr. Preece, indeed, demurred to the telephone claims, seeing that he himself was a telephone representative and naturally had their interests in his care; but, with this exception, nothing could have been more complete than the courteous agreement of the Council to our wishes in this respect. They would not listen, however, to our plea for a fixed proportion of representatives for each branch of the profession, holding that such a claim in its essence showed a distrust of the Council. When I pointed out that the Council of 1889 (when this same agitation was first begun) had equally agreed to our claims, and pledged themselves to carry them out; but that three years afterwards they had managed to undo all that had been done, and oust the whole of our representatives who had not attained the safe security of vice-presidents, the Council repudiated with indignation the possibility of such a thing again happening. It was in vain that we pointed out that however well disposed the present Council might be to us they could not pledge their successors to any course of action, and we had to retreat with the substantial conviction that for the present, at any rate, we were safe and might depart in peace.

Nothing more was heard of the matter until a few weeks ago when the Secretary wrote reminding us of our promise to submit the names of those gentlemen who would be prepared to represent their respective branches of the profession. Whereupon we had further colloguings, and finally submitted the names of two gentlemen to represent the cable and telephone companies, the railway engineers being content to accept anyone whom the Council might select, all they cared about being the inclusion of some one of their number.

Judge of our surprise and the indignation of the telephone members when the voting papers appeared without the promised telephone representative, but with the name of one of our deputation, Mr. Augustus Calder, in the associates' list. It is difficult to understand how a body of gentlemen of exceptional intelligence could fail to see that this action of theirs was a double-barrelled shot at the telephone companies. To say nothing about the good faith of the Council, which should surely have been their first concern, that must have seen that the offer of an associateship was first of all an unmerited slur, and next that they placed Mr. Calder in an awkward position from which there was no escape, except by refusal to serve. This course Mr. Calder, of course, promptly took, for I need hardly say that his name was inserted without his knowledge or consent. No one with any *savoir faire* should have failed to foresee that the Council's action would lead to the complete exclusion once more of the telephone interests.

The moral of this tragic tale lies in the application of it. So far from the Council being able to pledge their successors to a course of action which they admit is right and reasonable, they cannot even keep the warring elements in check sufficiently to redeem their own honour. And it is our chief contention that the constitution of the very rules makes it inevitable that the "predominant partners" must become more and more predominant, to the exclusion in the end of every other interest. The majority of the Council consisting of electric light men and professors, with no interest in other sections and great interest in the election of their friends, they forthwith proceed to elect more of their own genus. So long as human nature is what it is, and so long as the constitution of the Institute remains unaltered the Council must be swayed by cliques and coteries, and the weakest will go to the wall.

It is indeed possible to carry a member by a *coup de main* over the heads of the Council, as was nearly the case last year, when a telephone representative only failed to win by three votes. This year, although totally unprepared for the action of the Council, the telephone members have received so much sympathy and offers of assistance that they could with certainty have carried the same gentleman had he not refused to allow his name to be put forward. The victory, however, would in any case be a barren one; and, except for the purpose of showing the Council the strength of the opposition to their methods of election, it is hardly worth the trouble. What is wanted is a radical change in the constitution of the Society, which shall break up the close corporation it has now become and give each section a fair share of representation. The matter is of interest to all telegraph and cable men, because the fate of the Telephone Company this year will certainly be that of the others shortly, and the whole thing will have to be done over again.—Yours, &c., J. T. CROWE.

Winchester House, E.C., December 11, 1894.

THE UNIVERSITY OF LONDON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The writer of your paragraph on p. 157, concerning the Gresham University for London is under a strange misapprehension. The scheme of the Royal Commissioners, so far from having collapsed, has never been nearer fruition than now. It has received a more or less cordial approval from all the score of bodies concerned, save three; and of these, one only, namely, King's College, has been hostile. Only to-day it is announced that in January the Prime Minister will receive a deputation from a most influential group of colleges and medical schools, and from the Royal Colleges of Physicians and Surgeons, in support of the Gresham University scheme. Further, there is nothing in the regulations of the proposed university incompatible with any number of religious or irreligious tests on the part of King's College, or any other college that chooses to hold aloof. There was, indeed, a long and warm discussion at King's College as to whether the tests should be abandoned; but this discussion—in which nine-tenths of the College staff, it is said, supported the abolition of the tests—related to the renewal of a certain annual Government grant to colleges, and had nothing to do with the proposed scheme for the reconstruction of the University of London. It is true that some of the King's College partisans have tried to mix up these two entirely distinct matters. But then, what can one expect of a college that cannot appoint a bottle-washer in its chemical laboratory without requiring from him a declaration that he is a regular communicant of the Anglican Church?—Yours, &c.,

SILVANUS P. THOMPSON.

THE BREAKDOWN AT MADRID.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We notice in your issue of the 7th inst., a letter signed P. A. Latham, concerning the Madrid electric light installations.

As we think this letter may convey an erroneous impression, and lead to the assumption that the recent disturbances were attributable to the quality of the material used in the installation of the Madrileña Central Station, whereas, as far as we know, they were due to other causes. We have asked Mr. L. Kribben, the Director of the Madrileña Company, to write you a letter on the subject, and would esteem it a favour if you would have this letter inserted in your next issue.—Yours, &c.,

pr. pa. FELTEN AND GUILLEAUME.

Mülheim on the Rhine, December 10, 1894. C. Stevens.

LEGAL INTELLIGENCE.

Limited Liability!

In the Liverpool County Court, on Monday, before Judge Collier, an interpleader action was heard, in which Messrs. Lewis and Sons, tube makers, Wolverhampton, were the execution creditors, Messrs. A. Hall and Co. the defendants, and the Hall Electrical Company (Limited) the claimants. Mr. Tobin, for the claimants, stated that Mr. L. J. Barnacle had been carrying on business at South John-street as an electrical engineer, under the style of A. Hall and Co., and in October last he required more capital; and it was also a fact that one creditor might have swooped down upon all his assets. A limited liability company was formed, and 1,400 £1 shares were transferred to Mr. Barnacle for the business. An execution was afterwards put in, and the question now at issue was whether the Limited Company had become the owners of the goods supplied by the plaintiffs or not. He contended that, under two agreements which were signed, they were the owners. Mr. Barnacle said he bought the business in December, 1892, and paid £90 odd for it. Mr. H. H. Hall became his manager, but was not a partner. He thought £1,400 was a very fair price for his business, as he was to pay debts amounting to about £200. He valued the goodwill at £600, and the machinery, stock-in-trade, trade fixtures, and furniture at £600. The stock-in-trade, &c., had actually realised only £53 gross. The landlord had claimed the furniture, though he did not know why. The Company was not formed for the express purpose of preventing executions being levied. Most of the signatories to the Articles of Association were their workmen. He could not say that their shares were presented to them. He and Mr. Hall were to have £208 a year, and practically they could not be discharged unless they quarrelled with Mr. Keyser, their co-Director. During the hearing, it was intimated that a bankruptcy petition against the Company was being heard in another room, and the judge said it would be no use going on if the petition were successful.—Mr. Keyser was put in the box, but at this stage Mr. Registrar Bellringer announced that a receiving order had been granted against the Company.—Mr. Tobin withdrew his claim.—Mr. Wall, on Messrs. Lewis's behalf, asked that the agreements and letters in the case should be impounded.—His Honour said he would ask the Registrar to take care of the documents. He did not like to say much, but the circumstances were, at least, peculiar.

In reference to the above, the following letter has appeared:—

TO THE EDITOR OF THE LIVERPOOL DAILY POST.

SIR,—Your report of the above interpleader action states that a bankruptcy order was made (or pending) against the plaintiff company. As this most damaging statement has no foundation in fact, we must ask you to contradict same, and to give your contradiction equal publicity with the original statement. We should like to add that, so far from being bankrupt, or in difficulties, the Hall Electrical Company have never been defendants in any action whatever, and we are further able to state that their business is at present in a most flourishing condition.—Yours, &c.,

THE HALL ELECTRICAL COMPANY (LIMITED).

Liverpool, December 11, 1894. H. H. Hall, Managing Director.

Hilton v. Queen Anne's Mansions Lighting and Heating Company (Limited).

This was a motion before Mr. Justice Kekewich for judgment in a debenture holder's action, in which there were no pleadings, presented by Mr. Carson, who said the defendants appeared and consented. Mr. Aston Cross (interposing *ex parte*) said he appeared for a large debenture-holder and a Director of the Company, and he asked that he should be added to the defendants, and that the case should stand over on the ground that no notice had been given of these proceedings, either to the Board of Directors or any officer of the Company, and judgment had been obtained by collusion.

Mr. CARSON said this was the first he had heard of any such objection as likely to be raised, and Mr. Spencer said the Company now appeared in the case through him.

His LORDSHIP said, in the face of Mr. Cross's objection, the case must clearly stand over to give an opportunity of applying, if Mr. Cross chooses to do so, that his client might be added to the case, which would come on for hearing to-morrow (Saturday).

Gordon v. The Scottish House-to-House Electricity Company (Limited).

This case was heard on Friday before Mr. Justice Lawrance, without a jury, in the Queen's Bench Division of the High Court of Justice, London. The plaintiffs claimed a sum of £5,000 under an agreement with the defendants dated October 4, 1892. The defendants admitted the contract, but raised a number of defences.

The plaintiffs, Messrs. J. E. H. Gordon, were electrical engineers in London, and they entered into an arrangement with the defendants, who had a contract to light the town of Coatbridge, to do the work. The plaintiffs performed some part of their contract, but the defendants did not, and hence the plaintiffs claimed £5,000, which they alleged to be forfeited by breach of contract. Counsel having formally proved the plaintiffs' case in detail,

Mr. CRUMP, Q.C., for the defence, said the facts were as follows:—There was a Provisional Order granted for lighting Coatbridge with electricity, and several gentlemen formed themselves into a syndicate for the purpose of raising the necessary funds to float and finance a company and carry out the contract to light Coatbridge. The defendant company was then in a state of suspended animation, and it was desired to resuscitate it and put the shares on the market. Accordingly an agreement was entered into to undertake a number of shares, and in this manner the syndicate was brought into communication with the present plaintiffs. Messrs. Gordon and Co. agreed to find one-third of the capital if the syndicate could find the other two-thirds. This the plaintiffs did not do, and consequently the £5,000 was not supplied. No work had ever been done by the plaintiffs, and, as a fact, the Brush Electrical Engineering Company had carried out the whole of the contract since, as in January, 1893, the plaintiffs went into liquidation. The whole arrangement was subject to underwriting by certain persons, and, as they failed to do so, he submitted the plaintiffs were not entitled to recover.

Mr. Justice LAWRANCE held that the defendants were not liable to pay the £5,000; and he accordingly entered judgment for them with costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

Tenders Invited.—The Corporation of Hanley require tenders for the supply and erection of electric lighting plant under contracts Nos. 10 and 11, particulars of which are given in our advertisement columns. Tenders have to be sent in to Mr. Arthur Challinor, town clerk, not later than January 5th next.

——— The Corporation of the City of Melbourne invite tenders for the supply, delivery, and erection of alternating current dynamos, exciters, switchboard, transformers, instruments, &c. Specifications and conditions of contract may be seen at the offices of *The Electrician*, and tenders have to reach Mr. John Clayton, Town Clerk, Town Hall, Melbourne (Australia), not later than 11 a.m. on Tuesday, January 22nd next.

——— The Edmonton Local Board invite tenders for the supply, delivery, and fixing of a system of electric call bells and telephones for fire brigade and local board purposes. Tenders have to be sent in to Mr. W. T. Payne, Town Hall, Edmonton, by 12 o'clock Friday, the 21st inst.

——— The Corporation of Portsmouth invite tenders for the purchase of a quantity of electrical plant, now to be seen at the Town Hall. The plant has only been used for about four years, and is being sold in consequence of the Town Hall premises being connected up with the Corporation's electric supply station. All particulars can be obtained of Mr. Alexander Hellard, the town clerk, Town Hall, Portsmouth; and tenders have to be in not later than 6 p.m. of the 22nd inst. Some particulars will be found in our advertisement columns.

——— The Committee of the Birmingham Municipal Technical School invite tenders for the installation of the generating plant, fittings, and appliances for both electric lighting and transmission of power by electricity in their new school. Messrs. Lea and Thornbery, 38, Bennet's-hill, Birmingham, are the consulting engineers, from whom plans and specifications may be obtained. Some further particulars are given in our advertisement columns, and tenders must be sent in to Mr. George Mellor, secretary, at the offices of the school, Paradise-row, Birmingham, by January 12th.

Tenders Accepted.—The tender of Messrs. S. Z. de Ferranti (Limited) has been accepted by the Blackburn Town Council for the supply of electric meters.

——— The Joint Electric Light Works and House Committee of the Hampstead Vestry have accepted the tender of Mr. F. H. Taylor, of Ironmonger-lane, London, E.C., for electric lighting work at the stone yard for the sum of £68. 12s. 3d.

Sale by Auction.—*Wednesday next.*—The date of the sale by auction by Messrs. Wheatley Kirk, Price and Goulty at the Deptford Central Lighting Station, Stowage Wharf, Deptford, S.E., of a quantity of surplus plant and stock, for the London Electric Supply Corporation (Limited), is fixed for December 19th, at 10 for 11 o'clock. The lots include a large variety of plant and material, particulars of which will be found in our advertisement columns.

Vacant Appointments.—The Corporation of the Borough of Blackburn require a properly-qualified mechanical and electrical engineer to take charge of the electricity works, at a salary of £200 per annum. Applications have to be in by to-morrow (Saturday).

——— The Corporation of Worcester are about to appoint an electrical engineer to take entire charge of the electric lighting installation at Powick and in Worcester city, to be directly responsible to the Corporation. The salary is £250 per annum. Particulars can be obtained of Mr. Samuel Southall, Town Clerk, The Guildhall, Worcester, and applications have to be sent in not later than 12 (noon), of the 20th inst.

Liquidation.—A meeting of creditors of Thomas Woodall and James Woodall, trading as Woodall and Son, glass manufacturers, Birmingham, is to be held to-day (Friday) at the Grand Hotel, Birmingham, at three o'clock, to consider an offer made by Mr. George Woodall to purchase the whole of the estate for a sum equal to 10s. in the £ for all creditors, payable by equal instalments at £3. 6s. 9d., and 12 months from the date of the acceptance of the offer.

Bankruptcy.—The liabilities of William Hopkin Akester, electrician, 897, Fulham-road, S.W., recently adjudicated bankrupt, have been returned at £150. 4s. 7d., and the assets at £3.

New Branch.—Messrs. C. H. Cathcart and Co., whose chief offices are at 1, Dorset-buildings, Salisbury-square, Fleet-street, E.C., have opened a new branch at 62, Vauxhall Bridge-road, S.W.

New London Offices.—Messrs. Weyman and Hitchcock, makers of the "Trusty" engines, have opened London offices at 11, Queen Victoria-street, E.C. The firm have prepared a new catalogue, which can be obtained on application.

Electric Bells and Accessories.—Messrs. Croggon and Co. (Limited), of Upper Thames-street, E.C., have now ready a catalogue and price list of electric bells, pushes, indicators, telephones, batteries, &c. The list is very fully illustrated, and contains particulars and prices of a large number of electrical sundries, many of which are manufactured by the firm.

The Electric Construction Company's Traction Systems.—A book of illustrations and brief particulars of the systems of electric traction which have been carried out by the Electric Construction Company has been issued. Besides reproductions of photographs and sketches of their own systems, the illustrations include examples of rival methods, for the purpose of showing their defects. One of these is a photograph of a car and trolley line in an English town; another shows the complication which it is suggested would have ensued at Walsall had the American system of overhead work been adopted. If this style of catalogue becomes popular, we shall expect to see photographs of the death-struggles of grey mares in the price lists of low-pressure firms.

Exports of Telegraph Wire and Apparatus.—November was another active month in the export trade of this country in telegraph wire and apparatus connected therewith, the value of the exports during the month having amounted to £49,438, as compared with only £19,520 in the corresponding month of last year, and £39,993 in November, 1892. The improvement in this industry is more noticeable in connection with the figures relating to the exports during the eleven months of the year ended with November. During that period, we find the value of the exports to have amounted to £1,376,294, as compared with only £1,031,825 in the corresponding period of last year, and against £871,631 in the first eleven months of 1892.

Stanley and National Cycle Shows.—The recent cycle exhibitions, though containing but little of direct electrical interest, offered much that was attractive to engineers. Messrs. Churchill and Co.'s stand at the Agricultural Hall displayed several American machine tools of novel design, and specimens of a miniature oil engine were shown in action. The latest improvements in cycle construction were to be seen, and among them a number of ingenious single and double-speed gears. At least four exhibitors claimed that their gears would give out more power on the driving wheel than was put in by the pedal, and, judging by the mechanical nonsense which most cyclists talk when they begin to discuss mechanical theories, these statements were readily swallowed. The large business done in ready-made ball bearings is worthy of notice by electrical engineers, who could doubtless apply them with advantage in connection with the applications of small motors. The rival show at the Crystal Palace was extensive but monotonous. The object of this show is said to be the encouragement of a fixity of type for the benefit of the trade, and in this object some degree of success has been attained. Among the mechanical novelties, Prof. Everett's spring wheel was remarkable, if only for the lucidity and accurate language of the descriptive circulars. Among the many exhibitors who were to be found at both shows were Messrs. S. Smith and Sons, of the Strand, London, who offered a variety of non-magnetisable stop-watches and chronographs. A chronograph which should be very useful for laboratory work was shown by the English Watch Company, of Birmingham. It has a 2in. face; the movement, as well as the dial, is divided into tenths of seconds. A neat sand-blast plant was shown by Messrs. Leadbeater and Scott, agents for Messrs. Tilghmann and Company, and some attractive specimens of sand-fettled castings were on view. Fine and rather weak screw threads are commonly employed in cycle construction, but it is rather strange that in a trade in which such millions of wire spokes and nipples are made, the B.A. thread should be utterly unknown. The ignorance of several tool makers and cycle manufacturers on this subject was veiled by some rather amusing replies to our inquisitiveness on this subject. The only electrical exhibit that we could discover was at the stand of the Crypto Works. Here a cycle was provided with a stand and a fly-wheel, and drove a small dynamo. The maker hoped that by means of one hour's work he could charge an accumulator and produce a useful electric light for two hours. He readily furnished us with the following explicit information, from which any of our readers will, of course, be able to check his results. To light eight 2½-c.p. lamps with a dynamo running at 4,000 revolutions demands an expenditure of work equivalent to riding at a speed of 15 miles an hour "up a slight hill"; and it is to be observed that "one would not care to keep it up for more than half an hour at a time." A neat "Collier" two-speed gear was shown at this stand. The exhibit of machine tools by Messrs. Alfred Herbert (Limited) of Coventry, was perhaps the most interesting feature of the show. The construction of high-class automatic machinery is by no means a speciality of America, and one could only regret that the automatic hollow spindle capstan lathes, with chasing and cutting-off gear, were not shown at work. Lathes with ball thrust bearings and multiple automatic drills were also worthy of examination by anyone interested in modern mechanical engineering.

Smithfield Club Show.—This important annual exhibition of cattle, sheep, and implements used in agricultural work has been held during the week at the Agricultural Hall, London, N. Great interest was taken in the fine display of steam, gas, and oil engines by the leading makers, and especially noticeable was the advance made since the last show in oil engines. Magnificent displays were made by Messrs. John Fowler and Co., of Leeds, Messrs. Marshall, Sons and Co., Gainsborough; Messrs. Ransomes, Sims and Jefferies, Ipswich; Messrs. Robey and Co., Lincoln; Messrs. Crossley Bros. & Co. Openshaw; Messrs. Clayton and Shuttleworth, Lincoln; Messrs. R. Hornsby and Sons, Grantham; Mr. E. S. Hindley, of 11, Queen Victoria-street, E.C., and Bourton, Dorset; Messrs. Priestman Brothers, Hull; Messrs. Ruston, Proctor and Co., Lincoln; and Messrs. Weyman and Hitchcock, of Cheltenham. Included in Messrs. Robey's exhibit was a compound engine and locomotive boiler, fitted with patent automatic governor and link expansion gear, specially suitable for electric lighting purposes. It is claimed for the boiler that it is extremely economical, that the working parts are perfectly balanced, ensuring safety at high speed, and that the wearing surfaces are of ample size and run cool with heavy loads. A portable engine of great strength and extreme simplicity of design was also on view, and the exhibit included a horizontal fixed oil engine, built on principles insuring absolute safety from fire or accidental explosion. The engine is fitted with an improved starting lamp and fan, and the governor controls the engine with efficiency and regularity, rendering it suitable for electric lighting work. It is claimed that all ordinary lamp oils can be used at a cost of about one half-penny per brake horse-power per hour. The exhibits of Messrs. Marshall, Sons and Co., Messrs. Ransomes, Sims and Jefferies, and Messrs. John Fowler and Co. include fine examples of traction, horizontal, portable, vertical and fixed engines, and at Mr. E. S. Hindley's stall was shown a variety of horizontal and vertical engines, for which the firm is so well known. At Messrs. Clayton and Shuttleworth's stand a 6½ B.H.P. oil engine of the "Trusty" type was on view. This engine differs somewhat from the "Trusty" oil engine shown at Messrs. Weyman and Hitchcock's stand, the former firm being the owners of several patents which they have applied to their make of engine. We understand that an arrangement has been come to by the two makers by which the patents owned by both can be applied to either firm's engines. In addition, Messrs. Clayton and Shuttleworth had on view an example of their long-stroke fixed engine, which is specially adapted for electric lighting work, or where an unvarying speed is essential. Messrs. Crossley Brothers and Co.'s fine exhibit was a centre of attraction, the latest types of their well-known engine being on view. Messrs. W. H. Willcox and Co. had, as usual, an excellent display of engineers' stores and sundries. The main hall was, we were glad to find, lighted electrically, but very little else of an electrical nature was to be seen. Mr. Evans, the agent for the "Davy" arc lamp, was exhibiting; but otherwise electrical exhibits were, as usual, conspicuous by their absence. It is an unwise policy on the part of makers of electrical plant and apparatus to avoid this exhibition, as it is the centre of a very large gathering of folks who visit London but once a year, on the occasion of Smithfield Show, and it is noticeable that the greatest interest is taken in what may be termed the "side shows," where crowds of interested onlookers are to be found wherever anything of general interest is to be seen.

The New Electrical Works at Wolverhampton.—Last Monday the Mayoress of Wolverhampton (Mrs. C. T. Mander) formally opened the new and extensive electrical works of Thomas Parker (Limited), just completed on the Wednesfield-road. The buildings are very complete, and will enable the firm to undertake work of almost any magnitude. The buildings consist of an erecting, fitting, and machine shop, a pattern shop, and a foundry. The machinery throughout is of the most modern description. Mr. A. P. Brevitt is the architect, and the building work was entrusted to Mr. H. Lovatt, and Messrs. Heenan and Froude, of Manchester, were the contractors for the ironwork, and the other portions of the works were supplied by Messrs. McTear and Co., of Belfast. The Mayor of Wolverhampton, who is Chairman of the Company, said he hoped and believed the works would prove a great success. They had an able staff, and a more than able Managing Director in Mr. Thomas Parker, whose name in the electrical world was a household word. He could assure all interested that the concern was honest from start to finish. There had been no promotion money, and the Company's capital had not been watered in any way. Mr. Parker, in a brief sketch of the history of the Company, remarked that the site of the works was a field in July last. The idea of starting the works was fixed upon by the gentlemen who formed his staff, and who, about nine years ago, came to Wolverhampton as his pupils at the works of Elwell-Parker (Limited). They had grown with, and had taken a large part in carrying out, the works that had made the name of Elwell-Parker known throughout the world. They now gave Thomas Parker (Limited) their services and experience, and had each subscribed largely to its capital. The firm could now take in hand the largest work that was likely to be required, and intended doing the highest class at the lowest cost. There were plenty of orders in hand, and he had personally positive faith in the greatness of the future of electrical engineering where the object was sound legitimate business. The proceedings passed off most successfully.

American Agency.—Mr. E. G. Willyoung, who has just returned to Philadelphia after a two months' visit to England, has made arrangements to represent Messrs. Nalder Brothers and Co., of London, and Mr. James White, of Glasgow. Mr. Willyoung was for some years with Messrs. Queen and Co , of Philadelphia. Mr. Willyoung is to be associated with Mr. C. W. Pike, and the new firm have taken offices at 1,210 Betz-buildings, Philadelphia.

Hazell's Annual.—The 1895 edition of this very useful annual is now published by Messrs. Hazell, Watson and Viney (Limited), and can be obtained of all booksellers. The published price of the book is 3s. 6d., which brings it within the reach of all who require a mass of useful data for ready reference. The work is ably edited by W. Palmer, B.A., and is revised to November 26, 1894. New articles are included in the present edition on engineering, electricity in 1894, inventions, mining, railways, books of the year, employers' liability, municipal corporations, &c.

Reference Books.—The proprietors of the *Indian Engineer* have just issued the "Indian Engineer's Diary and Reference Book for 1895," in which the most important of the tables and formula previously given have been retained. In addition, a useful treatise is provided on "India as a Field for Industrial Enterprise." The diary is presented free to subscribers to the *Indian Engineer*, and can be obtained from the London office, 1, Victoria-mansions, S.W.

Accrington.—At the last meeting of the Town Council, Mr. Riley asked if it was intended to do anything with respect to the electric light this year. It was now over a year since a site was purchased for a central station, and he had been expecting to see a meeting called for the purpose of going on with the work. The Mayor said, in reply, that he would call a meeting of the Legal and Parliamentary Committee. Mr. E. Higham said the last time the matter was brought up, the Council decided against the light being introduced, and he did not think the Committee would be prepared to move unless they were requested by the Council.

Airdrie and Coatbridge.—On Thursday, at the meeting of the Airdrie Town Council, a committee was appointed to act with a similar committee at Coatbridge, to consider the formation of a joint trust for the purpose of laying down a line of tramways from Drumpellier (Coatbridge west) to Clarkston (Airdrie east), the line to be worked in the interest of the two burghs. The line will be about 4½ miles in length, and whether the motive power shall be electricity or cable is to be dealt with by the committee, who will shortly be applying for the necessary powers.

Awards.—The Halifax and Bermudas Cable Company (Limited) have obtained the highest award (a silver medal) for an exhibit of electrical instruments at the Provincial Exhibition, held at Halifax, Nova Scotia. The Exhibition Commission has conveyed to the Company's superintendent its thanks for the valuable exhibit, which proved of the greatest interest to visitors to the Exhibition.

Apprentices and Overtime.—An important action was heard in the Queen's Bench Division on Tuesday, before Justices Wills and Wright, on the subject of the working of overtime by apprentices. It was an appeal by Messrs. Priestman Brothers, of Hull, against a decision of the stipendiary magistrate, who had held that the apprentice's indenture was void on the ground that it contained a clause providing for unlimited overtime. It appeared that the defendant (Starbuck) was called upon to work, after he had attained the age of 18 years, for several hours' overtime, and had refused. Police-court proceedings were taken by Messrs Priestman Brothers, and the magistrate had decided that the apprentice was justified in his refusal, and that, owing to the unlimited nature of the clause, his indentures were void. The question of the amount paid for the overtime was incidentally raised, but this does not appear to have affected the decision of the judges. Having heard the appellants, Mr. Justice Wills stopped the further hearing of the case, and gave judgment as follows:—

> "The effect of the contract, which was entered into by the respondent when he was quite a lad, was that it was to the interest of the masters during the latter period of his apprenticeship to screw as much overtime out of him as they could. He did not think that was a reasonable contract. The interest of the employers was very strong, because they paid the respondent for overtime as nearly as possible at the rate of one-sixth of what they paid a man out of his apprenticeship, and who probably did not do the work much better than the respondent. That was a state of things which made it eminently desirable for the employers to insist upon overtime being worked. The existence of such a power was a strong temptation to the employers to use it more or less for their own benefit. He did not say that the appellants had done so; but taking the average of human nature, which was a thing he must look at in construing a deed of this kind, the existence of such a power might lead to an

attempt, at all events, at oppression and an unfair use of it. He confessed he disliked very much the absence from such a clause of any provision for limiting the amount of overtime to be worked by an apprentice, because so vague a stipulation was one which was certain to lead to conflict and misunderstanding, and possibly to litigation. It was a stipulation which a lad ought not to be called upon to agree to. He was not one of those who loved to interfere with freedom of contract, nor was he disposed to take an exaggerated view of the protection which ought to be cast by legislation around people who could take care of themselves, nor was he disposed to take generally a strong view on the infant's side of questions of this kind. He thought very often that objections raised to deeds of this kind were great nonsense. Therefore, while he did not approach the subject from the side unfavourable to the employers, he thought that the contract went beyond what was fair to the apprentice. The appeal would be dismissed, with costs."

Mr. Justice Wright concurred in this judgment, but leave was granted for an appeal ; and it is to be hoped that upon this most important subject an emphatic judicial decision will be forthcoming. The Factory Acts already clearly provide for overtime up to an apprentice's eighteenth year, and there is usually in the indenture a clause providing for overtime and the scale of payment therefor. In the absence of a model form of indenture, as such a judicial decision as the above would seem to necessitate, it is difficult to see how employers can protect themselves against the wilful disobedience of apprentices. The opinion of the learned judges was so unanimous that there must have been some reading of the indenture by the employers other than that which was shown in the evidence. A final judgment in this matter is one of the greatest importance, and affects a large section of the trading community.

Ayr.—The borings at the site for the electric lighting station have proved the excellence of the selection, as at the usual expense for excavation the Council will arrange for the foundations to rest upon solid rock. The Town Council offered the Harbour Trustees to supply current at 4d. per unit for lighting the harbour lamps, the latter to be provided by the trustees.

Barrow.—It is stated that a committee of prominent tradesmen has been formed for the purpose of urging upon the Corporation the necessity for at once proceeding to introduce the electric light into the town.

Bedford.—The Corporation electricity supply works were formally opened by the Mayoress of Bedford on the 6th inst., and the works have since that date been in constant operation day and night, supplying current for light and other purposes. The following particulars of the work done at Bedford will be of interest. There are two transformer stations at present erected, both underground, brick-built and arched, and with concrete floors. The pipes both of the high and low-tension cables are of cast iron, lead-jointed. All the boxes, both high and low-tension, have india-rubber rings between pipes and boxes, and also between the boxes and the lids. The feeders are for the most part in 6in. pipes, the low-tension cables are in 6in. pipes in the principal streets of the town, and 4in. pipes are used elsewhere. A practical test of the quality of the joints of boxes and pipes was provided by a flood a few weeks since, which put one or two of the streets under water for a depth of about a foot, without leakage being discerned. All the cables, both high and low-tension, are insulated with vulcanised rubber, double braided and taped. The high-tension cables are of 5,000 meg. quality, tested to 5,000 volts ; the low-tension cables are of 1,500 meg. quality. These latter are installed on the three-wire system, the secondaries of each transformer being arranged accordingly. At present the three cables are, throughout the town, of the same size, viz., 19/12. The low-tension boxes are 25 yards apart on an average, and are all large enough to facilitate the drawing-in of further cable, and also arranged to act as service boxes, the service pipes being of 2in. wrought iron screwed into these boxes. In each sub-station a 30-unit transformer is at present installed, and in one a 5-unit transformer for the day load. To this second sub-station there are three feeder cables, two of which are 19/17's and the third 7/18's, the latter being used for the supply of the 5-unit transformer, using one of the 19/17's as a return ; the other sub-station having two feeders, both 19/17's. The original contract for the work was for about 2,400 yards of pipe with cable pulled in, but this was finally increased to 3,800 yards, the whole being completed within the original contract time. The work outside the sub-stations, except the manufacturing of the transformer and the iron pipes, was executed by the Telegraph Manufacturing Company (Limited), of Helsby, under the supervision of the Company's engineer, Mr. A. Whalley, with whom was associated Mr. H. G. Norman and Mr. J. Grenall. The engines and condensing plant are supplied by Messrs. G. E. Belliss and Co., of Ledsam-street Works, Birmingham. The engines are of their well-known double-acting high-speed compound single-eccentric type, fitted with the latest lubricating arrangements, particulars of which have recently appeared in *The Electrician.* Alternators of a new type have been supplied by Messrs. Johnson and Phillips. The works were designed and carried out by Mr. F. H. Medhurst, the consulting engineer employed by the Corporation.

Blackburn.—Considerable extensions of the electric lighting mains have been agreed to by the Town Council.

Brighton.—The Corporation, at its meeting last week, adopted the report of the Electric Lighting Committee, particulars of which were given on page 175 of our last issue, by which it will be seen that considerable extensions of the electric lighting scheme are proposed.

Canterbury.—At the last meeting of the Town Council correspondence was read between the Council and the Canterbury Electric Supply Company. After some discussion a resolution was passed postponing the consideration of the electric lighting question for six months.

Country House Lighting.—Mr. E. Janson, having decided to light the whole of his country house at Speldhurst electrically, has placed the order with Messrs. Drake and Gorham. The motive power is to be supplied by a Priestman petroleum engine, and D.P. accumulators are to be included in the plant.

Darlington.—At the last meeting of the Town Council, on the presentation of the report of the Streets, Building, and Lighting Committee, Mr. Alderman Harding stated that there seemed to be an impression in the town that the Committee discouraged the consideration of the electric lighting question, but Mr. Alderman Barron replied that this was not the case.

Dewsbury.—On Monday last the ceremony of switching on the electric light was performed by the Mayor (Mr. Alderman Kilburn). After the ceremony Mr. Alderman Robinson, Chairman of the Lighting Committee, entered into details of the scheme, and said that the Corporation had been driven, in self-defence, to take up the electric lighting scheme, as two private companies had endeavoured to obtain powers to supply electric current to the town. Mr. W. H. Preece stated that although the number of applicants for the electric light was not large, it was about the average at the commencement of supply. He did not know of a single case where electric lighting works had not proved successful, and was convinced that success would result at Dewsbury.——A proposal of the Lighting and Water Committee of the Town Council to expend in wages for workmen at the central lighting station the sum of £468 per annum, was referred back to the Committee for further consideration.

Dover.—Reference was made in our last issue to the remarks of the Mayor, upon the strained relations between the Council and the local gas company for some years past. To this statement the gas company's officials took exception, but the Mayor at the last meeting of the Council reiterated the statement that for years past the Council had been dissatisfied with the price charged by the gas company for lighting the town. A letter was read from the Dover Electricity Supply Company (Limited) promising tender and other particulars with regard to the lighting of the Dover streets by electricity as soon as the survey had been completed, which would be in a week or two ; but in the result the tender of the gas company was accepted for another year.

Dublin.—The Electric Lighting Committee have presented a report to the Corporation relating to the estimates for 1895 for electric lighting. The Committee estimate a substantial increase in the revenue for private consumers, the amount for 1894 being estimated at £7,219, as against £7,417 for 1895. A credit balance for 1894 is shown of £2,903. The department (the report states) is working satisfactorily. The estimated profit for 1895 is £3,403.

Durban.—Our friends at the Cape have the smoke nuisance, and at the last meeting of the Durban Town Council complaints were made of the smoke from the electric lighting station in Market-square. The Town Clerk stated that it was the intention of the authorities to lengthen the chimneys, and, as they had been unsuccessful in the use of Natal coal, they were about to use Welsh coal at a considerably increased cost.

Ealing.—Out of the 70 arc lamps which have been put up for the public lighting, 39 are now in use, and a large number of the gas lamps in the district are extinguished. The number of incandescents taking current off the Local Board's mains is 2,649 8-c.p.

Fareham.—An inquiry hss been held by Col. J. T. March, R.E., on the application of the Fareham Local Board for the permission of the Local Government Board to borrow £7,000 for the purpose of electric lighting, this sum to include the purchase of the undertaking of the local electric light company. No serious opposition was offered to the application.

Glasgow.—At the last meeting of the Town Council the minutes of the Committee on Gas Supply and Electric Lighting were submitted. The Treasurer reported the collection of electric lighting rents on this date, as follows : 1894-95, £3,186 ; 1893-94, £2,118 ; or an increase of £1,068. The minutes were adopted.

Harrow.—A public meeting was held on Thursday last week, at the instance of the Local Board, to discuss the electric lighting question, at which Mr. R. E. Crompton and Mr. W. C. C. Hawtayne were present. Dr. Stiven, Chairman of the Local Board, presided. He pointed out that one of the first duties of the Local Authority was to retain in its own hands the lighting of the district. By the action taken some time ago in connection with the Harrow and Stanmore Gas Bill a reduction of 3d. per 1,000 in the cost was secured. In reply to questions he stated that sufficient private consumers had undertaken to take the current to pay working expenses. Mr. Kirby, Vice-Chairman of the St. James and Pall Mall Electric Light Company, proposed that the Board should be thanked for their exhaustive report on the subject of the electric lighting of the district, and be requested to take no further steps towards the promotion of the electric light in Harrow. He said there were a thousand and one difficulties surrounding the question. Mr. B. Denniss pointed out that the Board had already obtained a Provisional Order at a cost of £194, and this sum they could get back from a company. It was a case of the electric light now or never, for if the Local Board did not take the matter in hand Harrow school would have its own installation, and they would thus lose an important customer.

Hucknall.—At the final meeting of the Local Board a statement was made by the Chairman as to the improvements made to the town in the period of 26 years during which the Board had been established, and in the course of his remarks he stated that he trusted the town would shortly be lighted by electricity. This would complete a number of improvements of the greatest magnitude with which the town has recently been concerned.

Leamington Spa.—Warwick Castle is now lighted throughout by electricity, and the drive from the lodge to the main entrance is also lighted by electric lamps. About 400 lamps are installed. The work has been carried through by Mr. B. Fowler, M.I.E., and the contractors for the electric plant and fittings are Messrs. Edmundson (Limited), of Westminster. Messrs. Gilbert Gilkes and Co., of Kendal, have supplied a turbine for the installation. This has been fixed in the wheel pit of the old mill below the Castle. The plant includes storage batteries.

Lectures.—Prof. S. P. Thompson delivered an interesting and instructive discourse on the working of electric motors, at the London Institution, on Monday last. After a historical retrospect a number of experiments were made to the delight of a large audience, who frequently applauded the lecturer.——At the opening meeting of the session of the Andersonian Chemical Society, Mr. H. A. Mavor delivered a lecture, entitled "A Talk about Electrical Engineering." The lecture was illustrated by limelight views, and interested a large audience, who gave Mr. Mavor a hearty vote of thanks at the conclusion.——A lecture was delivered by Mr. William Tate, at the Masonic Hall, Muir-street, Wishaw, on Wednesday last week, entitled "Electricity."——Mr. Robert Hammond delivered a lecture at the Town Hall, Newport, before the local Literary and Scientific Society, on "The Electric Light: its Utility and Cost." Mr. Hammond severely ridiculed the idea of making a fixed charge of 15s. per light, as was proposed at Cardiff. This was, he said, a remnant of ancient practice, which had been many years superseded by the meter system, which was fair to all concerned.

Personal.—We are informed that Mr. Garcke will retire from the position of Managing Director of the Electric Construction Company (Limited) upon the expiration of his agreement with the Company at the end of the year.——We have received a notification that Mr. E. A. Browning has ceased to have any connection with the firm of Browning and Gardner, of 44, George-street, Edinburgh, and that Mr. Gardner is the sole partner in the firm.

Peterborough.—Notwithstanding that the Town Council have recently passed a resolution, under the terms of which a public electric light installation is to be immediately proceeded with, there appears to be still some doubt as to future progress. A circular is issued for signature by probable consumers of electric current.

Pit Lighting.—A number of improvements have recently been made at the Lady Sophia Pit, Irvine, by the proprietors, Messrs. William Baird and Co. Hitherto, both the overhead and underground workings have been dependent upon primitive oil lamps for lighting, but it has now been decided to introduce the incandescent electric light, both on the surface and below. An order was some time ago placed with Messrs. Hunter and Jack, of St. Vincent-street, Glasgow, to fit up a complete installation, with a successful result. Power is provided by the blowing engine, which is always at work, and produces plenty of superfluous power. Additional lamps are shortly to be provided.

Portsmouth.—In reply to a request that the clock at the Town Hall should be kept illuminated throughout the night, it was stated that this would involve an extra cost of £60 per annum. From careful calculations it has been found that the 32 lamps in the clock tower consume one unit of current per hour.

Prescot.—Mr. Hazlehurst, the Government auditor for the Prescot district, has surcharged Messrs. E. Dyson, J. Berry, and J. Preston, members of the Prescot Local Board, to the amount of £362. 17s. 3d., in respect of payments made to the British Insulated Wire Company for the lighting of the town by electricity. In his report, Mr. Hazlehurst states that the Company have failed to carry out their agreement with the Local Board in regard to the extent of the district and the number of lamps to be lighted by electricity, and that the Local Board, with the full knowledge of these facts, have improperly and illegally made payments to the amount surcharged. It was also pointed out that, owing to the absence of a penalty clause, the agreement which had been made with the Company was invalid. The members against whom the surcharge has been made maintained that Mr. Hazlehurst's facts are at fault, and that the ratepayers have received more than they had contracted for, and Mr. Hazlehurst has, it is stated, reported to the Local Government Board that there is excellent ground for remitting the surcharge, but he, as auditor, was bound to act according to the statutes. He suggests a new agreement with the Company, and this matter is now under the consideration of the Local Board.

Rathmines.—The Chairman of the Town Commissioners is also Chairman of the local Gas Company. A resolution was adopted at the last meeting of the Commissioners to appoint a committee to report on the advisability of introducing the electric light into the township, to which the Chairman of the Commissioners saw no objection, although he believed the Gas Company gave the ratepayers good value for their money.

Sheffield.—It is anticipated that the new machinery now being put down by the Sheffield Electric Light and Power Company (Limited), and which has a capacity for an additional 10,000 lights, will be ready at the end of the year.

Southport.—The Electric Lighting Committee have appointed Mr. Arthur Ellis engineer at a salary of £200. There are considerable extensions being made to the electric lighting scheme which will bring up the total number of lights required from the works to 6,000. The present capacity of the works is about 4,200. At present, out of borrowing powers equal to £28,000 only £14,000 has been spent.

Stafford.—The County Council have decided to light the technical instruction buildings by electricity.

Stanley.—Some surprise is expressed at the contemplated lighting of the streets at Stanley by means of paraffin oil. It is pointed out that excellent opportunities exist in the neighbourhood for a public electric light installation, as water power is plentiful.

Sunderland.—The Corporation's Electrical Engineer has reported that it will shortly be necessary to appoint an assistant, and this matter is under the consideration of the Highways Committee. It is anticipated that the complete public supply of electric current will commence at the middle of January. In the meantime a number of customers have been obtained, who are taking about one-sixth of the present capacity of the works.

Theatre Lighting.—The Empire Theatre at Belfast, which has recently been entirely rebuilt and much enlarged, is now lighted throughout by electricity.

Wakefield.—At the meeting of the City Council, on Tuesday, Mr. Lea, the Chairman of the Electric Lighting Committee, stated, in reply to a question, that the Committee had not yet done any actual business; but a meeting had been called for Thursday, when they hoped to seriously consider the whole question.

Wells.—The Town Council have considered the tabulated statement prepared by the Town Clerk, relating to the adoption of electric light in other towns in England, and in connection with its proposed adoption in Wells. The matter has been referred to a special committee to report to the Council.

Weston-super-Mare.—A special meeting of the Town Commissioners was held last week to receive the minutes of the Electric Lighting Committee and Mr. F. H. Medhurst's report on electric lighting, electric tramways and refuse destructors. This report deals very fully with the whole question of electric light and traction, and Mr. Medhurst's conclusions are (1) that electric tramways will not pay at Weston-super-Mare; (2) that the supply of electric current for lighting and power purposes will prove profitable; and (3) that if a refuse destructor is erected it should be worked in conjunction with the electric supply works. The Electric Lighting Committee, in presenting the result of their consideration of Mr. Medhurst's report, approve his conclusions, believing that the establishment of electricity works would result in profit to the ratepayers, and be a great advantage to the town.

Wishaw.—The Town Commissioners have retained the services of Mr. H. A. Mavor, of Glasgow, as electrical engineer to carry out their electric lighting scheme.

Works Lighting.—The large engineering works at Ovenstone have been fitted up for the electric light, motive power being provided by the existing plant.

COMPANIES' MEETINGS AND REPORTS.

Woodhouse and Rawson United (Limited).

A meeting of the debenture-holders in this concern was held on Tuesday at Winchester House, E.C., for the purpose of receiving a statement of the progress made in the realisation of the assets from Mr. F. D. Leslie, the receiver and manager, who presided.

The CHAIRMAN said that the circular the debenture-holders had received would have explained to them the object of the meeting. It would be impossible to go fully into all the details and matters relating to the liquidation of the assets of the Company in the written report as he could now do verbally. He proposed to give them a report which he had prepared, giving as clearly as possible the result of the liquidation of the assets that had been actually realised to the present time, and the estimated result of those assets which were still unliquidated. In doing this he should take the estimates of value based on the different groups of assets by the Directors in their statement of affairs, and show them, when possible, by comparative figures, where and how the differences had arisen. It had taken him, since his appointment on March 10, 1893, a considerable time to thoroughly acquaint himself with the nature of the assets, and, indeed, to find out where some of them were. The books of the Company—numbering nearly 200—were in anything but a complete condition, and, in fact, had not been posted since December, 1892. It consequently took many months to bring them up to the date of his appointment as receiver and manager. It was, of course, absolutely necessary that this should be done, as until this was finished he could not ascertain what were the assets of the Company, especially the book debts, or the position of the various branches. The Company had thirteen agencies and branches in the United Kingdom, as well as at various places on the Continent, at Johannesburg and other parts of South Africa, and in Australia. Now, as these branches not only traded with the head office, but traded amongst themselves, they would see that it was necessary that not only the books at the head office, but also the books at the various branches should be written up before he could ascertain and trace the assets that ought to be at the various branches. Whilst this was being done, amongst many other things, two important matters required his immediate and constant consideration. Firstly, the completion of the contracts entered into by the Company, and only partly carried through at the date of his appointment. On account of these contracts various sums of money had been received; but there were still considerable sums outstanding, representing work already done under the contracts, and which, had the whole contract not been completed, would have been forfeited. He was pleased to say that these contracts had all been completed, and so no forfeiture had occurred. Secondly, he had to consider which of the branches should be carried on, either with a view to the contingency of the reconstruction of the Company and their forming, with what goodwill might attach to them, a valuable part of the assets to be dealt with in such reconstruction, and also to ascertain which branches could only be carried on at serious loss. Having decided in which of these two categories the various branches must be placed, he had to take immediate steps to close down those in the second list. It took a considerable time to obtain from the foreign branches (especially those in South Africa and Australia) the necessary information to enable him to form any opinion of their position, and to decide upon any action to be taken in regard to them, more especially as in South Africa there were large contracts in hand which it was absolutely necessary to carry to completion. Much time was taken up in dealing with these matters, and of course no serious steps could be taken without applying to the Registrar for authority to take such steps, and the Court would, very properly, he thought, make no order without the fullest information being laid before it; so at the end of the first six months of his trading as receiver and manager he was not in a position to make out a trading and profit and loss account; in fact, he could not do so, as he had not received, and could not receive, from the foreign branches their returns. After due consideration he decided to make out a trading and profit and loss account at the end of his first year's trading; that was to March 9, 1894. In making out this account he soon found that the stocks on March 10, 1893, were overvalued. There appeared a loss of £3,872. 11s. 9d., the greater part of which was accounted for by the fact that the turnover was nothing like large enough to bear the standing charges, consisting of rates, taxes, rents, wages, salaries, &c., although in this connection he might say that, immediately after his appointment, and during the whole of the time he had had the management of this business he had given attention to the matter, in every way cutting down expenses. He reported to the Court, and received directions to take steps to close down the head office and branches, the result of which authority was that at the present moment all the branches, with the exception of the head office, Manchester, Kidsgrove Works, Birmingham, Chiswick, South Africa, and Australia, had been closed and had ceased trading altogether. He was now negotiating for the sale of the assets at the head office, and also for those at the Manchester, Kidsgrove, Birminhgam, Chiswick, South Africa, and Australian branches. The Official Receiver, as they were aware, issued a statement of affairs dated December 12, 1893, setting forth the valuation of the assets as estimated and certified by the Directors. He had found it practically impossible to give them a detailed comparative statement of the realisation of the general assets, as in many cases sales have been effected, including items appearing in the statement of affairs under several headings, the whole being sold at a lump sum. Moreover, as the stocks mentioned in the statement of affairs at £76,396. 4s. 5d. had, of course, been depleted, it would be impossible and unfair to compare the realisation of the remnant of those stocks with the estimate of the stock on March 10, 1893. With the exception of the items "stock in trade" and "trade fixtures and fittings," reliable figures could be given, and the various items could, he thought, be fairly estimated at £20,215. 11s. 9d. The cash at bankers' and in hand appearing in the Directors' statement of affairs was substantially correct. The investments in shares, &c., amounted to £31,768. The item appearing in the statement of affairs for property, £36,847. 4s., included the sum of £13,500 for goodwill at head office and the different branches, and the sum of £21,950 was for patents. The item for goodwill would realise nothing, but for certain of the patents he had received an offer of £2,000, while others were included in the offer of £8,500 for the Manchester and London businesses, the remaining patents being valued at £1,150. The book debts were estimated to be of the value of £37,519, but his estimate was a deficiency on the whole item of £24,521. The next item was bills receivable, which again according to the statement were estimated to produce £3,662. Of this amount £1,616 had been received, and the balance of £2,046 was valueless. With regard to the item of £13,599. 14s. 6d., which was the estimated surplus from securities in the hands of the creditors fully secured, not more than £2,500 would be received, inasmuch as it was estimated that the surplus from the sale of the Kidsgrove Works would show an excess of £5,000, but it would instead only show £2,500, and even part of this was for stock, &c., not included in the mortgage or in the above estimated surplus. From the Cadby Hall sale it was anticipated that a surplus of £7,000 would result, and this property has been disposed of by the mortgagees for £10,500, the amount of their mortgage money and interest. He had instructed a well-known firm of land agents and valuers in the West-end of London to value the property on his behalf as manager and receiver, and they had valued it at the sum of £6,000. He thereupon allowed the mortgagees to enter and take possession. The item for unpaid calls was estimated to produce £7,647; up to now he had succeeded in recovering £7,073, and anticipated that a further £100 would be realised. They would see, therefore, from his report that the realisation of the assets had fallen far below the too sanguine estimate placed upon them by the Directors in their statement of affairs. As all the assets were not realised it was practically impossible for him to give anything like a reliable estimate of what might be expected by the debenture-holders in the shape of dividend, but his estimate was that, subject to the costs of the realisation, there would be a sum of £32,000 available for distribution amongst the debenture-holders, of which about £3,600 would be due to the Five and a-Half per Cent. debenture-holders, £18,400 to the Six per Cent. debenture-holders, and £10,000 to the Ten per Cent. Secured Debenture Stock. In no case could the debenture-holders receive a full return for their investment, and although it would, of course, have afforded him much greater satisfaction to have been able to give more reliable figures that day from which he could arrive at an idea of what dividend he should sooner or later be in a position to pay them, they would see that under the circumstances all he could possibly do was to lay before them a full account of the present position of the assets existing when he took possession of what was their property, and the steps he had taken in their behalf and in the protection of their interests.

Mr. HOLT complained that he converted his Six per Cent. debentures into Five and a-Half per cents on the faith of a circular which was sent out by the Directors, and he then imagined he had obtained a first charge on the assets.

Mr. MADDISON (solicitor to the receiver) said if all the Six per Cent. Debenture holders had converted into the Five and a-Halfs, they would have been a first charge; but many of them did not do so. It had been anticipated that all would have consented, though possibly the circular ought to have been more cautiously worded. It must, however, have been patent to everybody that if they did not all consent, the First Mortgage Debenture-holders would remain with a first mortgage.

Mr. F. L. RAWSON said that was what was stated at the public examination of the Directors.

Mr. MADDISON said the matter was before the Court, and counsel who were consulted in the matter were of opinion that there was no misstatement on the point in the circular. People, no doubt, were slightly misled; but there was no misstatement in law.

In reply to remarks from the receiver of the British Electric Lighting Company, the CHAIRMAN said the amount of debenture stock outstanding on the respective issues was as follows: On the Six per Cent. Debentures, £65,500; on the Five and a-Half per Cent. Debenture Stock, £118,187; on the Ten per Cent., £19,905; but he did not anticipate that more than £13,600 of the last-named would rank.

Mr. RAWSON said only a certain amount of the sum stated for the Five and a-Half per Cent. Debentures would rank, as part of it was security.

A vote of thanks to Mr. Leslie concluded the proceedings.

General Electric Power and Traction Company (Limited).

An extraordinary general meeting of this Company was held at Cannon-street Hotel, on Tuesday last, Mr. James Pender in the chair.

The SECRETARY (Mr. William Bulloch) read the notice calling the meeting.

The CHAIRMAN stated that the only business they had to deal with that day was to confirm the resolution which was passed at the extraordinary general meeting of the Company on the 21st ult.—namely: "That the Company be wound up voluntarily under the provisions of the Companies' Acts." He was unfortunately absent at the last meeting; but he now begged to propose the confirmation of the resolution.

Mr. IMMISCH seconded the motion.

Mr. PAGE HOPPS said he thought the shareholders were entitled to a little further information before they were asked to pass such a resolution, for he considered that at the last meeting they received no information at all, or only very little, from Mr. Garcke. It seem him that the shareholders had been led on from step to step. He had attended nearly all the meetings, but he confessed that he did not know what had been happening, and he did not know what was happening now. He supposed that there would be some assets left, and he would like to know what they were. They had shares in the Acme and Immisch Company, and the Immisch Launch Company, and he would like to know what was to occur with reference to these shares. He expected that everything would be sold; but he wanted to know. He desired to be informed who was likely to be the purchaser of these shares. He thought that the original shareholders, who were about to lose everything, ought to have a chance of applying for them, if they were good. At their last meeting it was said that there was a prospect of some complication arising with reference to the rights as between the Preference and Ordinary shareholders; but he did not see how any complication could arise on such a matter, the terms of the Articles of Association being clear. After quoting the clause dealing with this point, he remarked that the right of the Preference shareholder was to be paid out of the assets of the Company to the full amount subscribed on his shares before anything could be received by the Ordinary shareholders.

The CHAIRMAN remarked that that was the case. As far as he was aware, the Preference shareholders had a first claim on any assets which might exist.

Mr. GARCKE, in reply, said that with regard to there being any complication in the position between the Preference and Ordinary shareholders, the whole of the complication existed in the minds of a few speakers at the last meeting, who could not understand why there were Preference shares in the Acme and Immisch Company and the Immisch Launch Company. There was no question raised with regard to the position of the two classes of shareholders in the Traction Company. That position was clearly defined, and the liquidators who were to be appointed would have difficulty in dealing with it. If it were the wish of the shareholders that they should be kept informed regarding the steps taken by the liquidators for the realisation of the assets, the latter would no doubt give full consideration to any such view.

Mr. HOPPS asked whether any arrangement had been made with regard to a sale of the shares in the two companies mentioned.

Mr. GARCKE: None whatever.

The CHAIRMAN then put the motion and declared it carried, there being one dissentient. Continuing, he proposed a resolution appointing Mr. E. Wilding and Mr. Bulloch liquidators, and fixing their remuneration for their services in winding up the Company at £150.

Mr. IMMISCH seconded the motion.

The CHAIRMAN, in answer to Mr. Hopps, said that Mr. Wilding was the accountant of the Company, and Mr. Bulloch was the secretary. The shareholders would be called together again if the liquidation lasted more than a year, and if it lasted only six or eight months they would also be called together to pass the accounts.

The motion was then adopted, and a vote of thanks to the Chairman terminated the proceedings.

STATUTORY RETURNS, &c.

ELECTRIC TRAMWAYS CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED)—The annual return of this Company, made up to July 2nd, was only recently filed, when only the seven signatories' shares were taken up out of a nominal capital of £25,000 in £1 shares, and on these no calls have as yet been made.

ELECTRIC MOTIVE POWER COMPANY (LIMITED).—The statutory return of this Company, made up to July 18th, was only recently filed. Only seven Preference shares were subscribed for out of a capital of £20,000, divided into 10,250 Preference and 9,650 Ordinary shares of £1 each. On these shares no calls have been paid.

MATHER AND PLATT (LIMITED).—The annual return of this Company, made up to October 31st, was filed on November 2nd. Out of the nominal capital of £200,000, in £10 shares, 15,000 shares have been subscribed for and allotted. On each calls amounting to £9 per share have been made and paid. No transfers have taken place during the year covered by the return.

MONTE VIDEO TELEPHONE COMPANY (LIMITED).—The annual return of this Company, made up to November 14th, has been filed. The nominal capital is £220,000, divided into 29,000 Preference and 15,000 Ordinary shares of £5 each; 28,000 of the former and all the latter have been taken up and allotted, of which 3,000 of each class have been issued as fully paid. Consequent upon a call of £5 per share on the remaining 25,000 Preference and 12,000 Ordinary the whole amount of £185,000 has been received.

NATIONAL COMPANY FOR THE DISTRIBUTION OF ELECTRICITY BY SECONDARY GENERATORS (LIMITED).—The annual return of this Company, made up to October 3rd, has been filed. The Company's capital is half a million, divided into 3,000 Preferred and 47,000 Ordinary shares of £10 each; 2,669 Preferred and 20,000 Ordinary have been taken up, of which 1,000 Preferred and all the Ordinary shares have been issued as fully paid. The full amount per share has been called on 1,669 Preferred shares, resulting in the payment of £17,690 (which includes a sum of £1,000 paid in respect of 100 forfeited shares).

NATIONAL ELECTRIC ENGINEERING COMPANY (LIMITED).—An agreement, dated November 27th, between Arthur C. Cockburn and Douglas C. Bate (the vendors) and John C. Bowler (trustee for the Company) provides for the sale to the Company of the businesses carried on by the two former, for £2,415. 0s. 7d., payable £415. 0s. 7d. in cash and 2,000 by the allotment as fully paid of 2,000 shares of £1 each.

CITY NOTES.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—Warrants for the interest payable January 1, 1895, at the rate of 5 per cent. per annum for the six months ending 31st inst. on this Company's first issue of £100,000 debenture stock will be posted on the 31st inst.

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ended December 9th were £941, as against £913 in the corresponding period of 1893, being an increase of £28. The total receipts for the half-year amount to £20,517, as against £19,188 for the corresponding period of 1893, an increase of £1,329.

CASSEL'S GOLD EXTRACTING COMPANY (LIMITED).—The *Financial News* states that the annual meeting of this Company was held in Glasgow on Wednesday, when Mr. L. Gow, who presided, said that, as their patent cases in Germany and in South Africa would come on early in the coming year, he was debarred from commenting thereon; but the Directors hoped for success. The profit for the year was £27,000, from which they had written off for depreciation of the MacArthur-Forrest patent £14,500, and for depreciation of plant £5,000, leaving £2,839 to be carried forward. The formation of a local company in Chili for acquiring and working mines under their process was important. The contract in Peru had been arranged. The New Zealand business was increasing generally, and royalties were increasing.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announce the payment, on 14th January next, of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum on the Preference Shares for the quarter ending 31st December, and the usual interim dividend of 2s. 6d. per share on the Ordinary Shares, free of income tax, in respect of profits for the quarter ended 30th September. The transfer books will be closed from the 7th to 14th January, both days inclusive.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The Directors of this Company on Wednesday declared an interim dividend, for the quarter ended September 30th last, of 2s. 6d. per share, free of income-tax, payable on the 15th prox. The share register will be closed from the 7th to the 14th prox., both days inclusive. The coupons on the Company's Five per Cent. Australian Government Subsidy Debentures, due on January 1st next, will be paid on and after that date at Messrs. Barclay, Bevan and Co.'s bank, 54, Lombard-street, E.C. Coupons must be left three clear days for examination.

ELECTRIC CONSTRUCTION COMPANY (LIMITED).—Particulars are issued of the drawing of 133 Six per Cent. Second Mortgage Debentures of £10 each of this Company, particulars of which can be obtained of Mr. J. Cecil Bull, secretary to the trustees, 1 and 2, Great Winchester street, E.C.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL COMPANY (LIMITED).—The profit and loss account of this Company just issued shows a loss for the year ended December 31, 1893, of £12,076. The Directors state that the loss on trading is made up to a considerable extent by the reduction made in the values taken of the various descriptions of copper in stock, it having been deemed desirable by the German managers and auditors that these should be written down to almost their raw material value. It is also partly made up by the loss incurred on the sale of 10 tons of stock tubes, which had to be sold at the raw copper value, instead of the market value of such sized tubes. Subject to these reservations the actual loss on trading did not exceed £600. The largeness of the profit and loss account is partly accounted for by the fact that, according to German company law, it was necessary to write off the establishment expenses, as shown in the last account, amounting to £4,471, as loss, and the depreciation on the various accounts comes to the sum of £3,300.

GLOBE TELEGRAPH AND TRUST COMPANY (LIMITED).—The Directors announce the payment on the 18th proximo of an interim dividend of 1s. 6d. per share.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended the 9th inst. amounted to £855. The amount for the corresponding week last year was £606.

NATIONAL TELEPHONE COMPANY (LIMITED).—The transfer books of the Debenture stock of this Company will be closed from the 18th to the 31st inst. inclusive, preparatory to the payment of interest due January 1, 1895.

MESSRS. MIX AND GENEST (LIMITED). A dividend for the year 1894 of 10 per cent. has been declared, against 8 per cent. for 1893, by this Berlin Company.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Tuesday, December 18th, a special settling day in the 20,459 Six per Cent. Cumulative Preference shares, Nos. 30.001 to 50,459 and 19,375 Ordinary shares, Nos. 1 to 19,375, of Willans and Robinson (Limited); and have ordered the fully and partly-paid scrip of £1.100,000 Three and a-Half per Cent. Debenture stock of the National Telephone Company (Limited) to be quoted in the Official List after January 1, 1895.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The Directors of this Company yesterday (Thursday) received the following telegram from their representative in Rio de Janeiro:—"Bill passed second reading Upper House yesterday."

This Company's traffic receipts for the week ended December 7th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited) were £3,084.

WESTERN UNION TELEGRAPH COMPANY.—The usual quarterly dividend of 1¼ per cent. has been declared by this Company.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Dec. 5.		Price Wednesday, Dec. 12.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 12.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£1,012,880	Stock	9 0	Anglo-American	38	39	38	39	5 2 7	Jan., Apr., July, Oct.	..	..
£2,993,560	Stock	18 0	Do. Preferred	72	73	71½	72½	5 10 4	,, ,,	72½	72
£2,993,560	Stock	5/0	Do. Deferred	6¼	6¾	6¼	6¾	..	..	6⅝	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 17 8	January and July ..	..	..
130,000	£10	4/0	Brazilian Submarine	11	11½	11	11½	5 13 11	Mar., June, Oct., Dec.	11½	11⅛
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	114	111	115	4 8 11	June and December	..	–
10,000,000	$100	$1¾	Commercial Cable Capital Stock	140	150	140	150	4 13 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12½	13½	12½	13½	5 18 6	February and August	13¼	13
6,000	10	10%	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	,, ,,	20	..
12,931	5	1/8	Direct Spanish (£4 paid)	4¼	4¾	4¼	4¾	4 4 3	April and October –	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¼	9¾	9¼	9¾	5 2 7	,, ,,	..	–
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	4 3 4	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8½	9	8½	9	5 0 0	Jan., Apr., July, Oct.	8 9/16	8½
400,000	10	2/6	Eastern	15¾	16	15¾	16¼	4 1 3	,, ,,	16 3/16	15⅞
70,000	10	6%	Do. 6 per Cent. Preference	16½	17	16¾	17¼	3 9 7	,, ,,	16⅝	16⅝
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	118	121	119	122	3 5 7	May and November	120	119½
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	110	106	110	4 12 2	February & August	..	..
250,000	10	2/6	Eastern Extension	15⅞	16⅜	16	16¼	4 6 2	Jan., Apr., July, Oct.	16¼	16
£820,000	Stock	4%	Do. 4 per Cent. Debenture Stock	117	121	118	122	3 5 7	February & August	120¼	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	107	103	107	4 15 8	January and July ..	–	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	103	107	4 15 8	,, ,,	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	104	107	105	108	3 15 2	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	107%	110%	107%	110%	3 12 11	May and November	108½	108
180,227	10	1/3	Globe Telegraph and Trust	8⅝	8⅞	8⅝	8⅞	5 1 2	Jan., Apr., July, Oct.	8¾	8⅝
180,042	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16¼	3 13 11	,, ,,	16	15⅝
150,000	10	5/0	Great Northern	21½	22	21¾	22½	3 18 10	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	..	..
17,000	25	12/6	Indo-European	47	49	47	49	6 8 2	May and November	..	..
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	.	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	102	106	102	106	5 14 10	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	104	107	105	108	3 15 6	..	..	..
11,839	8	4/0	Reuter's	3	5	3	5	..	April and October –	..	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	104	109	107	111	5 9 1	,, ,,	109½	108½
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July ..	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	100	103	101	104	4 17 4	March & September	103	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July .	1¾	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	100	105	100	105	7 12 5	June and December	..	..
88,321	10	6d.	West India and Panama xd	1	1½	1	1½	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	5 6 8	May and November	11	10¾
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 11 9	June and December	..	..
64,242	15	3/0	Western and Brazilian xd	11	11½	11½	12	..	May and November	11¾	11
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	..	6¾	6½
33,129	7½	4/6	Do. 5 per Cent. Deferred	5	5½	5	5½	.	..	5 5/16	5
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 16 6	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 16 6	,, ,,	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	112	118	112	118	5 19 2	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 17 1	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	..	..	..
224,850	10/0	2½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	..
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	7/16	9/16	7/16	9/16	..	Yearly	–	..
484,507	5	3/4	National	5	5½	5⅛	5⅜	4 15 3	June and December	5⅜	5
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 15 0	,, ,,	16	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	,, ,,	15⅞	15¾
119,234	5	3/4	Do. 5% Non-Cumulative 3rd Pref.	5⅝	5⅞	5¾	6	4 5 1	..	5⅞	5¼
1,000,000	Stock	4½%	* Do. Debenture Stock, 4½% (red.)	110	113	110	113	4 1 3	January and July –	..	..
58,000	5	1/0	United River Plate	2	3	1	2	..	,, ,,	1¾	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	88	94	88	94	5 6 5	,, ,,	..	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	13	14	13½	14½	..	–	13¾	13½
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	14¾	15¼	14¾	15¼	3 18 8	..	15⅛	14¾
£400,000	Stock	5%	Do. 5% Debenture Stock (red.)	131	133	132	135	3 14 1	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	4½	5½	4½	6½	3 12 9	–	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	..	..	..
8,322	£5	..	House-to-House Electric	..		..		–	–	..	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		–	..	..	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		–	January and July –	–	–
45,000	£5	2/6	Liverpool Electric Supply (fully paid)	7 5/16	7 7/16	7⅜	7¾	–	..	..	–
111,000	5	..	London Electric Supply	½	⅝	⅜	⅝	..	..	..	..
49,000	£10	5/0	Metropolitan Electric Supply (fully paid)	10	10½	9¾	10¼	2 18 9	..	10⅜	10
£150,000	Stock	4½%	* Do. 4½% Debs. (Bonds of £10, £20, and £40)	114	116	115	117	3 16 11	June and December	115¾	115
6,452	£10	..	Notting Hill Electric	6½	7½	7	7½	–	..	7 1/16	..
19,080	£5	2 0	St. James and Pall Mall	7¼	8¼	7¾	8¼	.	..	..	..
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8½	9	3 17 9	..	..	.
59,000	5	2/0	Westminster Electric Supply (fully paid)	7¼	7¾	7¼	7¾	2 18 1	..	7½	7⅜
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅜	2⅝	2⅜	2⅝	5 11 3	..	2⅝	2 9/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2¼	2½	4 16 0	..	..	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	110	113	111	114	3 19 10	March & September	113	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2¾	3¼	2¾	3¼	–	January and July –	..	..
12,139	5	..	Edison and Swan United	–		–		..	..	–	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	–	–	..
120,000	2	..	Electric Construction	⅜	⅝	½	¾	–	–	⅝	..
12,845	2	2 9d	Do. 7 per Cent. Cumulative Pref.	1¼	2	1½	2	..	–	–	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1½	1¾	1½	1⅝	–	–	1 3/16	1 3/16
20,000	5	..	Fowler-Waring Cables (fully paid)	¼	1¼	¼	1¼	.	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	25½	26½	25½	26½	4 14 4	February & August	26	–
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1890	102	104	102	104	4 7 7	March & September	..	–
15,095	£10	6/4	International Okonite Ordinary	..		..		–	–	..	–
16,000	£10	..	Do. 8 per Cent. Preference	–		–		–	December and June	..	–
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	¼	—	¼	.	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	41	43	41	43	5 11 0	March and July .. –	42¾	41¾
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July .	..	–
37,514	£5	–	Woodhouse and Rawson Ordinary (£3 15s. paid)	–		–		..	..	..	–
41,008	£5	..	Do. Preference (fully paid)	..		–		..	–	..	..
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	8½	9½	8½	9½	5 5 3	..	–	..
£30,000	10	..	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1%	City and South London Railway	40	42	41	43	2 6 6	May and November	42½	41⅜
7,000	10	5%	Do. 5% Perpetual Preference	13¾	14¼	13¾	14¼	3 10 2	..	..	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	122	124	124	126	3 3 6	May and November	124½	124
87,500	£10	1%	Liverpool Overhead Railway	8	8½	8½	8⅞	1 3 2	..	–	..
6,296	10	5%	Do. 5% Preference	13	13½	13	13½	3 15 6	..	–	–
£125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July ..	–	–

In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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NOTES.

The companies and Local Authorities who are using, or proposing to use, transformer pits under the pavements are to be congratulated upon the outcome of the Board of Trade Conference. As will be seen in another column Sir Courtenay Boyle at the close of the proceedings yesterday announced his intention of advising the Board of Trade not to veto the principle of transformer pits, intimating at the same time that the Board of Trade would be advised to consider each particular type of construction as it came up for sanction, and not to pledge itself now to any general pattern.

◆

This decision, it seems to us, meets the case very fairly. It is true, no doubt, that the companies are granted a valuable concession not contemplated, it is admitted, by the framers of the Works Clause in the original Act from which the company immediately concerned ultimately derives its powers. At the same time, there is so much inclination, just at present, to regard all private concerns carrying out important and more or less public duties at a profit as fit only to be hampered and harassed at every turn, that it is satisfactory to see the balance somewhat redressed in this particular instance. The transformer-pit system is probably cheaper to the companies than that of large sub-stations constructed on private property, and that fact is by itself, perhaps, quite sufficient to condemn it in the eyes of the London County Council. On the other hand, it has to be remembered that the transformer-pit system allows, as no other system could do, of an indefinite multiplication of feeding points, and in consequence it tends to uniformity of pressure all over a network, and also to reduce the size of the area affected by any one breakdown—two results of considerable importance to the public weal.

◆

Mr. Bassett Hopkins argued at great length that Clause 12 of the County of London (North) Order, which we give in full below, never contemplated transformer pits. This was frankly admitted by the Board of Trade to be a tenable position; but it was pointed out that the clause could, without undue straining, be made to include transformers placed in pits. Was not, it was asked, a transformer a "controller of energy"? The County Council, however, does not assent to this view, and contemplates the possibility of contesting the jurisdiction of the Board of Trade; in which case two days' time and much money will have been wasted.

> **12.** Subject to the provisions of this Order and the principal Act and any regulations made under this Order the undertakers may construct in any street such boxes as may be necessary for purposes in connection with the supply of energy, including apparatus for the proper ventilation of such boxes.
>
> Provided that no such box or apparatus shall be placed above ground except with the consent of the local authority, body, or person by whom such street is repairable.
>
> Every such box shall be for the exclusive use of the undertakers, and under their sole control, except so far as the Board of Trade may otherwise order, and shall be used by the undertakers only for the purpose of leading off service lines and other distributing conductors, or for examining, testing, regulating, measuring, directing, or controlling the supply of energy, or for examining or testing the condition of the mains or other portions of the works, or for other like purposes connected with the undertaking, and the undertakers may place therein meters, switches, and any other suitable and proper apparatus for any of the above purposes.
>
> Every such box, including the upper surface or covering thereof, shall be constructed of such materials, and shall be constructed and maintained by the undertakers in such manner as not to be a source of danger, whether by reason of inequality of surface or otherwise. . . .

◆

There is, perhaps, a danger lest the importance and effect of the decision given on Tuesday last in the Court of Appeal, in the action Shelfer *v.* The City of London Electric Lighting Company, may be exaggerated and misunderstood. The City Company, no doubt, is at any moment legally liable to have its operations at Bankside summarily stopped. But no one need fear that such a catastrophe is likely to be brought about, at any rate by the machinery at the Law Courts; would that one could be equally sure about the machinery south of the Thames. A good ship may be spoilt for lack of a ha'porth of tar; but the electric lighting of the City of London will not be extinguished because the meditations and repose of the frequenters of the Waterman's Arms are interfered with. The injunction is merely tantamount to the enforced expenditure of a large sum of money in order to stop further structural damage to the publichouse in question, and to arrest the vibration complained of. The City Company, in fact, is not very markedly worse off after this judgment than is any other electric supply company possessing a station more or less central; all such concerns carry on their trade in fear of writs and actions at law. *In futuro* electric lighting companies will do well to buy the land for their generating stations beforehand, and obtain Parliamentary sanction—if they can—to the carrying on of their lawful business at that particular spot; in which case, as we understand Lord Halsbury's dictum, the Act of Parliament will, like charity, cover a multitude of sins, whether of omission or commission.

◆

As will be seen by our "Legal Intelligence" the Appeal Court has decided by a majority that the Muirhead American duplex patent, No. 234,490, of 1880, is substantially identical with that taken out in England in 1876; so that from July 1, 1891, the Commercial Cable Company have been entitled to make use of their licensors' device royalty free. It is, we think, to be regretted, both on legal and on ethical grounds, that Lords Justices Rigby and Lopes, to use the expression of the Master of the Rolls, preferred the clamour of counsel to the plain and simple judgment of Mr. Justice Kennedy. We have been given to understand that in these days the Court of Appeal, recognising the disadvantages under which it labours of not hearing the evidence, was chary of upsetting the decisions of the Courts below. We could have wished the Court had exhibited this tender solicitude in this case, bristling as it was with technicalities beyond the proper comprehension of many electricians, let alone Judges of Appeal. And in view of the great care bestowed upon the case by Mr. Justice Kennedy and his admirably argued judgment, to which the Master of the Rolls paid such eloquent tribute, one might almost have looked for refusal to disturb the previous decision as a matter of right.

We are always very sorry when we offend Mr. Mordey, but it seems inevitable. It would be very easy to humour everybody, and to encourage general mutual admiration, but that is not the way of progress. By the publication of Mr. Partridge's article we have forced Dr. Fleming's hand. He has experiments in progress; we are content to wait for the results until they are ready; but he has lost nothing, and our readers have gained a good deal, from the article which has been thus elicited from him. Even Mr. Mordey, though his feelings are wounded, has been induced to lift a corner of that veil which immemorial custom has ordained shall hide a subject which is in the interesting stage of being communicated to the Royal Society; and in another column he throws out some valuable hints on the matter. Most of the statements in our abused Note have been literally fulfilled, and some of them have been misunderstood by Mr. Mordey. Whether Mr. Partridge was the first to call the attention of manufacturers to this phenomenon or not does not much matter; he has, undoubtedly, done good service by communicating his short but interesting article.

Among the minor points raised in the discussion at the last meeting of the Physical Society was a question addressed to Prof. Ayrton by Prof. S. P. Thompson, who asked why the volt was described in his Paper as the ratio of the ampere to the ohm. This may not be Ohm's idea of a volt, and even Volta might have been surprised at it, and it would, perhaps, be more accurately expressed as the product, the word ratio being probably a slip for "relation." But the fact remains that the Imperial Volt has not been honoured by an independent determination; but, as was clearly stated in our description of the Board of Trade Standards Laboratory (p. 696 of our last volume), the ohm was accepted from the British Association determinations, the ampere was obtained from the silver voltameter, and the two were co-related on the volt standard. The scale of this instrument is long enough to include the pressures due to 69, 70, and 71 Clark cells, and, fortunately, it turned out that the value of one cell thus determined is 1·434. If it had turned out to be something else, something else it would have been. Many people have regretted that the ohm and the Clark cell were not given preference, and the ampere left to settle itself, because an ohm is easily copied, and the Clark cell is easily reproduced, and both can yield in ordinary hands better result than an ammeter or current balance.

Frequenters of the paths of science may, perhaps, be forgiven if their repeated use of scientific terms leads them to abbreviate and, so to speak, abstract the terms to the detriment of rigid accuracy. Custom, so potent in sadly marring the railway porter's announcement of the name of a station, is often not less potent in the professorial chair; and the dispenser of scientific truths will often yield to the temptation to follow the popular custom and talk slang. At first sight the oft-used phrase, "the mechanical equivalent of heat," does not seem at all slangy; but, in reality, it is slipshod at two points. "Heat" is vague; it should be "the heat unit," or some definite quantity of heat. But even "the mechanical equivalent of the heat unit" is not sufficiently exact. Very often it is not the mechanical equivalent at all, but some other energy-equivalent. For example, in the ingenious apparatus of Prof. Ayrton and Mr. Haycraft described in our columns this week, it is the electrical equivalent of the heat unit which is really measured. Something has to be assumed—namely, the conservation of electrical and mechanical energy interchanges—before the experiment devised by Prof. Ayrton can be said to be mechanical. Those persons who wish to be extremely precise in their use of words often turn up their noses at anything less scientific than the well-rounded phase, "the absolute specific heat of water," or something like that, which is apparently so far removed from Joule's researches as to appear to a plain man as altogether a different thing. But when the plain man prefers such a barbarous phrase as "the weight of the earth"—weight, forsooth, not mass—to the expression, "the constant of gravitation," what is to be thought of him? He is altogether out of the running; and scientific thinkers and speakers may feel at liberty to think and speak as they please, irrespective of his *bourgeois* clamours.

The advocates of the American system of rope driving for dynamos—namely, the plan of using one single rope carried several times round the pulleys and crossed by a jockey pulley—may learn a lesson from the recent mishap at the Sheffield supply station. There a rope, arranged on this plan, parted in the busiest hour of a Saturday evening—dearest hour to the shopkeeper—and two mortal hours of darkness supervened while a new rope was being spliced. All too late, it is decided to adopt the more common English system of placing several independent ropes on the same drive. This is well; but a far better plan would have been to use no ropes at all.

The Light Railways Committee.—The Committee appointed at the recent Board of Trade conference on the subject of light railways has met several times at the Board of Trade, Sir Bernhard Samuelson, M.P., presiding.

The Berliner Patent.—The United States Circuit Court has declared the Berliner telephone patent void.

Personal.—Prof. George Forbes, F.R.S., is expected back in this country almost immediately, the construction stage of the Niagara scheme being now completed.

Electric Power Transmission in Sweden.—In connection with the projected large power transmission from the Trollhätta Waterfalls for account of the Swedish State, a serious dispute has arisen as to the ownership of these vast falls.

Prof. Helmholtz's Successor.—Dr. Kohlrausch, Professor of Physics at Strasburg University, has been offered and has accepted the position as Director of the Physico-Technical Institute in Berlin, in succession to the late Prof. Helmholtz.

A Tax on Light in Italy.—In the course of his financial statement in the Italian Chamber of Deputies on Monday last week the Minister of the Treasury announced that a sum of 27 million lire would have to be provided for by increased taxation; and among the means proposed for raising this amount was a small tax on the consumption of gas and the electric light by private persons.

Electric Traction in Austria and Hungary.—A company has just been formed in Budapest, to be known as the Neupest-Rakos-Palota Electric Tramway Company. The Company, in which Messrs. Ganz and Co., of Budapest, are interested, has been formed to construct and operate an electric tramway from Neupest to Rakos-Palota. It is proposed to construct an electric tramway from See-am-Mondsee to Unteriah-am-Attersee.

The New Gas.—It is announced that a Paper by Lord Rayleigh and Professor Ramsay on the newly-discovered gas will be taken as the subject for discussion at a meeting of the Royal Society on January 31st, which will be the first meeting under a resolution of the council, passed last session, whereby certain meetings—not more than four in each session—are devoted each to the hearing and consideration of some one important communication.

Electricity in the United States Navy.—The United States Naval Ordnance Bureau has invited a number of electrical firms to submit designs of electrical apparatus for the operation of turrets and guns. Electricity has been used for the operation of the "Montauk's" turrets for some time, and the experiments have resulted very satisfactorily. It is intended to place electrical apparatus in the turrets of the "Brooklyn" and "Iowa."

Interurban Telephonic Communication in Germany.—Telephonic communication has just been made available between Berlin, Königsberg, Tilsit, Insterburg, and Memel, as also between Celle and Hamburg, and between Hanover and Celle. An exchange is being established at Barth, while one has recently been completed at Nauendorf, which is also in communication with Löbejun and Wettin. A trunk line is being erected between Barth and Stralsund, where a new direct line between Chemnitz and Leipzig has recently been put in operation.

An Electrical Annealing Process.—A method of electrical heating by which the temper of a "harveyised" armour plate at any given point can be "let down" and made soft enough to permit the drilling of bolt holes without affecting the surrounding surface has been devised at the Homestead plant of the Carnegie Steel Company, and has been successfully tested at the Cramp shipyards. Before the method was introduced it was necessary to leave an entire strip six inches in width of the plate unhardened, rendering it at such points penetrable by projectiles.

Cable Interruptions:

	Date of Interruption.
Amoy—Gutzlaff	Nov. 10.
Latakia—Cyprus	Nov. 27.
Lourenço Marques—Durban	Dec. 10.

With reference to a telegram in the *Daily Graphic* of 19th inst., stating that the later scores of the cricket match at Sydney, between Stoddart's Eleven and All Australia, were not received, owing to the total interruption of the Australian cable communication, we are requested to state that it was the Australian land lines and not the cables which were interrupted.

Royal Institution.—The following are some of the Friday evening discourses to be delivered before Easter. On January 18th, Prof. Dewar will discourse on "Phosphorescence and Photographic Action at the Temperature of Boiling Liquid Air"; February 22nd, Prof. A. Schuster, "Atmospheric Electricity"; March 8th, Prof. A. W. Rücker, "The Physical Work of Von Helmholtz"; March 15th, Prof. Roberts-Austen, "The Rarer Metals and their Alloys"; March 29th, Prof. H. E. Armstrong, "The Structure of the Sugars and their Artificial Production." A course of six lectures on "Light and Sound," will be given by Lord Rayleigh, on Saturdays, March 2nd, 9th, 16th, 23rd, 30th, April 6th.

The City Telephone Tubes.—At Tuesday's meeting of the Commissioners of Sewers, Mr. Johnson inquired whether any progress had been made towards securing an advantage to the public by means of a bargain with the Electric Lighting Company for the use of telephone tubes, or whether there was any fear that by undue delay the Commission might be placed in a false position. Mr. Burmester, in replying, explained that in July Mr. Gordon placed on the Paper of business a motion to accept an offer of the Company for the use of the tubes in question, but that offer was not officially before the Commission, so it could not be described as a bargain. But the sense of the Commission was against any such offer, notwithstanding that it was one which, in his opinion, should have been accepted, it being somewhat in excess of what the Company was prepared to offer originally. The question was, however, still before the Streets Committee.

Gas Engines for Electric Lighting in America.—Writing in the *Engineering Magazine* on the use of gas engines for electric lighting in private houses in America, Mr. Nelson Perry says:

> "One of the greatest drawbacks to the more general introduction of lighting plants such as here advocated has been the absence of anyone who would guarantee the performance of the plant as a whole. Heretofore one company has put in the engine, another the dynamo, and a third the storage battery, &c. The investor has therefore been compelled to assume the risk and responsibility, which has in some cases proved irksome. The average investor, too, seldom has the time to investigate the merits of the various parts that go to make up the plant, and still less often is he qualified to discriminate between what is bad and what is really good. What is required is a firm or company that will assume all these obligations, that will contract to erect a plant complete for a certain price on a guarantee of performance, without the fulfilment of which they will hold the investor safe, and without expense for the experiment. There would seem to be an immense field for the proper parties in this direction. The only astonishing thing about it being that it has remained so long unoccupied."

Electric Tramways for Cairo.—*The Times* Cairo correspondent writes under date December 10: The concession for constructing and working during 50 years the tramways of Cairo has been given to a well-known Belgian firm, La Société des Chemins de Fer Economiques. The traction is to be by means of electricity through an overhead wire, and, as the suburbs will enjoy complete communication at a very small cost with the interior of the city, a great boon will be conferred upon the inhabitants. In 1890 Mr. Fell, the well-known tramway contractor, obtained a concession for the Cairo tramways, also for a period of 50 years, with the condition of payment of 2 per cent. of the receipts to Government. He is now claiming heavy damages from Government because in 1891 they cancelled his concession and sequestrated his £2,000 caution money. He adduces evidence of having made the necessary survey of 13½ miles of road, and of the purchase and landing at Alexandria of rails and rolling stock in due time.

Dioptric Glass Shades.—MM. Engelfred et Cie., of Paris, are introducing globes and shades invented by MM. Psaroudaki and Blondel. These shades are made of clear glass and are covered with prismatic corrugations for the purpose of diffusing the light, and of distributing it uniformly over a definite area. The invention has been described in several of the French electrical journals. Mr. A. P. Trotter, who claims to have anticipated this invention in 1882, compares his attempts with the new French system in the *Electrical Review* of December 14th. He attributes the want of success of his own invention to the difficulty of cleaning such glass, to the expense of manufacture, and to the rather unattractive shape of his shades. He questions whether uniform illumination is really wanted for street lighting, since the superfluous light is shed over a small area, and the dimly-lighted space is large; the superfluous light would go a very little way towards illuminating it well, and is more useful where it is. The general appearance of the French shade is a globe covered with numerous cross corrugations.

Le Rat de Ville.—A rat roaming about in the City Electrical Light Works of Baltimore recently played havoc, says the *Electrical World*. While investigating behind the station switchboard he stepped from one brass terminal to another, with his front feet on one pole and his hind feet on the other, thus being subjected to 2,700 volts. In an instant there was a flash, a heavy ironstone piece of insulation was smashed, the network of wires blazed up, setting fire to the wooden frames of the switchboard, and hundreds of houses in the down-town streets were plunged in darkness. The hair of the rat was completely burned off and the body became rigid as if suddenly frozen in the act of stepping across the terminals. Although the hair was burned off and even the skull bone protruded, the body being instantly carbonised and rendered rigid, its attitude, when discovered, was life-like and exactly that of a rat stepping across a small cavity. If the remains are not yet disposed of, says our contemporary, Dr. Gibbons would probably consider it a favour to have them forwarded to him for resuscitation.

The London County Council and the Tramways.—The Bill which will be promoted by the London County Council in the coming session of Parliament to obtain powers to work tramways has been finally drafted. The preamble sets out that the Council has purchased a portion of the London Street Tramways Company, and is proceeding to give effect to the powers of purchase with respect to other tramway undertakings, and that it is therefore expedient that power should be conferred upon the Council for working the tramways when acquired. It is provided that the Council may, by agreement, grant running powers over its tramways to other companies, and acquire running powers itself over other companies' lines; and, further, that all the expenses incurred in the execution of the powers contained in the Act shall be defrayed as payments for general county purposes. Appended to the Bill is a schedule of the Acts and Provisional Order under which the Council is now proceeding to purchase tramways. These Acts are the North Metropolitan Tramways Act, 1871; the Metropolitan Street Tramways (Extension, &c.) Order, 1873; and the Pimlico, Peckham, and Greenwich Street Tramways (Extensions) Order, 1873. A second schedule to the Bill contains a list of tramways which the Council may hereafter purchase. These lines comprise the whole tramway system within the county of London.

Gas v. Electricity.—The following incident at Southport, gleefully reported in the *Gas World* of the 15th inst., is a sample of what causes infinite harm to electric lighting, be the excuse what it may:—"While the discussion was in progress the Council had an amusing if somewhat inconvenient experience of the vagaries of the electric light. The light suddenly went out, leaving the council chamber in darkness. 'That showed the folly,' the Mayor remarked, 'of removing all the gaslights when they introduced the electric light. He had protested against it from the first; they must have gas in conjunction with the electric light.' In a minute or two it was decided to adjourn to the mayor's parlour, but on the way thither it was ascertained that the light there had also gone out. Almost at the same moment it was announced that the light had come on again in the council chamber, and the members returned to their places. The gentleman who was on his feet when the light went out resumed his speech, but had only uttered two or three sentences when the chamber was again plunged in darkness, amid the laughter of the members. A few wax vestas were lighted, just sufficient to render darkness visible, and a couple of gas jets at the end of the room having been lighted business was resumed. Fortunately, the electric light returned very shortly, and for the rest of the evening behaved with becoming propriety, although a little unsteady."

Telephone Troubles in France.—A few days ago, says a daily newspaper, the French Postal Department found itself under the necessity of refusing fresh subscriptions for the telephone service. The reason for this state of things is that the department is suffering from a scarcity of funds, which is not only an obstacle to the proper working of the department, but also to the development of the telephone service, especially considering the rate at which new subscribers to this service are coming forward. The real origin of the difficulty is that out of the eight million francs voted by Parliament for the postal service in 1889 (when the State took over the telegraph lines) only four millions have, up to the present, been placed at the disposal of the department. These four millions have been spent, partly in reorganising the telephonic services, and partly in the building of the superb establishment in the Rue Gutenberg. As further funds are not forthcoming, the Director-General of Posts and Telegraphs finds it impossible to increase the number of telephone wires at his disposal, to provide additional instruments, or to renew those which are becoming unfit for service. It is under these conditions, therefore, that the French Postmaster-General finds himself obliged to show the cold shoulder to would-be new subscribers to the telephone service, whose requirements he is not able to satisfy.

Municipal Purchase of Tramways.—At the last meeting of the London County Council the Highways Committee recommended—

> (*a*) That the tramways and depôts, the subject of Sir Frederick Bramwell's award, dated January 11, 1893, and of the agreement therein referred to with reference to the London Street Tramway Company's undertaking, be leased for a term, to expire on December 31, 1900, or on such earlier date on or after December 31, 1898, as the Council may by three months' notice determine. (*b*) That the lessee do take over and pay for, at the price to be paid by the Council, the cars, horses, harness, and stable utensils, and that at the termination of the lease the Council do, if required by the lessee, take over from the lessee, at a valuation to be then made, a similar amount of stock then in use and suitable for working the tramways. (*c*) That the lessee do take over, and pay to the Council £150 in respect of the engine, boiler, and shafting in the car-shop at the Cressy-road depôt.

These were agreed to; and it was further agreed—

> That companies and others be invited by public advertisement to tender for a lease of the tramway, &c., and to state in such tenders the amount of annual rent which they would be prepared to pay to the Council under the lease.

It was also agreed to inform the Board of Trade and the London Tramways Company that the Council declined to defer the purchase of the undertaking of the Company until 1898, as suggested by the Company.

The Measurement of Small Resistances.—The current number of *L'Elettricista* contains a description of a new method for measuring small resistances, due to Dr. Pasqualini. This method, which requires no special apparatus that cannot be easily set up in the laboratory, consists in having a coil, composed of a few turns of wire, wound double, so that there are two similar circuits. This double coil is fixed to the case of an ordinary galvanometer, so as to act on the needle. The main current sent through the resistance to be measured passes through one of the circuits of this auxiliary coil. A shunt circuit to the resistance is formed by the second circuit of the coil, the galvanometer, and a resistance-box. The connections are so arranged that the main current and the shunt current in the galvanometer coils tend to turn the needle in opposite directions. The resistance of the shunt circuit is varied till the galvanometer deflection is zero. Suppose K is the galvanometer constant, while K_1 is the constant which expresses the effect of either of the circuits in the auxiliary coils on the needle, and if I and i are the total main current and the fraction which passes through the shunt circuit respectively. Then $K i = K_1 I - K_1 i$, or if R is the resistance of the shunt circuit, the resistance to be measured $= \frac{K_1}{K} R$. The value of the constant $\frac{K_1}{K}$ can be obtained by performing the experiment on a known resistance. With an auxiliary coil consisting of two similar circuits containing four turns each, and a Wiedemann galvanometer of 8 ohms resistance, the author finds he can measure a resistance of 0·0002 ohms within $\frac{1}{1,000}$ I, using a standard ohm to determine the constant $\frac{K_1}{K}$.

ELECTROMAGNETIC THEORY.—LXI.*

BY OLIVER HEAVISIDE.

(Continued from page 185.)

§ **232.** In connection with the above problems in cooling by diffusion and escape of heat at the surface of bodies there are a number of incidental matters of great interest, some of the most noteworthy of which may be briefly noticed. In the first place, as was remarked in § 228, the prolongation of the time of cooling of a sphere from a given uniform initial temperature until a given gradient of temperature is reached at the surface of escape, produced by augmentation of the conductivity and capacity of the inner portion only, is not by any means an obvious result, though not difficult to understand in the case of an infinite block with a plane boundary when there is a similar augmentation of conductivity and capacity within its skin. In fact, we can easily make it be either a retardation or an acceleration at pleasure, when it is a sphere that is in question. To show this, let the conductivity be made infinitely great as an extreme case, except in the skin, where it remains finite, without changing the capacity either in the skin or body of the sphere. The theory of the cooling of the sphere is then like that of the discharge of a condenser through a resistance. The resistance here is the resistance of the skin, and the capacity is that of the inner body. Now by reducing the depth of the skin, and therefore the resistance, we may accelerate the discharge as much as we please. Thus, with the skin conductivity as in § 230, or 0·006, and the internal capacity per unit volume also the skin value, or 0·5, the time taken to fall from an initial uniform temperature of 4000°C until the present gradient of temperature is reached in the skin is 160^8 years when the skin's depth is 10 kilometres, but only 330^7 years when it is 1 kilometre. If it is 4 kilometres, as in Prof. Perry's example, the result is 920^7 years, which is only 9 times the standard result of 10^8 years found by Lord Kelvin. It is raised to 960^8 years, as Perry has shown, by reducing the internal conductivity from infinity to 79 times that of the skin, whilst at the same time increasing the internal capacity to 5·7 times that of the skin. To obtain the standard result, 10^8 years, with infinite internal conductivity and with internal capacity as in the skin, requires the skin to be only $\frac{1}{4}$ kilometre in depth, or a little less. When made thinner still, the time required falls off to any extent. These examples will show the danger of over-hasty generalisations regarding the effect of varying the internal conductivity and capacity. It is a general principle that increasing the conductivity accelerates the subsidence of a normal system, or a distribution of temperature which will subside according to the condenser law, and Prof. Perry's case is no exception. But there are other considerations, and the case is considerably mixed. If, in Prof. Perry's 960^8 years problem, we raise the internal conductivity to infinity, making no other change, we *reduce* the time to 520^8 years. Here the internal capacity is still 5·7 times that in the skin. Now reduce it to the same value as in the skin, and the time falls to 920^7 years, as just mentioned. Lastly, reduce the internal conductivity to the skin value, and it falls to 10^8 years, being now Lord Kelvin's case.

§ **233.** After these illustrations of the curious nature of the problem, consider another matter. It was mentioned in § 229 that the flux of heat into an infinite homogeneous block due to sources maintaining its plane face at the constant temperature V_0 was not altered by changing the material under the skin to another having the same value of the product ck. Or thus, by equations (2) and (3), the flux of heat, say C, per unit area, is

$$C = kg = (ckp)^{\frac{1}{2}}V_0. \tag{28}$$

This is unaltered by a change of material not altering the value of ck.

The result may be extended to include any number of slabs of different materials put together to make a block, provided ck is the same for all; or, in the limit, to a continuously heterogeneous material in which ck is constant, with, however, homogeneity in every slice parallel to the plane face.

Conversely, since the final temperature due to the impressed V_0 is a state of uniform temperature V_0 everywhere, if we start with V_0 everywhere constant, and let it subside by internal diffusion and free escape at the surface, the flux of heat at the surface will be unaltered by any change of material, provided every plane stratum is homogeneous in itself, and ck is the same for all.

A similar result applies to a sphere, with concentric shells instead of plane slabs, provided the correction for sphericity, due to the finite size of the sphere, be insensible: or if it be sensible, then we may have approximately the same result.

§ **234.** Another interesting point is the magnitude of the correction for sphericity. As mentioned in § 230, this is very large in Perry's 9,600 millions problem of a shell of depth 4 kilom., surrounding a homogeneous sphere of greater capacity and very much greater conductivity. The time for the corresponding infinite block is then 4·7 times that for the sphere. This was so remarkable that I suspected and suggested to Perry an error in his calculation of Fourier's formula. But I confirmed the result, and also obtained very nearly the same result from an entirely different formula which allowed for the capacity of the skin.

On the other hand, when the surface values of c and k extend all through the earth, as in Lord Kelvin's problem, the correction for sphericity is quite small, as mentioned in § 227. It only reduces the time of cooling by $\frac{1}{29}$th part of the 10^8 years which belongs to the infinite block.

Now in Perry's case we have a large increase in c and a very large increase in k beginning at a moderate depth. But if we increase them gradually, so as only to become very big near the centre, we do not get the Perry effect. To illustrate this I have calculated a few cases of continuously heterogeneous material.

When c and k both vary inversely as the distance from the centre of the earth, with the same values at the surface as before, I find that the correction is reduced to $\frac{1}{58}$ part. That is, the 10^8 years of the infinite homogeneous block is reduced by $\frac{1}{58}$ part to represent the new case of variable c and k in the earth, instead of by $\frac{1}{29}$ part, as when they are constant.

Also, to accentuate this effect, let the c and k in the earth vary inversely as the square of the distance from the centre. Then I find that the correction vanishes. That is, the time of subsidence from the initial state of 4,000 C to the given gradient of temperature at the surface is 10^8 years, the same as for the infinite homogeneous block.

Similar results occur in other cases of gradual variation, with, it may be, very large changes in c and k near the centre, but very little near the surface, or between the surface and half-way down; and clearly great latitude in the law of variation is permissible, provided we do not introduce great changes in c and k near the surface.

§ **235.** We may get an insight into the meaning of these corrections by dividing the sphere into a series of shells of unit depth. Since the flow of heat is radial, it is like the diffusion of heat through a series of flat plates of variable conductivity and capacity. Now the total conductance of a shell is proportional to its area, and so is its total capacity. Therefore, if the c and k in the sphere be constant, the conductance and capacity of a shell varies as the square of the distance from the centre, being zero at the centre, very small round it, and greatest and increasing most rapidly at the surface. So we see that large variations in c and k near the centre may make only trifling differences in the state of things at the surface, as the conductance and capacity of the innermost shells are naturally low. Besides that, they are so far away from the surface where the escape takes place that their c and k may become of little moment in the practical problem concerning the gradient of temperature in the skin. These considerations may help one to understand why when c and k vary as the first or as the second inverse power of the distance from the centre, so little difference is made in the time of cooling to the present gradient.

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Also, by substituting a block for the sphere, say a block of length equal to the radius of the sphere, and of cross-section equal to the surface of the sphere, this block to be insulated at its sides and open at its ends, we see that to represent the sphere of uniform c and k, the c and k in the block must vary directly as the square of the distance from the far end (corresponding to the centre of the sphere) when they are zero (equivalent to insulation). On the other hand, when c and k in the sphere vary inversely as the distance from the centre, c and k in the block must vary directly as the distance from the far end. Finally, when c and k in the sphere vary inversely as the square of the distance from the centre, c and k in the block must be *uniform*. That is, we have a homogeneous block, only it is of finite depth instead of infinite.

We now see why the correction in the last case disappears, the time for the sphere being the same as for the block. It is not asserted that the complete solution of the problem is the same in both cases, but that the problem is reduced to one of linear diffusion in a homogeneous medium, and that under the circumstances the finiteness of depth of the block does not influence the result sensibly, the secondary waves to and fro along the block due to its finite depth being of insensible effect because the depth is so great.

§ 236. In contrast with the above results with continuously varying c and k, Prof. Perry's case involves so large a correction for sphericity as to deserve an independent confirmation by a method not requiring the use of the Fourier expansion. For it is by the consistency of results obtained in different ways that a conviction of the accuracy of the results of complicated processes may best be obtained. It is very easy to make mistakes in calculating Fourier series of complicated forms. Fortunately, in this case, I find that my operational method leads straight to the solution by a simple process.

We found in § 228, equation (8), that

$$\mathrm{V}_1 = \frac{\mathrm{V}_0}{1+\mathrm{R}kq} \tag{29}$$

expresses the temperature V_1 just inside the skin due to V_0 impressed on its outside, when R is the resistance of unit area of the skin, k the internal conductivity, and $q=(cp/k)^{\frac{1}{2}}$. This is in the plane problem.

Now get the corresponding solution for the sphere. Let V be the temperature at distance r from the centre of a sphere of radius a and of uniform c and k due to V_0 impressed on the outside of an enveloping skin. Then V is given by

$$\mathrm{V} = \frac{\dfrac{a \operatorname{shin} qr}{r \operatorname{shin} qa}\mathrm{V}_0}{1-\dfrac{\mathrm{R}k}{a}+\mathrm{R}kq \coth qa}. \tag{30}$$

To prove this, note that in the first place V satisfies the spherical characteristic

$$\frac{1}{r^2}\frac{d}{dr}r^2\frac{d\mathrm{V}}{dr} = q^2\mathrm{V}\,; \tag{31}$$

next, that it is finite at the centre; and, lastly, that at the inside of the skin, where $r=a$, it satisfies the condition of continuity of the flux of heat there, or

$$\frac{\mathrm{V}_0-\mathrm{V}_1}{\mathrm{R}} = k\frac{d\mathrm{V}}{dr}. \tag{32}$$

This is complete. But what we want is V_1. So put $r=a$ in (30). This makes, if $s=\mathrm{R}k/a$,

$$\mathrm{V}_1 = \frac{\mathrm{V}_0}{1-s+\mathrm{R}kq \coth qa}, \tag{33}$$

which gives V_1 in terms of V_0. Comparing with (29) we see that 1 becomes $1-s$ (which is a trifle less) and $\mathrm{R}kq$ receives the factor $\coth qa$, which brings in an infinite series of secondary diffusive waves between the centre and boundary.

To show them explicitly, we may develop (33) by long division to the form

$$\mathrm{V}_1 = (a_0+a_1y+a_2y^2+\ \ldots\ )\mathrm{V}_0, \tag{34}$$

where

$$y = \epsilon^{-2qa}. \tag{35}$$

Here $a_0\mathrm{V}_0$ is the result of the primary wave from the source V_0 outside the skin, as modified by sphericity; the second term is the result of the first wave reflected from the centre, the third term results from the weaker second reflected wave, and so on.

But all these secondary waves are of insensible effect in our problem, as we know by the solutions previously given when the proper numbers for c and k, &c., are put in. The significant solution is merely the first part independent of y. This amounts to the same as making a infinite in the coth function, when it reduces to 1. So, by (33),

$$\mathrm{V}_1 = \frac{\mathrm{V}_0}{1-s+\mathrm{R}kq}, \tag{36}$$

is the practical solution in operational form. We see that it is equivalent to (29), only with a changed constant.

We also know, by (11) and (12), § 228, that only the first power of q is significant in the earth problem. This makes (36) become

$$\mathrm{V}_1 = \frac{1}{1-s}\left(1-\frac{\mathrm{R}kq}{1-s}\right)\mathrm{V}_0, \tag{37}$$

which, by (5), is converted to the algebraical form

$$\mathrm{V}_1 = \frac{\mathrm{V}_0}{1-s}\left\{1-\frac{\mathrm{R}}{1-s}\left(\frac{ck}{\pi t}\right)^{\frac{1}{2}}\right\}, \tag{38}$$

the required result. The subsidence solution is got by subtracting the right member from V_0. This makes

$$g = -\frac{\mathrm{V}_0 s}{(1-s)l}+\frac{\mathrm{V}_0}{k_1(1-s)^2}\left(\frac{ck}{\pi t}\right)^{\frac{1}{2}}, \tag{39}$$

if $\mathrm{V}_1=gl$, where g is the gradient of temperature in the skin of depth l. We may write (39) thus,

$$g' = \frac{\mathrm{V}_0}{k_1}\left(\frac{ck}{\pi t}\right)^{\frac{1}{2}}, \tag{40}$$

if

$$\frac{g'}{g} = (1-s)^2\left(1+\frac{\mathrm{V}_0 s}{(1-s)lg}\right). \tag{41}$$

Now (40) is of the same form exactly as (12), with a changed value of the gradient. The effect of the sphericity is, therefore, the same as changing the gradient in the plane problem from g to g'.

Now put in the numerical values as in § 230. That of s is 0·0495, l is 40^5, and V_0 is 4000. So

$$g' = 2{\cdot}1819\,g, \tag{42}$$

which is to be used in (40). This increased value of g requires t to be reduced as its square. So the time required to make g be $\frac{1}{2743}$ is $(2{\cdot}1819)^2$, or 4·76 times as long for the infinite block as for the sphere. Q.E.D.

If desired, the full expression for the secondary waves can be developed from (34), but all we wanted was a direct corroboration of the result got from the Fourier expansion. The method followed is an example of the theory of § 12 of my paper "On Operators in Physical Mathematics," *Proc. R. S.*, Vol. LII., 1893, which is of very general application.

The formula (39) allows us to see readily the effect of varying the constants. The time of cooling varies directly as c and as the square of V_0, so these may be dismissed at once. There are left l and k. Varying k only, I find that t has a maximum and a minimum when l is under 7 kilometres. The minimum is of no consequence. The maximum occurs when $k/k_1=73$, and is $t=95{\cdot}5$, the unit being 10^8 years. That Perry should have spotted the maximum so closely is (unless he is a witch) one of the most remarkable coincidences in ancient or modern history. But the hump is so flat-topped that much smaller values of k will do for big t. Thus $k/k_1=30$ makes t be about 90.

Another (and perhaps physically better way than increasing k) of getting big t is to increase the depth of the crust. Then a smaller k will do. Thus with $l=20$ kilometres we get $t=68{\cdot}5$ when $k/k_1=15{\cdot}95$ only. And $l=30$ kilometres allows us to have $t=53{\cdot}4$ when k/k_1 is only 10·65, and $t=95$ when k/k_1 is 21·8. These results altogether favour Perry's view, and are better than his own example.

§ 237. We now leave heat problems, and pass to the theory of electrical matters involving diffusion. Pure diffusion, as of heat, comes in principally in two different ways. There is, first, Lord Kelvin's electrostatic diffusion in a submarine cable when perfectly insulated and free from self-induction. Secondly, there is Maxwell's diffusion of magnetic induction in electrical conductors. There are also two comparatively unimportant cases, viz., diffusion in a cable or other circuit, when it is the self-induction and the leakage that control matters, and a kind of diffusion in a magnetic conductor. Of these, the electrostatic diffusion involves the simplest fundamental ideas, and will therefore occupy us first. After that, diffusion in electrical conductors will naturally follow.

How these diffusive propagations arise from the general theory of electromagnetic waves has been explained in Chapter IV. in considerable detail, including the more difficult case of elastic diffusion. What we have now to do is to consolidate the knowledge by actual exemplification. We shall then be able to explain the meaning of the operational mathematics above employed, as it turns up naturally. The physics itself will serve to guide us along to useful methods and results. At present the above illustrations from the theory of heat diffusion will serve a double purpose. First, to illustrate Lord Kelvin's theory of the age of the earth and its recent extension by Prof. Perry, the practical import of which, however, remains to be discovered, as very uncertain and speculative data are involved. Next, to show that my operational method of dealing with these and similar more advanced problems is of importance. I assert that by its means problems can be attacked and successfully solved with greater power than by any other known method. Furthermore, that it is essentially simple in operation; so that, although it goes deeper, yet it requires less work and less mathematics of the complicated kind. And, finally, that it is for the above reasons and others quite practical. It is rather disagreeable to have to be self-assertive and dogmatic (especially when one thinks of the always possible risk of error); but there may be times when it becomes a duty—*e.g.*, when mathematical rigourists are obstructive.

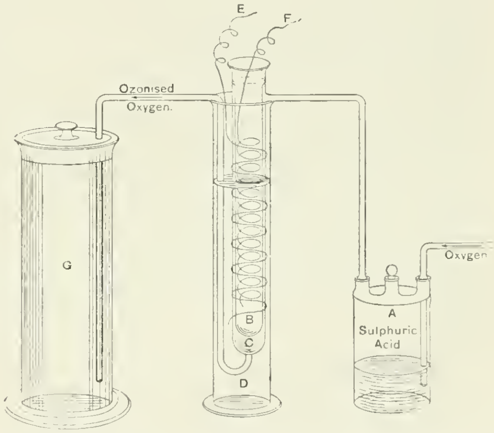
(To be continued.)

THE UTILISATION OF OZONE.

A Paper of interest, by Dr. O. Frölich, on the utilisation of ozone, has recently been published in the Proceedings of the German Electro-Chemical Society. The statements which it contains are based upon observations made on a working scale in many cases, and refer in some instances to applications which are in actual operation. Certain of the methods of utilisation put forward are admittedly only suggestions, but they are in all cases of a practicable kind and worthy attention. The apparatus used was one designed by Siemens and Halske, and is in principle identical with the Siemens ozone tube—now a classical laboratory instrument. A useful modification in detail consists in the substitution of mica for glass as a dielectric. Each unit of the apparatus is, therefore, composed of a metal tube with a mica sheath, enveloped in a mica tube with a metal sheath, the annular space between the two mica surfaces serving as a channel for the gas to be ozonised. The well-known modification of the Siemens tube, differing therefrom in that the coatings of the dielectric are water or dilute acid, is also useful, especially for small installations. It has the advantage of being transparent, and thus allowing the observation of the character of the discharge taking place between its opposing surfaces.

The two essentials for the successful formation of ozone are the use of an alternating current of high voltage and the production of a "silent" discharge. In modern practice the induction coil which has sufficed for laboratory experiments is replaced by a step-up transformer. It is not a matter of indifference in what manner the alternations occur. Should the curves representing the rise and fall of the current be unsuitable, a reduction in the output of ozone per unit of electrical energy is to be expected. The author states that the form of alternation found by experience to be most efficient has now been ascertained, but gives no details of the construction of the transformers designed for this particular end. When the right character of alternation has been arrived at, the working of an ozonising plant is simple, fair regularity of running being the chief requisite. The only measurement needed is that of the voltage at each ozoniser, which should be tolerably constant. It is noticeable that with an increased production of ozone a rise in the temperature of the ozonisers takes place, this being sufficiently great to need the circulation of water through the inner tube of the ozoniser. The uses to which ozone can be put may be conveniently dealt with under the following heads :—

Chemical Processes.—Ozone, when used on account of its chemical activity, varies greatly in its effects, according as it is used alone or in conjunction with other substances, *e.g.*, chlorine. When ozone is blown through spirits of turpentine copious white fumes are evolved, the composition of which is at present unknown. The substance thus produced has strong bleaching properties, textile materials dipped in spirits of turpentine and then exposed to ozone being readily decolourised. A similar effect is produced when ammonia is substituted for turpentine, ammonium nitrite being a product. A considerable obstacle to the wide utilisation of ozone is its comparatively high cost. Up to the present, only 20 grammes of ozone per horse-power hour can be prepared, while 70 grammes of electrolytic oxygen can be obtained by the same expenditure. It follows, therefore, that the remunerative employment of ozone must be confined to cases where action upon the whole bulk of the material treated is not contemplated, but merely a removal of impurities, or improvement in quality of a tolerable high-priced commodity is aimed at.



Description.—The apparatus shown in the figure is of the modified Siemens type. The oxygen is dried by passage through sulphuric acid in the bottle A, and then passes through the annular space between the inner glass cylinder B and the outer C, where it is subjected to the influence of the silent discharge taking place between the opposed glass surfaces. The inner cylinder B and the glass jar D are filled with dilute sulphuric acid, and are connected with the terminals of a suitable induction coil by the spiral wires E F immersed in the acid. The glass jar G serves for the reception of the ozone, and the exposure to the ozone of any substance to be acted upon. All parts of the apparatus are of glass, the joints being blown or ground in.

Sterilisation.—Ozone acts rapidly upon micro-organisms, and a special investigation has been made by Dr. Ohlmüller to ascertain how far this action can be utilised. The chief conclusion arrived at is that when oxidisable matter as well as bacilli is present in the liquid to be treated, the former is attached first and the latter are killed only after this initial oxidation. The destruction of the bacilli when once begun is rapid, pathogenic organisms being killed almost instantaneously. It appears, therefore, that the use of ozone for sterilising water is only advantageous when the water is fairly pure and free from much oxidisable organic matter. The author suggests that the town supply in Berlin, which is nearly free from organic matter, should be ozonised before being sent into the mains.

Ventilation.—The action of ozone upon micro-organisms on the walls and in the air of living rooms is not great; moreover, the smell of pure ozone—as distinct from the products associated with hydrogen peroxide, which characterise the air of pine forests, and are vulgarly termed "ozone"—is unpleasant, and if the gas be present in notable amount it has a strongly irritating action on the throat and lungs, resembling chlorine in this respect. It follows that any utilisation of ozone for furthering ventilation must depend upon the conjoint use of substances—*e g.*, ethereal oils, capable of modifying the effects of the pure gas.

Improving Articles of Consumption.—The effect of ozone upon spirits has long been known to resemble that which results on keeping. Apparatus has been devised for treating the contents of casks in a cellar or store individually. It has been found that the improvement is more marked with strong, sweet wines, spirits and liqueurs, than with alcoholic liquids light or acid in character. The ozonising is best applied moderately but repeatedly. The method has been in use by one cognac maker for several years, good results having been obtained. The flavour of tobacco and coffee is also improved by ozonising. A crucial test of this alteration has been afforded by the action of ozone upon the so-called "stink-beans" sometimes found in coffee. These are isolated beans, which, during storage and transport, have suffered a fermentative change sufficient to cause them to contaminate the whole consignment with their own offensive taste and smell. One circumstance constitutes a drawback to the treatment of coffee with ozone, viz., that the broker has a strong prejudice in favour of a particular gloss and colour, which properties are deteriorated by ozonising, although the flavour is improved.

The applications about to be described have either actually been found of technical value, or are fairly certain of being adopted commercially. René, a piano maker of Stettin, has used ozone since 1881 to improve the resonant properties of the wood used in making the instruments which he constructs. The wood is placed in a warm, well-closed chamber, and ozonised air is passed through for 12—24 hours. The wood is thus uniformly hardened and made less sensitive to fluctuations of temperature; the alteration is probably due to the oxidation of the resin contained in the wood.

The customary method of oxidising linseed oil for the manufacture of linoleum, by hanging strips of fabric (termed "scrim") saturated with the oil in an airy loft, occupies several months. By the use of ozone the oxidation is completed in a few days.

The author, in conjunction with Herr Keferstein, a bleacher having a factory at Greiffenberg, has worked out the details of the application of ozone to the bleaching of linen, with the result that grass bleaching is now given up. The ozone installation has been running for a year. Its capacity is 500 kilogramme of linen per day. It is impracticable to use the ozone *per se*, both on account of its high cost and its excessive "tendering" action on the fibre. The linen is therefore subjected to the usual preliminary treatment with acid, alkali, and chloride of lime, precisely as is often done in the case of grass-bleaching, the only point of distinction being the substitution of the ozone bleaching for the last-named stage of the process. Favourable results were also obtained by steeping the linen, previous to exposure to ozone, in weak solutions of hydrochloric acid, spirits of turpentine, and ammonia. The treatment with ozone is carried out in a closed chamber, and continued for 6 to 7 hours, whereby the decolourisation is carried to about three-quarters the extent ultimately reached. The completion of the process is effected by alternate treatments with ozone and chloride of lime. The saving of time, and the independence of weather attained by the use of ozone are the chief advantages of the system

Bleaching by ozone can also be applied to beeswax, which is still sometimes sun-bleached. A whole series of starch products have also been prepared by the aid of ozone, the work having been carried out by the author in association with Herr Hellfrisch. The usual methods for preparing such substances as soluble starch, dextrin, &c., from raw starch, often yield products of dark colour and bad smell, which diminish their commercial value. The bleaching action of ozone in conjunction with chlorine is found to give materials of this kind a lighter colour and better odour and flavour.

LIGHT RAILWAYS IN BELGIUM.

The following is the report addressed by Major G W. Addison, R.E., to the Board of Trade and alluded to on page 197 of our last issue :—

Société Nationale des Chemins de Fers Vicinaux.

Light railways in Belgium are entirely in the hands of the "Société Nationale des Chemins de Fers Vicinaux," formed by an Act of June 24, 1885. with the object of establishing light railways along the reads. Although the Government retains the power of granting concessions to private companies, for similar undertakings, the "Société Nationale" has always the first offer.

Finance.

The capital of the "Société Nationale" is contributed one-fourth by the State and three-fourths by the provinces and communes directly interested in the construction of a line; private individuals may also subscribe if they wish to push on a line, to the extent of one-third the capital required. As will be seen further on. the actual amount subscribed privately is very small indeed. The contributions of the provinces and communes are raised, with the assistance of the State, by means of 90 years' annuities at 3½ per cent. interest, which interest includes the sinking fund for the redemption of the debt in 90 years. If the annual profit on any line, after deducting working expenses, is insufficient to pay a dividend of 3½ per cent., the balance must be made good by the province and communes concerned; when more than 3½ per cent. is paid, certain portions of the balance are allotted to the formation of (*a*) "fonds de prévision," for future improvements to the line, and (*b*) a reserve fund, applicable to the system generally, and not only to the particular line earning the profit, as in the case of the "fonds de prévision." In 1893 about 25 per cent. of the lines earned dividends of 3½ per cent., or more. Should a line fail to earn sufficient to pay working expenses, the loss to that extent falls upon the "Société Nationale"; but the latter is not responsible for the interest, &c., of the annuities.

Organisation.

The headquarters of the Society are in Brussels, and it is administered by a board consisting of a president, four members, and a general manager; the president, two of the members of the board, and the general manager being nominated by the King, all the Society's operations are. practically speaking, controlled by Government. There is also a "Comité de Surveillance" of six members, appointed by the annual general meeting, at which each province and commune is represented by one delegate, and private subscribers have a certain number of votes.

Demands for new lines.

The demand for a new line must come from the council of the commune, to the National Society, giving full information as to the population and industries to be served by the proposed line, and the route the line should take. The commune must undertake to repay to the Society any expenses incurred in making surveys, &c., should the line not be constructed, and they must furnish details of their financial position and ability to subscribe their share of the required capital. The Society, after making estimates of the cost of constructing and working the line, and arranging with the provinces and communes concerned, the share which each should contribute towards the capital, forwards a reports, with all plans and documents, to the Minister of Agriculture and Public Works; the latter decides whether any public inquiry is necessary or not before the concession is signed by the King.

Construction of lines.

The lines are made by contract under the supervision of the Society. It is calculated that 2,000fr. per kilometre (£128 per mile) should suffice to repay to the Society preliminary expenses and the cost of watching the work of construction.*

Working arrangements.

When finished, the lines are handed over to subsidiary companies to maintain the permanent way. keep up the rolling stock, and work the lines generally. These companies receive a fixed percentage of the gross receipts, with generally, but not always, a guaranteed minimum of 2,000 francs per kilometre (£128 a mile) a year.

Report for 1893.

A separate account, both as regards construction and working, is kept by the Société Nationale for each line, and they furnish an annual report giving very full details of everything. From the report for 1893, I find that :—

(1) The Society was then working 58 lines with a total mileage of about 730 miles; for lines, 40 miles in length, were in course of construction; and projects were under consideration involving about 900 miles additional.

(2) The gauges of the above 62 lines were :—

About 615 miles, 1 metre gauge.
" 125 " 1m. 067 "
" 30 " 4ft. 8½in. "

The intermediate gauge lines (1m. 067, *i.e.*, about 3ft. 6in.) form extensions of the Netherlands "Vicinaux" railways. Practically, therefore, the Belgian lines may be considered a metre gauge system.

(3) The subscribed capital amounted to about £2,350.000. subscribed in the following proportions; viz. :—

By the State, 27 per cent.
By the provinces, 28 per cent.
By the communes, 41 per cent.
By private individuals, 4 per cent.

(4) The cost of constructing the lines, providing rolling stock, &c., averaged £2,688 per mile—the sum paid for land being less than £220 per mile of line.

---

* This amount is included in all estimates.

(5) The system included sidings at 62 stations of the main railway lines, and 93 sidings constructed for private companies and individuals. Of the latter, about one-third are in the interest of agriculture.

(6) The society had—

245 locomotives,
663 passenger carriages,
1,574 waggons and luggage vans.

The locomotives are principally of 18 tons weight, but there a few lighter, and some up to nearly 30 tons in weight.

Of the waggons, more than 70 per cent. carry 10 tons, the remainder being for freights of five tons (a few also for 20 tons).

(7) The working expenses were 71·31 per cent. of the gross receipts, the expenses including 175 francs per kilometre (about £11 per mile) to the Society for administration, &c.

(8) The receipts from passengers and goods respectively were 72 per cent. and 28 per cent of the total.

(9) The mean recent dividends paid on all the lines are :—

1890	2·65 per cent.	1892	2·76 per cent.
1891	2·75 „	1893	2·80 „

In 1893 four lines were unable to pay working expenses, and there appears to be a loss to the Society on the working of those lines to the end of 1893 of rather over £3,000. On the other hand, the Society had a reserve fund of between £8,000 and £9,000, and the "fonds de prévision" amounted to nearly £5,000.

(10) During 1893 no accident is said to have occurred to any person due to collisions or to the train leaving the rails.

The actual numbers killed and injured were :—

—	Killed.	Injured.
Passengers	5	3
Companies' servants	0	3
Other persons	20	7

In nearly every case of death contributory negligence is claimed to relieve the company working the line from blame.

I thought it desirable to inspect a line intended primarily to serve an agricultural district, and with this object the line from Andenne to ghezée was selected. M. de Burlet, the general manager of the Société Nationale, kindly sent one of his engineers, M. Paul Berger, with me.

Andenne to Eghezee.

This line is about 12½ miles in length, and is mainly dependent upon its goods traffic, which produced last year about 60 per cent. of the gross receipts of the line. Like all the Vicinaux railways, it is constructed on the road, excepting where steep gradients, &c., make slight diversions desirable. Usually a line of way is formed at one side of the road, raised slightly by ballast, &c., and separated from the remainder of the road by kerbstones ; it resembles a footpath alongside a country road. In this way the railway is not available for ordinary carriage traffic, nor is it used by pedestrians. Through villages, and where roads have to be crossed, the line is of the usual tramway type.

The line is of 1 metre gauge, with steel rails weighing 21½ kilos (42lb.) per yard. In the towns, I believe, they use a deeper rail, weighing about 60lb. per yard. The rails are of the "Vignolles" type, secured by dog spikes to creosoted sleepers about 4ft 8in. by 8in. by 4in. Points are worked in the country by a lever at the side of the line, and in towns by a key, fitting a screw-head placed between the rails. I did not obtain details of the curves and gradients of Andenne Eghezée line, but, as examples of the Vicinaux system, I take three lines, amounting to 45 miles in length, where the sharpest curves are—30 metres, 35 metres, and 40 metres respectively : *i.e.*, about 1½ to 2 chains radius. On the same lines there are gradients of $\frac{1}{20}$ and $\frac{1}{25}$. Round the very sharp curves gauge ties are used to prevent the rails from opening out. Guard rails are only used in towns.

The speed is limited, by regulation, to 30 kilometres (about 18 miles) in the country and six miles per hour in towns and through villages ; the time allowed in the time table for the journey from Andenne to Eghezée, 12½ miles, averages 1 hour 25 minutes, but one train in the day each way only takes about 1 hour 5 minutes. On another line, Ostende-Furnes, which is chiefly a passenger line, the train takes about 1¾ hours on a journey of 20 miles.

The engine of the Andenne line, 18 tons weight, had six wheels coupled, each of 3ft. diameter ; all moving parts were cased, and it was driven from either end (the driver, of course, always being in front). It was, in fact, an ordinary tramway locomotive. The engine was only provided with a hand-screw break. I notice in the Police Regulations, issued from the office of the Minister of Agriculture, &c., that the breaks on the engine wheels should be sufficient, alone, to stop a train on the steepest gradients in a length of 30 metres (33 yards). They were trying a simple form of continuous break actuated by either the driver or guard releasing a cord ; upon which weights fell and applied the breaks ; the cord passed over the tops of the carriages or waggons (to which this arrangement is equally applicable). The engine always carries two men, a driver and a stoker.

The train in which I travelled was composed, at starting, of one goods waggon next to the engine, one passenger carriage, and one fourgon or luggage van ; subsequently we dropped the goods waggon, but picked up three more waggons. The mixed trains usually have one van, in front of the train in one direction, and in rear on the return journey. The van carries any passenger luggage, and goods of small bulk ; when not employed elsewhere, the guard rides in the van, and makes out his way bills, &c. For the suburban passenger traffic there is usually no van, but the Society has a certain number of vehicles forming a second-class compartment, and a small van. Vans have a post office letter box, in which letters can be posted at the various halting places.

The waggons, carrying 10 tons of goods, weighed about four to five tons, and had four wheels coupled. They were of various patterns, according to the purposes for which they were intended to be used. The carriages on the Andenne-Eghezée line are about 20ft. in length, to the ends of the buffers, and about 8ft. 3in. in width ; they are divided, so that one-third forms a first-class, and the remainder a second-class, compartment ; with seats across the carriage, a central passage, and doors at the ends opening from platforms. They are provided with a screw hand break on one platform. There are various patterns of carriages in use on other lines On one line running into Brussels I noticed a carriage nearly 40ft. long, with bogies at each end ; I also saw some carriages with a very small wheel base, short bodies over the wheels, and large outside platforms. In all, however, the seats were placed across the carriages, and not along the sides. If more than two passenger carriages go with the train, they are supposed to have a second guard or brakesman. The length of the train is fixed for each line according to the gradients, the brakes in use, &c. ; but, as a general rule, it is limited to about 130ft. (engine, van, and five carriages or waggons as a maximum).

There were several sidings on the Andenne-Eghezée line, at the side of the road, so that carts could draw up alongside the goods waggons either to load or unload them ; the running line is then outside the siding, on land acquired for the purpose. Sidings on the level usually had two dead-ends, roughly made with a bank of earth and a few timbers. The stoker acts as foreman shunter at the sidings. The train only picks up loaded waggons, and does not stop to load *en route*.

There were no signals of any description in use on the line I examined, M. de Burlet informed me they were only used at specially dangerous points, such as level crossings over main lines of railway, where there are safety points, and a signal indicates to the driver when he is approaching these points. Before sunrise, after sunset, and during foggy weather the locomotive carries two white lights in front, one on either side, and a green light is attached to the tail of the train.

A room in an inn generally forms a waiting-room for passengers, and a place where parcels can be left either until called for or to be picked up by the train. No tickets are, however, issued, or other ordinary station business transacted. I believe it is not usual to make any payment to the proprietor of the inn, who gladly affords these slight facilities in return for the custom brought to the house. In addition to the stations as above, there are also fixed points (with a notice board only) where the train stops if there is anyone to pick up or set down, such as at important cross roads, &c.

At Eghezée the Vicinaux railway connects with the main railway system ; there is, however, neither here nor elsewhere, any physical junction of the metre gauge with the 4ft. 8½in. gauge line. Passengers alight in the road, near to the main line station, and there is a goods siding alongside a similar siding of the main line, that is all. Only the Vicinaux trains of 4ft. 8½in. gauge run into the stations of the main lines.

The only other point I have to mention in connection with the working of the "Chemins de Fer Vicinaux" is that the police regulations issued by the Minister of Agriculture, &c., fully recognise the necessity for protecting the railway as well as the public. Riders, drivers of carriages carts, &c., are warned upon the approach of a train to keep at least 5ft. clear of the rails ; if the rider or driver is not sure of his horse, he is enjoined to lead it until the train has passed. Before crossing the railway, persons are instructed to ascertain that no train is near. The level crossings of roads, excepting in a few instances, are not watched or guarded in any way.—I have, &c.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

THURSDAY, December 27th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "The Working of an Electric Current," by Prof. J. A. Fleming, F.R.S.

Acetylene as a By-Product of the Electric Furnace.—That the electric furnace should afford a product employed in the manufacture of an illuminating gas designed to compete with the electric incandescent lamp, is a result, says the *Electrical Engineer* of New York, which even the most imaginative of prophets would scarcely have predicted ; yet such, it would seem, is the latest development now attracting the attention of those interested in light distribution. The great illuminating power of acetylene has long been known, but until recently no method was forthcoming by which it could be manufactured cheaply enough to compete with the enriched water gas which has been rapidly displacing coal gas in America. In prosecuting his work in the reduction of refractory oxides at his aluminium works, Mr. Thomas L. Willson found that large quantities of calcium carbide could be produced commercially, from which acetylene is readily obtained. It is claimed that a burner taking 1 to 1¼ cub. ft. of acetylene per hour affords an illumination equivalent to about 50 c.p.

The Electrician.

(The Oldest Electrical Journal, 1861—1878.

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CHRISTMAS WEEK.

Contributors and Advertisers are requested to forward their communications as early as possible next week, owing to the Christmas Holidays.

No alterations to Serial Advertisements can be made after Monday night.

Small Advertisements will be accepted up to 4:30 p.m., on Thursday as usual.

A STUDENT'S EXPERIMENT AND ITS TEACHING.

Considering that a large proportion of those members of the Physical Society of London who most regularly attend the meetings are engaged in education, it is perhaps surprising that educational questions should be so seldom discussed by them. The more remarkable is this because it is manifest that widely different systems of instruction both in the lecture room and in the laboratory exist in different colleges; and this, not by reason of the aim of the teaching, whether under some inflexible syllabus for a rigid examination, or by a totally independent teacher with high ideals, or for an evening class of artisans, but by reason of entirely different views about methods of teaching. An interesting discussion on a purely educational matter took place last Friday at Burlington House, and, while most of the speakers took diametrically opposite views, the pros and cons seem to us to be so evenly balanced that it is worth while to examine the matter a little more closely.

We can imagine a scientifically-minded engineer who has sent his son to the Central Technical College for a course of physics, saying, "Why home so early, my son?"—(of course, no father talks like that in real life) "I thought you had laboratory work this afternoon." "Yes, father, the lecture was over at 3; but as I had only to make a determination of Joule's equivalent, I did the trick and caught the 3:15 at South Kensington easily. I worked out the result in the train, and it comes within point nought, nought, nought two of the mean between Griffiths (who is *the* nailer at Joule's equivalent) and the chap they call Michael S. Q. By-the-bye, I've taken Greenwich foot-pounds, what correction ought I to make for difference of latitude of the 'Central'?" Well may the father fear that he is not up to date, but at the same time he may comfort himself with the reflection that these technical colleges must be wonderful institutions. In another column will be found an abstract of a Paper read at the Physical Society on "Students' Simple Apparatus for Determining the Mechanical Equivalent of Heat," and a brief report of the discussion thereon. The remarkable feature of this apparatus is the careful elimination of corrections or the reduction of them to negligible quantities. Prof. Ayrton's object is, if we understand him rightly, to impress on the student's mind the nature of the important quantity which is called the mechanical equivalent of heat; and he asserts, indisputably we should imagine, that no amount of lecturing and reading will impress this so vividly as an actual experiment. If the experiment can be carried out conscientiously and with accuracy (that is to say, without any slovenly makeshifts or neglect of ordinary precautions) in two or three minutes, and the result can be produced in ten minutes, the student obviously has more time for other work. The aim of Prof. Ayrton and his colleague in this particular instance was to enable junior students to obtain a "sufficiently accurate result"—namely, correct to 1 per cent.—"without the introduction of troublesome corrections." In order to achieve this, an electrical method was chosen, and part of the equipment of the experiment is a pair of "good commercial" instruments, an ammeter and a voltmeter. It is only within the last year or so—if, indeed, the time has already come—when "good commercial" instruments may be relied upon "to measure either current or pressure with an accuracy much greater than 1 per cent." Of course, the German rubbish which is generally placed on the switchboard of a supply station, thanks to lowest tenders and lax specifications, seldom touches 1 per cent.; but the switch boys soon get to know their peculiarities, and apply corrections, as did Captain Cuttle to his wonderful watch. It is stated in the Paper that "the current was known within about one-third of 1 per cent., and the average potential difference within about one-fifth of 1 per cent." It may be that instrument makers send the very pick and pride of their goods to technical colleges, even for the use of junior students; for they are liable to be calibrated quite as often as they are used, and it would suit no instrument maker to be held up to derision for a matter of a half per cent. or so before these wonderful junior students of to-day. Thermometers are not, like voltmeters, invariably branded with the maker's name; but the maker may be excused, perhaps, for he cannot defend any errors which may be found by saying that the instrument has been roughly handled, and is out of order. The stop-watch in the hands of the junior student is supposed to have an error of one second in a minute and a-half, an error which, by-the-bye, would not be tolerated at the most rustic athletic sports.

The scientific interest of this apparatus lies in the elimination or reduction of the experimental errors. It is here that opinions begin to differ; but part of this difference arises from the too common reason that the disputants are talking about different things. Let us take this point first. One set of teachers say that the use of such an apparatus is harmful in three ways. It so clears the path of difficulties and renders the experiment so absurdly easy that the student never has to watch for or to apply corrections; he merely has to turn a handle, and he gets the result. Secondly, he is tempted to rely on the indications of direct reading instruments—a ready-made unscientific method of measurement; and, thirdly, he thinks, when he compares his result with those of elaborate researches, that he is doing high class work, and will, therefore, become conceited. Now, we are inclined to think that all these objections would hold, if it could be shown that no precautions are taken at the Central Technical College to avoid them. It was not to be expected that a paragraph of the present Paper would be devoted to a statement of such precautions, and Prof. Ayrton in his reply to the discussion plainly asserted that the more advanced students had to deal with the application of corrections, and that the calibration and verification of direct reading instruments is a common part of their laboratory work. So far as the postponement of corrections is concerned, surely this is but a case of learning to walk before learning to run; not long ago Mr. Callender or Mr. Griffiths, we forget which, published nearly a whole page of corrections to be applied to a single reading of a mercurial thermometer. Prof. Carey Foster, one of those who opposed Prof. Ayrton, admitted that this experiment was a good example of the way in which experiments should be devised, and Prof. S. P. Thompson went a step further when he pointed out that not only was the choosing of proper dimensions an important matter, but that it was a distinct gain to find, as a reward for such a choice, that one might neglect certain corrections. We are disposed to think that as a rapid method of teaching a junior student what is meant by the mechanical equivalent of heat this experiment is very useful, but that it is vastly more useful as an example for advanced students of the design of apparatus for physical measurement, and we do not doubt that full advantage is taken of this latter use at the Central Technical College.

The second point, that of the use of direct reading instruments leads to quite another branch of the discussion. Direct reading galvanometers, first suggested by Mr. J. T. Sprague, developed and barbarously christened "ammeters" by Profs. Ayrton and Perry, were for many years unworthy of the appellation "direct reading." A calibration table which could be torn up and re-calculated from time to time, would have been much better than a scale which pretended to read in amperes, but which was always wrong, and which sometimes required a variable correction throughout all its length. Unworthy, too, were such instruments of a place in a laboratory unless as shocking examples; and voltmeters which began to warm up almost before the needle had stopped fidgeting were perhaps worse. No wonder that they failed to gain an entrance into many a laboratory, and are now even excluded from some. But is not this undue conservatism? The ampere and volt have been in practical use for only some 13 or 14 years. But they have gradually crept into use, and to-day nobody dreams of using any other system; we should say, rather, dreams of not using this system, for there is none other. If, then, we are able to procure instruments which may be relied on to read direct to within half of one per cent., surely the time has come when they may be accepted as ordinary laboratory instruments for work in which a one per cent. error is allowed to pass. In no physical laboratory is the attempt made to refer all measurements to length, mass and time; and if the thermometer is accepted, if a resistance box is used, if a Clark cell is recognised, where shall the line be drawn? What virtue is there in a tangent galvanometer as a measuring instrument for ordinary work, invaluable as it is as a piece of educational apparatus? Ammeter or no ammeter, the tangent galvanometer must be abandoned in high-class work if only on account of the inevitable variations of the magnetic field, and for the best work the potentiometer and Clark cell are sure to come in. But the day will surely never come when the tangent galvanometer shall have disappeared from the laboratory and shall have vanished like the expensive apparatus used for and useful for nothing else than the "guinea and feather" experiment in the forgotten science of pneumatics. We can quite understand the reluctance of conservative teachers to introduce ammeters and voltmeters into their laboratories; but the argument that a student should be forbidden to time an experiment with a stop watch until he has made one, seems logical, and as neither Mr. Griffiths nor Prof. Carey Foster had an opportunity of replying to this suggestion, and presuming that they allow students to use ready-made resistance boxes, or at all events ready-made resistance coils for use with a slide-wire bridge, we should be interested to learn where they would draw the line. Prof. Rücker took an exactly intermediate course between the two parties, but his method necessitates a declaration on the part of the student of his future calling; he is to be taught only to use the instruments that he will hereafter merely use, but he is to be taught to make those which he may hereafter manufacture. That is practicable in the case which Prof. Rücker took as an example, namely, watchmaking. Those of us who merely use watches, and rely on them for timing, are greatly inconvenienced when they work imperfectly, and if poking about with a pin in the region specially provided for such a practice, and clearly limited by the letters F and S, fails, as it generally does, to effect a cure, we are helpless, and we send it to a watchmaker. But an electrical engineer and, *a fortiori*, a physicist ought not to be so helpless when he suspects or discovers something wrong with a direct-reading ammeter or voltmeter; and we therefore venture to differ with Prof. Rücker, who would, we understand, treat the use of an ammeter klie that of a watch.

The last objection does not need much comment. Mr. Griffiths fears that the young student who in ten minutes can do something which is rightly or wrongly called making a determination of the mechanical equivalent of heat, and who arrives at a result within 1 per cent. of the most elaborate determinations, is likely to become conceited. Such conceit, if it exists, is as ridiculous as that of the organ blower who said, "Shall it be 'we' this time?" To say nothing of the admirable design of the apparatus, the student takes ready-made, as we understand it, the water-equivalents of the glass vessel and of the resistance. Mr. Griffiths almost understates the case when he says that the student has only to turn a handle and the result comes out. We must confess that we rather regret to see any attempt at a comparison between the result of this experiment and those of Rowland and Griffiths. Let the authors of this Paper by all means make a determination without setting as low an ideal as a one per cent. error, and let that be called a determination; but let an experiment be an experiment. The idea of allowing a student to make a "determination" is probably part of the system of laboratory work which seems to be identified with Prof. Ayrton. No doubt it is preferable to grinding through a fixed routine of set experiments, and the appreciation even in a rudimentary fashion of the intense pleasure of original research must act powerfully as an incentive to good work in a laboratory, but we would rather see an enthusiasm imparted by the personality of the teacher or demonstrator along a well-ordered course of physical laboratory work. The wonderful amount of instruction which the Rev. F. J. Smith makes his pupils extract from the most simple mechanical apparatus, not allowing them to leave it until, as it were, they have sucked it dry, and their exclusion from the workshop instead of encouraging the playing at making a half horse steam engine, has much to recommend it. If we remember rightly, the application of corrections of all possible kinds is an essential part of the routine at the Millard laboratory, but this cannot be compared for a moment with the Central Technical College, the two laboratories are worked on totally different lines. But, to return to the comparison between this educational experiment and the determinations of Griffiths and others. These investigators would never think of using a ready-made ammeter or voltmeter, even if provided with a Reichsanstalt certificate endorsed by Major Cardew. They might even use the much-derided tangent galvanometer amongst other things. Was it not the incautious acceptance of the indications of a thermometer which compelled Mr. Griffiths to go over his work and modify his result of 778·99 in 1893 to 779·77 in 1894? The approximation of the results of this educational experiment with those of the high-class determinations does not, we think, justify a comparison. It does not necessarily follow that the reduction of errors to a negligible quantity by mathematical design of the apparatus is better than the facing of actual observed errors and the application of necessary corrections. In some respects the former process resembles the careful setting of a micrometer gauge to zero when closed instead of using a "zero correction." For rough work, indeed, for ordinary work, a close approximation to zero when closed, and direct reading without correction is sufficiently accurate; but in the highest work "sufficiently accurate" is unknown, and it is indeed better that the "zero error" of a micrometer should be something distinctly readable, in order that it may be as distinctly corrected.

WATER HAMMER IN HYDRAULIC MACHINERY.

Everyone is familiar with the shock which may be communicated to a water-pipe when a tap at the end of it is suddenly closed; and no doubt it is generally known among our readers that this phenomenon is utilised in the hydraulic ram for forcing water to a very much higher level than that from which it started. There are two principal facts which enter into the phenomenon, namely, the momentum of a moving pipeful of water, and the infinitesimal compressibility of water in the liquid state. If a column or moving mass of water in a rigid pipe is gradually throttled at the outfall, the water moving under a constant effective head, the velocity of the water in the pipe will vary inversely with the section of the passage through the throttling outfall. Thus, if the throttling is done by a simple, rectangular sliding gate or sluice; and if when the sluice is fully opened the velocity in the pipe is V ft. per second, then when the sluice is lowered so as to expose a passage of $1/n$th of the section the velocity in the pipe will be V/n. While closing the sluice, therefore, the whole body of the water above it will be losing speed and momentum. The time rate of change of the momentum measures the effective resistance opposed to the flow, and it also measured the impulsive force exerted by the water on the confining pipe and on the surface of the sluice. If a given change in the velocity of flow takes place the average force of the blow exerted by the water will vary inversely with the time occupied by the change; so that the more rapidly the stream is checked the greater does it stress everything which constrains it. The stress, in fact, depends on the *rate* of cutting of the stream by the gate or sluice. Take, for example, a volume of 500 cubic feet of water moving with a velocity of 10ft. per second. If the throttling takes place so rapidly that the entire motion is destroyed in one second, and impulse equal to

$$\frac{500 \times 62{\cdot}4 \times 10}{g} = 10{,}000\text{lb. (nearly)}$$

will take place; while, if the same change of speed is spread over 2sec. the impulse will equal only 5,000lb.

These are average forces; for, as a matter of fact, the force changes proportionally to the rate of shutting down the gate.

The ratio of the maximum to the average force depends on the design of the sluice passage, as well as on the way in which it is closed. In practice, the maximum force will be twice, or more than twice, this average value.

If there is an air vessel attached to the pipe above the gate the momentum of the moving mass of water will be absorbed in compressing the air, and as this compression may be extended over a very much longer period than that actually occupied in moving the gate, the rate of change of momentum—and, therefore, the impact of the water—is very much lessened. The air cushion, in fact, spreads the impulse over a longer time and lessens its maximum force in direct proportion. To a certain extent the extensibility of the other constraining surfaces act in a similar manner to the air cushion; the only difference between the cushioning effect of an iron pipe and that of an air vessel being that the modulus of elasticity of the latter is, to its disadvantage in this respect, many millions of times larger than that of air. Consequently the iron pipe cannot spread the shock over so long a time as air can; but, nevertheless, it does produce a certain amount of distortion. The compressibility of the moving mass exerts a similar effect. Even if air were as dense as water, it would not exert an equal impact if a moving pipeful of it were throttled; for the air would be a cushion unto itself, to an enormously greater degree than water can ever be. The practical point in all this is that it would be impossible to produce an infinite impact, even were the sluice closed instantaneously. There is a limiting impact, depending upon the initial velocity of the stream; so that the statement that the stress varies inversely as the time occupied in reducing the flow is not strictly true. But it is true enough for engineers, and for ordinary pipes and hydraulic plant; and it is true enough to make it necessary to take this water-hammer action, as it is called, into account when designing head-pipes and sluices for turbines. The speed at which the column of water in the head-pipe is checked is of special importance in connection with regulation of speed of the turbine on a variable load. It is often necessary to exert a quick and large check on the flow of water into the engine, and it is at such times that the conduits and passages are most heavily stressed by water hammer. Not uncommonly they are fractured, or the rivets are so strained that wasteful leakage is set up. Already a very large proportion of the time which can be allotted to a governor to do its duty is swallowed up in the preliminary process of pulling itself together—taking up the slack. The modicum which remains for the real work of adjusting the sluice is all too brief, and it is little wonder that the hydrostatic stresses rise to or exceed the danger limit. What is wanted is that less time should be occupied by the governor in making up its mind to act, in order that more time might be spent in action.

COUPLED DRIVING WHEELS ON ELECTRIC CARS.

It has been considered by some engineers, not without very good reasons, that the use of electromotors on tramcars and locomotives enables the wheel coupling rod to be dispensed with. The advisability of having sub-divided motor power on each vehicle, *i.e.*, two motors instead of one, is conceded alike by those who admire and those who condemn the coupler; but there is a difference of opinion, and a corresponding divergence in practice, as to whether the two axles, on each of which a motor is placed, shall be linked together, or left to their own devices. Our English practice is entirely, and European practice is largely, on the lines of uncoupled motors; but in the United States it seems that some very excellent results have been obtained with the coupler. Against coupled wheels it is justly urged that the tractive friction and stiffness of the locomotive are very considerably augmented, especially where there are many curves or curves of small radius. On this account the running expense is increased, because more energy per ton of rolling stock is consumed. The advocates of the coupling rod claim, however, that this disadvantage is more than counterbalanced by the reduced tendency to slipping and skidding which result from the use of coupled wheels. At first sight it may not appear that four uncoupled driving wheels can have any less grip on the rails than four coupled drivers have, since the distribution of wheel loads is not affected by the use of the coupler. As a matter of fact, however, there are properties of an electromotor which tend to vitiate such an argument. If the wheels are uncoupled, then each motor can race independently; and, at the same time, the racing of either of them depends on the grip of only two wheels. If the wheels are coupled racing depends on the grip of all four wheels, and both motors must race if either does. Supposing, in the first arrangement, a jolt or a greasy bit of line lets one motor start racing, immediately all the strain and tractive effort are thrown on the other motor, which, having all the work to do with only two wheels, starts racing too. The consequence is that if the car is on a very stiff gradient, as it was in an experimental trial in America recently, "when the wheels once starts to slip the car immediately slides to the bottom of the incline, although the wheels continue to revolve in a direction to take the car up the grade." But if the motors are coupled the sudden reduction of the grip of one pair of wheels will not upset the distribution of power between the motors, so that the chances of a general slip are reduced very considerably.

Such, in brief, is the evidence for and against the use of coupled wheels on electric cars. As to which is the better plan can only be settled by careful practical balancing of the gain and loss by each; setting the reduced slip and the augmented tractive power against the increased stiffness and rail friction.

ON SLOW CHANGES IN THE PERMEABILITY OF IRON.

BY W. M. MORDEY.

This subject, introduced by the article of Mr. Partridge and Prof. Ewing in *The Electrician* of December 7th, is of considerable interest.

For several months I have been investigating it in connection with the manufacturing work of the Brush Electrical Engineering Company, and as the results obtained have some scientific and engineering interest, they have been communicated to the Royal Society. Under the circumstances, I cannot go into the matter at all fully; but I may say that the tests, so far as they have gone, lead to the following conclusions:—

1. The effect is not fatigue of the iron caused directly by repeated magnetic reversals; it is not "progressive magnetic fatigue."
2. Neither magnetic nor electric action is necessary to its production.
3. It is a physical change resulting from long continued heating at a very moderate temperature.
4. It is greater if pressure is applied during heating.
5. It is not produced when the iron is allowed to rise more than a few degrees above the ordinary atmosphere.
6. It is similar to the effect produced by hammering, rolling, or by heating to redness and cooling quickly.
7. The iron returns to its original condition on reannealing.
8. It does not return to its original condition if kept unused and at ordinary atmospheric temperatures, whether the periods of rest are short or long.

The practical outcome of the matter is that transformers should be made larger, more costly, and less efficient if it is desired to avoid this effect; or that the increase, when it occurs, should be endured. The latter appears the preferable course.

The importance of this effect may, perhaps, be over-estimated. It is not nearly as important as it would have been a few years ago, before the magnetising losses had been reduced to their present very low values. If the percentage loss be confused with the percentage increase of percentage loss,* a grave misapprehension may arise. This distinction must not be overlooked. For instance, the 40 per cent. increase on which you comment is really only 0·388 per cent.; that is, 40 per cent. of 0·97 per cent.—enough for regret, certainly, but not enough for alarm.

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* As in the Editorial Note of December 7th.

In the interests of technical journalism I wish to protest against the sneering references to "alternate current experts," by which this matter was editorially introduced to the readers of *The Electrician*, and to the ungenerous comparison suggested between two classes of workers. Such utterances do not advance knowledge or tend to any useful ressult. In this instance they were singularly ill advised. *The Electrician* does not go so far as to say we should not test our own apparatus—we may do that if we will, but we should send "a few data from which such men as Prof. Ewing may be able to extract some scientific deductions." Then, in the same issue appears a sample result submitted by an electrical engineer to Prof. Ewing, with a wrong deduction by the latter—certainly scientific men must pray to be delivered from such friends as the writers of *The Electrician* editorials.

OPEN CIRCUIT LOSSES IN TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following extract from a long series of experiments upon a 2,000-watt Westinghouse transformer bears out some of Dr. Fleming's remarks in your issue of the 14th inst.

On April 20th last the transformer in question was tested cold at 10 a.m., for open circuit loss; its average temperature during test being 16°C. At 4 p.m., or six hours from start, it was again tested; its average temperature being 50°C.

The results show that the losses were, after six hours' running, *smaller* than at the commencement by about 4 per cent. The transformer was well wrapped up in non-conducting material during the six hours so as to stop radiation.

In addition to correct data as regards temperature, the *form* of the curves is most important, and this is for the same alternator a function of its load.—Yours, &c., E. WILSON.

Siemens' Laboratory, King's College, W.C.,
December 15, 1894.

THE PHYSICAL SOCIETY.

At an ordinary meeting of the Physical Society at Burlington House on the 14th inst., Prof. Rücker in the chair.

A Paper by Prof. W. E. AYRTON and Mr. H. C. HAYCRAFT, on

"Student's Simple Apparatus for Determining the Mechanical Equivalent of Heat,"

was read. In this Paper, the authors describe the construction and use of an apparatus which, when used with a good commercial ammeter, voltmeter, thermometer, and watch, would give the value of the mechanical equivalent of heat correct to 1 per cent. without any corrections having to be made, and without any special manipulative skill being required on the part of the observer. The measurements to be made were as follows:—(*a*) The value of the constant current passed through the resistance. (*b*) The average value of the potential difference between its terminals. (*c*) The mass of water heated, to which must be added the water equivalent of the containing vessel, resistance coil, and stirrer. (*d*) The rise of temperature of the water. (*e*) The time during which the current is passed. With the excellent electrical measuring instruments now obtainable it is possible to measure either current or pressure with an accuracy much greater than 1 per cent. The mass of the water was 2,000 cubic centimetres, and could be measured with considerable accuracy, and the water equivalents were small. The change of temperature must either be fairly large or the thermometer very sensitive and the stirring very efficient. There is a certain minimum time required, with an ordinary stop watch, to give the required accuracy, and the ratio of the heat lost to the heat generated during the experiment must be kept equal to the probable error in the time or temperature measurement. It was shown by calculation that as the area of surface of the vessel varies as the $\frac{2}{3}$rd power of the mass of the water, the error is proportional to the 6th root of the mass; hence, if the number of watts available is doubled, the accuracy of the experiment is only increased about $\frac{1}{6}$th. The thermometer used was graduated in 20ths of a degree, the rise of temperature adopted should be 3·87° in 2min. 20sec. The time actually adopted was 2min. The resistance was a strip of varnished manganin about $\frac{1}{4}$in. wide, 0·03in. thick and 5ft. long, bent in a series of zigzags into a double gridiron held together by ebonite. This gridiron was used as a stirrer. The resistance was rather less than $\frac{1}{3}$rd ohm, the current was 30 amperes and watts about 260. The heating surface was about 60 sq. inches, the vessel was a thin glass beaker. The size of the flexible connections and stout copper wires by which they were connected to the resistance was chosen with the intention that there should neither be heat received or heat lost on account of these connections, the rise of temperature in the wires being about equal to that of the water. The water equivalent of the glass up to the water level was 37 grammes, and of the manganin strip 10. The following is a sample experiment. Time 120 seconds. Initial temperature 18·40, final 22·02, rise 3·62, amperes 30, mean volts 8·634. Calories per watt second 0·2383. The mean of nine experiments was 0·2375, and the average deviation from the mean 0·001, or 0·42 per cent. The equivalent in ergs of one watt second is known to within $\frac{1}{1}$th per cent., and the mechanical equivalent of heat in ergs per gramme degree at 15°C. equals $4·211 \times 10^7$, or 782 foot-pounds per pound deg. F. at 59 F. It is easy to arrange that the mean temperature of the experiment shall be equal to that of the air, but this is not necessary to ensure the accuracy required. When this was done the result, 779 foot-pounds, was obtained.

A section of the Paper is devoted to previous determinations of the mechanical equivalent of heat. The results obtained since 1879 by stirring water or by the electrical method are tabulated thus:—

Rowland (friction), $4·189 \times 10^7$ or 778.
Dieterici (electrical), $4·1880 \times 10^7$ or 778.
Miculesen (friction), $4·1880 \times 10^7$ or 778.
Griffiths (electrical), $4·192 \times 10^7$ or 779.

The results obtained by the students is greater than the mean of these results by just $\frac{1}{2}$ per cent. The Paper concludes with a short history of the practical electrical units.

Mr. GRIFFITHS admired the design of the apparatus, and thought that some such arrangement might yield very fair results. He called attention to several errors or misprints in the table of determinations of other observers. He did not wish to criticise the results of the authors, as he quite recognised that the apparatus was intended for educational purposes. But he disagreed altogether with the educational use of such an apparatus, for it failed to familiarise the student with the intelligent application of corrections. If a student need, as it were, only turn a handle, and the result comes out, he is tempted to think that he is doing good work and would become conceited. In working with such an apparatus all his difficulties would be smoothed out for him. Mr. Griffiths trusted that such simplification of experiments would not extend, since he thought that they would do distinct harm.

Prof. CAREY FOSTER thought that the apparatus was a good example of the way in which experiments should be devised. He objected to the use by students of direct-reading instruments. Such instruments gave no scientific information. He would prefer that they should use such an old-fashioned instrument as a tangent galvanometer, or a potentiometer and Clark cell. He had never given his students direct reading instruments.

Prof. S. P. THOMPSON observed that the present apparatus afforded an excellent lesson in choosing the proper dimensions for an experiment. The student gained in finding out that he might neglect corrections under certain conditions. He differed from Prof. Carey Foster as to the use of direct-reading instruments. He denied that they were harmful. Should the student be provided with other old-fashioned instruments such as a water-clock? Where should the line be drawn? Should he be denied a set of weights, and be compelled to cut them out of sheet lead for himself? Should he not be allowed to time an experiment unless he had made his own watch? Prof. Thompson asked why the expression "watt-seconds" was used throughout the Paper instead of "joules"; what precautions were taken to calibrate the thermometer, and on what authority did the authors assert that the volt was the ratio of the ohm to the ampere?

Dr. SUMPNER described the apparatus which he had been using at Battersea for making a similar experiment. He used a length of flexible metal tubing, and passed a current through it, and at the same time kept it cool by passing a stream of water through it. The difference of the temperature of the water at the two ends of the tube was measured. The water acted as its own stirrer. He thought that it necessary the apparatus could be arranged to give as good results as those of the authors. It was possible to eliminate the correction for cooling by arranging that the temperature of one end of the tube should be as much above that of the air as the other end was lower. This could be easily managed, as the temperature of the water from the mains was generally lower than that of the air. He differed from Mr. Griffiths as to the educational value of this experiment. He thought that it was desirable that young students should be set to simple experiments, in which corrections could be neglected. Afterwards they could proceed to take corrections into account.

Prof. RÜCKER took an intermediate view of the matter. It was absurd, to put an extreme case, that a student should not be allowed to use a clock until he had made one. If, in his future work, he would merely have to use certain instruments, it would be sufficient that he should use them as he found them, in his laboratory work. If, on the other hand, he would in the future have to manufacture such instruments, he should be taught how to make them.

Prof. AYRTON, in reply, said that it might be necessary to observe that a student's time at the Central Technical College was not wholly spent upon determining the mechanical equivalent of heat. Part of his work was the calibration of instruments. When a student was using—not calibrating—an instrument, he did not assume that it was wrong. If a student was not allowed to take an ohm as an ohm, how was he to begin at all? He must start somewhere. No absolute determination of the ohm had been made at the Central Technical College. They accepted the ohm as an ohm. The object of the student in carrying out the present experiment was not to make corrections or to learn how to make corrections. His object was to learn what was meant by the mechanical equivalent of heat. He was allowed to find this out by measuring it for himself. By so doing the true idea of what was meant by the mechanical equivalent of heat was impressed on his mind. If a parent wished his child to learn the size of a room, he would give him a foot-rule, and let him actually measure it. He would assume that the foot-rule was right, and would no more apply corrections than he would use refined trigonometrical methods for making such a measurement. The elementary student can best learn what a thing means by doing it. By all means let the student improve the apparatus. Mr. Haycraft was a student, and he had improved the apparatus; but having done so, he had brought it before the Physical Society—he had not burned it. In reply to a question by Mr. Inwards, Prof. Ayrton said that the resistance was made of manganin, an alloy which was supposed to have a zero temperature coefficient. It was, however, quite a chance in practice whether any sample of manganin would have any better temperature coefficient than a piece of platinum.

BOARD OF TRADE CONFERENCE ON TRANSFORMER CHAMBERS.

The resumed sitting of this Conference took place at 7, Whitehall-gardens, yesterday (Thursday), Sir Courtenay Boyle presiding.

Mr. RADFORD, surveyor for the parish of Putney, and Mr. MARTIN, surveyor for the parishes of Streatham and Tooting in the district of the Wandsworth Board of Works, put in plans showing the drains and water and gas mains in some of the streets in their districts, in which it was proposed to place transformer chambers. They objected to these chambers being placed under the footways on the ground that there was not room for them, especially in view of the probable widening of many of the streets, and the fact that new streets would be opened up in some places. There would be no difficulty in obtaining private land for the purposes of transformer chambers.

Mr. CRIPPS, Q.C., then opened his argument on behalf of the County of London Company. First, he said, it was absurd to suggest that there was not sufficient space in the roadway for the transformer chambers. If there was at any particular spot interference it was a simple matter to shift a foot or two one way or the other; that was always an incident of work under the streets. That view was strengthened by the fact that transformer chambers had been put in without the least difficulty in the City of London, which was much more crowded with regard to its underground passages than Streatham or Putney. The conditions under which new works of this kind could be undertaken, and the position of the Board of Trade with regard to them was thoroughly discussed by Sir George Trevelyan's Committee, and the principle settled. The old works were always to be protected, in the sense that there was an adjustment to be made between the old works and the new, and the new works were not to interfere in any way with the old; then, when the new works were laid down, they were protected in turn from interference by any fresh comers. The County Council had more than once tried to upset those clauses, but had not succeeded, and they were retained as model clauses. Those difficulty where there were two conflicting interests. But the question of public safety was the real point at issue, and was the one upon which the Board of Trade was really called upon to decide. The clauses were adopted in order that works might be carried on without County Council had for a long time been raising the point that public companies, of whatever kind, should not occupy the soil of the public street without their consent, which really meant without paying for it. They claimed that there was a sort of public property in the streets and they were not to be used without payment, and in order to enforce that argument they had always suggested that too much room was being taken up which was wanted for other purposes, and therefore companies coming in to occupy that room ought to pay for it. The answer to this was two-fold, and was conclusive. From the commencement, the railways, the gas mains, water mains, and other mains had occupied the public streets without any compensation being paid, the much sounder principle being adopted that those companies should be encouraged to supply a commodity which the public wanted upon reasonable terms; and further, the County Council were not the proper people to deal with the matter. Control of the gas, water, and other mains rested with the Vestries and not with the County Council, who only had certain limited rights over the streets. First of all, therefore, he said the Council had exaggerated the facts as to the question of room, and, secondly, they had no authority. So far as the Wandsworth Board of Works were concerned he met them by saying that they were perfectly entitled to raise objections, but they were mistaken in the view they took. With regard to the suggestion that the word "boxes" in the Provisional Order could scarcely have contemplated such a large structure as a transformer chamber, as he read the words of the Order. Section 12 it enabled them to do so with the approval of the local authority. He contended that a transformer chamber was required for the purposes of directing and controlling the supply of energy, and therefore came within the definition of the word "box." The only remaining question was that of safety, and upon that he should submit the evidence of the leading experts to the effect that the form of chamber which they proposed to adopt would avoid any risk of explosion or other public danger.

Sir FREDERICK BRAMWELL was the first witness called on behalf of the Company, and examined by Mr. Cripps: he had examined the drawings for the proposed transformer chambers. In the first place, he believed a chamber of the small size, built as it was proposed to be built, having a thickness of asphalte in the side walls intermediate between two pieces of brickwork, and a plate of lead at the bottom, was a chamber which, under ordinary circumstances, could not receive gas from leakage. He would suggest that gas, even in very considerable quantities, getting into a chamber provided with a grating at the top was incapable of forming an explosive mixture, because it would go out at the grating. If he understood the word ventilation as meaning a current of air through the place, he thought ventilation was not really needed there at all. Gas would get out by reason of its levity at the opening at the top of the chamber, in the same way that water, by reason of its gravity, would get out through an opening at the bottom. When the question of subways came up before Parliament in 1867 he and others went to the subway in Southwark and made openings in the gas pipes laid there. They were provided with an invention of Mr. Ansell, analyst to the Mint, which indicated the percentage of gas in the air. They found by that that, do what they would, they could not form an explosive mixture in that subway. As a rule they got 2½ per cent., and once 3 per cent. In the crown of the subway, at intervals of 100 feet, were openings 2ft. square, with bars across, and, with the exception of a small pipe up an ornamental lamp-post at each end of the subway, which was half a mile long, these were the only means of escape for the gas. He suggested, therefore, with regard to these transformer chambers, that if they provided a grating at the top they might have a considerable leakage of gas into the chamber, although he did not know how it was to get there, and there would be no danger of an explosion.

Cross-examined by Mr. Bassett Hopkins: Other things being equal, an explosion would be more violent in a large confined space than in a small confined space.

Mr. BASSETT HOPKINS: I take it what you rely upon is the grating at the top, and you think they may remove this pipe ventilation they have made by an up-and-down exhaust altogether? A.—It will not do any harm to leave it in, and it may satisfy people who have not had the practical experience I have had, therefore I would advise them to leave it in.

Do you regard it as an essential condition that these chambers should be gas-tight and water-tight? A.—In the way of explosions, no. In the way of convenience and for the working of the company's business, I do.

Cross-examined by Mr. Earl, WITNESS said he advocated a grating flush with the street, and he did not think there would be any danger from water running into the chamber. Any inconvenience from that would be obviated by placing a pan with a drain pipe leading from it under the grating. Any gas given off by electrolysis would be very small indeed in quantity. He thought the chambers might just as well be placed under the roadway as under the footway, and he did not think any damage to the structure was to be feared even from the passing of steam rollers over it. He doubted that the lead at the bottom would be more liable to waste away than asphalte, or any other material, as Prof. Robinson had suggested. Water had got into the conduits of the Knightsbridge Company, of which he was a Director, and the bare copper conductors were submerged; but the only result was that they found they had been boiling the water in a particular part of the conduit for an hour or two.

By the Chairman: There was the possibility of the earth over the transformer chamber becoming charged at a different potential, although it was difficult to understand how it could occur with a properly constructed chamber. He did not anticipate as much danger from that as there was of a train running off the line or of an ordinary boiler bursting.

Prof. S. P. THOMPSON, examined by Mr. Cripps, agreed with Sir Frederick Bramwell's evidence as to the safety of the means provided for the prevention of gas leakage into the chambers, and for its getting out again if it should get in. In order to prevent the gas from ascending through it, the air outside the chamber must be raised to a temperature nearly three times as great as that of boiling water.

By Mr. Earl: If the transformer chambers were placed above ground on private property there would be no difficulty with regard to ventilation. On the other hand, they would be more exposed to the public. It would not be advantageous, upon other grounds than those of expense, to have fewer transformers of larger size. It was more convenient to regulate the pressure through a small district than through a large one, and in case of mishap the inconvenience of loss of light extended over a smaller area.

By Major Cardew: Apart from the question of the light being interfered with, the danger to the public in the case of a breakdown would be much less with a small chamber than with a large one.

Dr. FLEMING being called and examined by Mr. Cripps, said he was conversant with the proposed method of constructing the transformer stations, and he did not consider these would entail risk to public safety. It would be practically impossible for gas to enter the chambers with the construction proposed, and if it did leak in, he agreed with Sir Frederick Bramwell that the gas would immediately go upwards.

Cross-examined by Mr. Bassett Hopkins, Witness agreed in the opinion that if the chambers were heated there would be a current of air set up. Asked if he deemed the heating of the chambers an advisable precaution, he said, the chambers heat themselves to some extent, and that this would set up a ventilation. He thought the general temperature would be about 120° centigrade, which would, of course, assist in mixing up the gas to some extent.

To Major Cardew the WITNESS replied that if the gas pipes were properly laid the transformer chambers would be perfectly tight. Of course, it was within possibility that a crack might happen through which gas might come in, but with the proposed method of construction that was very unlikely.

In reply to Mr. Cripps, the WITNESS admitted that the risk of gas getting in would be to some extent minimised by means of the stuffing-boxes—the pipes would be brought through what were called "glands." This finished the witness's evidence.

Mr. CRIPPS asked the opinion of the Chairman as to the advisability of his calling evidence from Dover and other places in regard to the construction and use of transformer chambers.

The Chairman did not deem it advisable.

Mr. LAWSON, Engineer and Manager to the County of London and Brush Company, was examined by Mr. Cripps. The Witness referred to the plan put in, and explained the position of the transformer stations in St. Luke's. The plan there adopted did not interfere with the existing system of laid pipes, because notices had been given of the proposed positions of the transformer chambers. In St. Luke's parish the local surveyor was satisfied; and in regard to Wandsworth, there need be no difficulty, because the Company were prepared to vary the positions of the chambers to suit the circumstances. Adjustment in such matters was always possible, and almost always done. The same method of construction as now proposed had been followed at Dover and at Bournemouth. In both these cases it was a company which laid the system, and in both cases the transformer chambers were laid beneath the footways.

To Mr. Bassett Hopkins, WITNESS explained that the experience at Bournemouth had been about a year.

This closed the case for the Company.

MR. BASSETT HOPKINS' REPLY.

Replying to the whole case, Mr. BASSETT HOPKINS said there had been points raised by Mr. Cripps which needed clearing up. The Chairman had had presented a great deal of scientific evidence, and the most he could claim on that section of the subject was that the evidence of the experts had differed. Scientific men of known and admitted eminence had expressed the opinion that the proposed system of ventilation was unsatisfactory; and that if not altogether impossible it was yet very difficult to frame any efficient system of ventilation—the term "ventilation" being taken as meaning a means for preventing a possible explosion. Of course the Board of Trade must come to a conclusion which set of experts was correct, but he pointed to the fact of discrepancies of judgment in scientific men of established and equal eminence. And the same conclusion was forced upon him in regard to making the transformer chamber gas tight and water tight, and also the danger of explosive compounds and explosions. And even if the chambers were erected gas and water tight there was the question of whether they could be so maintained; and would they be so maintained. He argued that in any case it would be a very expensive process of construction and maintenance, and, therefore, that there would be great temptation not to maintain the chambers efficient. He ventured to submit with respect that the Board of Trade would not assume the responsibility in this matter when such eminent experts so distinctly differed. Mr. Bassett Hopkins could not pass over a contention by Mr. Cripps at the outset of the inquiry, to the effect that the Company had a claim to the principle of the proposed works, under Clause 12 of the Electric Lighting Confirmation Act of 1892 (County of London Order). But Mr. Hopkins contended that that was an unreasonable construction to put upon the phraseology of that clause, and he believed that neither Parliament nor the Board of Trade ever contemplated such a construction. Mr. Hopkins proceeded to argue in detail that the term "street boxes" in the Order was never intended to cover or mean such structures as the present day transformer chambers. Certainly, those gentlemen who advised the local authorities at the time never dreamt of such a rendering of the phraseology, and did Mr. Cripps now suppose that he was going to secure the sanction of the Department for these transformer chambers without the imposition of conditions? On the contrary, the very fact of there being such an array of evidence produced went to show the need of conditions being imposed. All who remembered the General Act of 18 8, and the subsequent legislation, down to the Provisional Order now in question, would agree that the Company now proposed an absolutely new departure—a departure upon which Parliament had had no opportunity of discussion, or of pronouncing as to the question of public policy and expediency. He suggested that this was not a fair policy, it was not a policy which should be encouraged, and that there ought to be an opportunity afforded for fair and proper discussion. He took an absolutely opposite view of the law to that enunciated by Mr. Cripps, and instead of seeing any vested interests in having these transformer chambers subject to regulations, he held that the law on the matter was against the vested interests, and he was not sure that an injunction would not lie if the Company sought to exercise its powers. But, so far as he was concerned, he had such confidence in the Board of Trade that he did not think the London County Council would be advised to test the question of law, but would rather leave the whole matter in the hands of the Board of Trade.

Passing to the question of the law in respect of the ownership of the subsoil, Mr. BASSETT HOPKINS argued that the sole right of ownership was by law vested in the frontager, subject to certain powers held by the local authorities. Was the Board of Trade to allow the introduction of the principle that these transformer chambers were to be permitted, of an undefined and elastic length and depth—and in the City of London enormous rooms had been constructed, 10ft. square by 13ft. deep? Such a question was not a fit one for an arbitrary decision, it was one, rather, for Parliamentary settlement. For the first time in history it was now proposed to establish the right to take the curtilage—the subsoil—in front of a man's house, for private purposes, without asking his leave, without giving him an opportunity of objecting, and without offering him any compensation. He submitted that that was a matter of law which the Board of Trade would not take the responsibility of deciding. If the promoters insisted on the right of having the transformer chambers as proposed in the streets, the matter should go before Parliament, so that in a committee room the question might be discussed, and the Legislature might have an opportunity of deciding whether this new principle in law should be established. Then, as regards public policy, he opposed the scheme, inasmuch as it was not merely a question of asking for a hundred or so of these chambers, but ultimately it would devolop into thousands of transformers throughout the metropolis. This, if carried out, would impose an enormously increased obligation on the London County Council, and an enormous increase of cost to the ratepayers. Such an increase of responsibility to the Council, and of outlay to the public, ought not to be caused except by the authority of Parliament, especially after having it shown that it was proposed only to save expense to the Company themselves.

Mr. EARL, on behalf of the Wandsworth Local Board, followed on the same lines as Mr. Bassett Hopkins, and reiterated the objections his Board had to the chambers, as stated in his opening speech. He opposed on the grounds of danger of explosions; possible presence of water in the chambers; public danger of having the chambers in roadways; the infringement of the rights of adjacent owners; and the contact with gas and water mains. As an alternative scheme, he suggested the erection of the chambers on private ground, which his witnesses had shown was easily obtainable, or their erection above ground. The whole question was one of saving expense to the Company.

THE CHAIRMAN'S DECISION.

Sir COURTENAY BOYLE then said: I think it might be convenient if I stated now what is the nature of the advice which I propose to give to the Board of Trade. I cannot be certain that my advice will be taken, but the ultimate decision of the Board of Trade will be made in writing. I have no power to say what construction will be put upon the Provisional Order. The clause—the Works Clause—was settled by Parliament, and the Board of Trade did not then contemplate that the term "street boxes" would be extended to mean transformer chambers. But, although that was not contemplated by the Board of Trade, it does not in the least follow that the word "street box" in the Provisional Order does not mean and include the transformer chambers. There is a great deal to be said for the view that it does, in the words "controlling energy." That is exactly what is done in the transformer chamber—the energy is controlled; it is altered from 2,000 volts to 100 volts. But I am in this difficulty, that if in the Provisional Order the words "street box" does not include and mean "transformer chamber," then the Company have no right here at all, nor am I the proper person, nor the Board of Trade the proper authority to settle the objections of the London County Council. If there is no power given by the Provisional Order to go under the streets for the purpose of constructing transformer chambers, then nothing that the Board of Trade can do can give that power. The Board of Trade have no power to give the undertakers any rights as regards the public streets which are not given in the Provisional Order. And, therefore, unless the word "box" includes "transformer chamber" it seems to me that the procedure to prevent the use of these transformer chambers must be taken before some other tribunal than the Board of Trade. That being so, it behoves me to act as if the word "box" does include and mean "transformer chamber." I noticed that on the point of whether the London County Council should go for an injunction or not, Mr. Bassett Hopkins said with the politeness which always characterises him, that the County Council would be glad to leave it to the Board of Trade. Bearing in mind that representation, I propose to base my advice to the Board of Trade on the assumption that the work "box" includes "transformer chamber."

The next question is in respect of the public safety in a system of supply which includes the use of transformer chambers under the streets, and upon that point my advice will be based upon the assumption that the case against the transformer chambers has not been made out. As long as a high-tension system of supply is allowed at all, it must be allowed on the condition of the transformer chambers being placed under the streets so as to satisfy the Board of Trade. The promoters have promised to listen to any representations that are made by the advisers to the County Council, or by the Wandsworth or any other Local Boards, as to such improvements in the construction of those chambers as are possible, or can be suggested; but, having regard to the scientific evidence laid before us to-day, I should certainly hold, and advise the Board of Trade, that transformer chambers, as they can be made, will be so reasonably free from risk that it does not become the duty of the Board of Trade to veto their usage.

Then comes the question of within what limits they are to be used? And upon that point I am immensely impressed by the argument of Mr. Bassett Hopkins. We are threatened with a large number of these transformer chambers. I see no limit, nor does the Engineer to the Company as to the number which the Company will ask for. Now, it appears to me that an apparently unlimited number of transformer chambers such as these is an extent of user of the public streets which the local authorities are justified in resisting, and which Parliament did not contemplate, and which the Board of Trade did not contemplate. Therefore the action of the Board of Trade will be based on the view that the user of the streets for transformer chambers should be as far as possible curtailed, and that the transformer chambers should be placed where they do not cause unnecessary interference. If there is any particular objection to a particular transformer which is to be placed where the local authority says it ought not to be placed, the appeal clause comes in, and each case will have to be considered as it arises. But if the Board of Trade takes my advice we shall not oppose *in toto* the use of transformer chambers under the streets, although we shall insist upon the adoption of proper safeguards.

Mr. BASSETT HOPKINS asked if the Chairman would consider the question of taking the opinion of counsel as to the question raised in the preliminary stage, of whether the word "box" includes "transformer chamber."

The CHAIRMAN replied that he would.

The inquiry then closed.

Below we give the respective pleadings of the London County Council and the County of London and Brush Provincial Electric Lighting Company, as laid before the Board of Trade to adjudicate upon :—

Case of the London County Council.

The Council contend :—

1. That the transformer chambers proposed to be used by the Company should not be allowed to be constructed under the streets or footways unless it can be shown that in any particular case it is indispensable to place one there.

2. That such transformer chambers are not necessary to the carrying on of the Company's business.

3. That such transformer chambers would be detrimental to the use of pipes, wires and sewers in the streets, and will be serious obstructions to such pipes, wires, and sewers, and will in practice, notwithstanding any conditions which may be imposed upon the Company, necessarily involve expensive modifications.

4. That such transformer chambers would be a source of danger to persons passing along the streets, would greatly increase the number of explosions and accidents, and would be dangerous to workmen and others using them.

5. That the construction of such transformer chambers would also interfere with the construction of future street widenings and street improvements.

6. That the use of such transformer chambers, to the large extent to which their admission as a principle would necessarily lead, would be very embarrassing to the public authorities, in the exercise of their duties, and could not but involve them in much expense for the purpose of supervision, &c.

7. That from the experience obtained by accidents which have occurred, and from the difficulty of ventilating such transformer chambers and their constant liability to flooding and to percolation from gas, water, &c., and the very explosive character of high-tension currents when not properly ventilated, the construction of such transformer chambers would be most detrimental.

8. The Council maintain that the proposed use of the streets is purely one of saving the Company expense, and that the Company should not be allowed to increase their dividends by utilising the streets instead of acquiring houses, cellars, gardens or courtyards for the purpose of such transformer chambers.

December 7, 1894.

Reply of the County of London and Brush Provincial Electric Lighting Company.

The Company contends :—

1. In reply to paragraph 2, that the transformer chambers proposed to be used by them are not only necessary but essential to the carrying on of the Company's business.

2. In reply to paragraph 1, that the construction of such transformer chambers under the streets and footways is in accordance with the practice heretofore adopted with the approval of the Board of Trade and many local authorities, and is the most convenient place having regard to (1) the safety of the public ; (2) the convenience of the customers ; and (3) the convenience of access for workmen and others.

3. In reply to paragraph 3, that such transformer chambers would in no way be detrimental to the use of pipes, wires, and sewers in streets, or serious obstructions to such pipes, wires, and sewers, or involve expensive modifications. A larger number of transformer chambers—in many cases of far greater dimensions than those proposed to be constructed by the Company—have been constructed under footways and streets without detriment to the use of pipes, wires, and sewers, or any serious obstruction to the latter, and any modifications of existing pipes, wires, and sewers required have been carried out by the "undertakers" under the Provisional Order, in accordance with the terms thereof. The Council are not owners of pipes or wires or of any sewers but the main sewers, and there is no ground for the suggestion that the transformer chambers will either interfere with the use or be a serious obstruction to such main sewers.

4. In reply to paragraph 4, the Company say that the transformer chambers, wherever placed, are no source of danger to the public provided reasonable precautions are taken in constructing the chambers and connecting the machinery and mains, and that if supplied with a grating at the top, as proposed by the Company, the proposed transformer chambers will in no way be a source of danger to persons passing along the streets or to workmen and others using them.

5. In paragraph 5 the Council say that such transformer chambers would interfere with the construction of future street widenings and street improvements. The Company state that their mains and transformer chambers will not interfere with any such improvements, and, moreover, that the exercise of the powers given to the Company by Provisional Order should not be interfered with simply on the suggestion that at some future date it may become desirable to widen or improve any particular street for reasons which do not at present exist.

6. The Council, in paragraph 6, say that the use of such chambers to the large extent to which their admission as a principle would necessarily lead would be very embarrassing to the public authorities, and involve them in much expense for the purpose of supervision. The Company would point out that the principle of transformer chambers is no new one, but has already been accepted, and that in reference to the exercise of their duties by the Council the Company will become a large ratepayer.

7. In reply to paragraph 7 the Company claim that there is no difficulty in ventilating transformer chambers ; that their construction as proposed by this Company shows complete ventilation and no liability to flooding or to percolation from gas and water, and that they will be in no wise detrimental.

8. In reply to paragraph 8 the Company maintain that the construction of the chambers under the footway and streets is not merely a question of economy. (*a*) They point out that if they are driven to the acquisition of private property they will probably purchase the right to use cellars that extend under the pavement and into the streets to which the Council object. (*b*) That the transformer chambers are proposed to be placed under the footways of the streets, because of the danger that would occur in the efficient lighting of the district in the possible event of the premises under which the transformer chambers might be placed being burned down, with possible destruction (1) of the ventilating arrangements of the transformer chambers, (2) of the means of access to the transformer chambers, (3) of the connection between the mains and the machinery within the transformer chamber, whereby a large district might be placed in darkness by causes entirely outside the Company's operations and over which they would have no control whatever.

9. The Company would also call attention to the restrictive clauses in their Provisional Orders as to the maximum price chargeable and as to the revision of such price, and also to the purchase clauses in favour of the Local Authority, and say that no good reason is or can be shown by the Council for putting upon the Company the additional expense of the purchase of a large number of bits of property in different parts of their districts merely to prevent the proposed small user by them of the subsoil of the pavements and streets. The Company suggest that their transformer chambers are in no way dangerous to public safety, and point out that if the Council are successful in their contention it could in some localities prohibit the Company from carrying on its operations because it is not possible to find space other than space under the public footways for the construction of transformer chambers.

10. The Company are prepared to take the necessary precautions to make the transformer chambers absolutely safe, and from time to time to take such further precautions as experience may show to be necessary, and would point out that, notwithstanding the very large extent to which electrical mains and transformer chambers have been laid under the streets and footways within the metropolis and in many large and populous centres during the last four years, there has been no fatal accident or serious injury done to any human being or any appreciable damage to property, and claim that no industry can show a record so free from accident as is shown by that of the supply of electricity from central stations in populous places.

December 11, 1894.

PARIS NOTES.

(FROM OUR OWN CORRESPONDENT.)

PARIS, *December* 10, 1894.

Electric Traction in Paris.—A matter of general interest, and one which may very well give rise to a considerable trouble, is now under consideration by the Municipal Council. The French Thomson-Houston Company have for some time past been making applications to the Council for permission to introduce the trolley system into Paris. After having undergone several rebuffs, the refusals being based on the impossibility of allowing any concern to erect poles and overhead wires along the thoroughfares, the Thomson-Houston Compagny has just been informed that its latest request will be considered. If the Council authorises the Thomson-Houston people to lay down overhead wire electric tramways, there will be a loud outcry that the beauty of the capital is being spoilt, and others will have something to say, because a similar right was not accorded to them. In fact, the electric supply concerns may very well ask why an overhead system is to be allowed in the case of tramways and forbidden when it is a question of electric lighting. The companies may lay stress on the first cost and heavy maintenance of their underground system, and demand permission to convert it into an overhead one.

The Lighting of the Champs Elysées.—The lighting of the Champs Elysées now carried out by gas is about to be changed. The Municipal Council has studied the cost of substituting electricity for gas, and the following are the recommendations arrived at in the report which has been submitted to it. The light to be supplied by 35 arcs 50 metres apart, the cost being :—

	Francs.
Pillars	5,425
Painting	875
Laying	1,606
Miscellaneous	194
Total	8,190

The cost of supplying current has been estimated at 45,233fr., or 13,715fr., according as either one or the other of the following plans is adopted :—(1) The light to be available all night all the year round at 40 centimes per lamp per hour, a fixed sum of 8fr. per lamp per annum being paid in addition by the town for maintenance. The sum of 53,472fr. thus arrived at is reduced to 45,233fr. by the economy of 8,239fr. in connection with the gas lighting. (2) The second scheme relates to special lighting from April 1st to October 31st, up till 12:45 at night:—

	Francs.
Current	15,386
Maintenance	280
Total	15,666
Less gas bill	1,951
	13,715

It is to be hoped that the electric light will be adopted as much from the point of view of appearance as from that of safety to the promenaders, who are often victimised owing to the present gloom.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

New York, Dec. 8, 1894.

Telephones in Hotels.—In one of the several magnificent hotels built in New York recently a complete telephone service was installed for communication with the various rooms. This was considered an innovation in the right direction, and it was freely predicted that in a short time the old time annunciators would be a thing of the past. There was consequently much surprise when it was learned that the telephone service had been replaced at considerable expense by a "teleseme" system which, though permitting a considerable number of wants to be indicated, yet is almost absurd as a substitute for the telephone. Upon inquiry, however, we learned that the telephones became a huge nuisance on account of the facility they afforded for easy communication with the office, and particularly through the use made of them by the ladies for transmitting complaints. The slightest cause of complaint afforded a pretext for calling up the office, with the result that the two operators on duty very frequently were several calls in arrears; the delay thus caused in answering calls furnished another source of complaint, so that the harrassed management finally had the telephones taken out and substituted a "teleseme" system.

The Herzog "Teleseme" System.—The "teleseme" system in the above hotel is a combination of a most ingenious apparatus. In each room is a transmitter, circular in form, having upon its face 128 names or messages equally spaced along 16 concentric circles. To transmit a message a pointer which has both an angular and a radial movement is set with its extremity over the desired want, and then a button pressed. In the office is a chemical annunciator, with a face only about 8in. by 12in., yet containing 400 numbers; a call is indicated by this through the appearance of a red spot on a small platinum disc in a liquid, the number of the room being immediately above the disc on the glass face confining the liquid. After the number of the room has been noted, the attendant presses a bulb which forces air into the liquid, and the spot disappears; he then plugs in a switchboard, pulls down a hook on the receiving "teleseme," the pointer of which then moves around a dial, stopping a moment at two numbers, one of which corresponds to the number of the circle on the transmitting "teleseme," and the other to the number of the want on that circle; the face of the receiving dial is a facsimile of that in the rooms, with the addition of a number to each want, so that by a glance the attendant determines the want corresponding to the number indicated as above.

Storage Battery Consolidation.—A most important consolidation of storage battery interests has just been made which ends the litigation that for years has afflicted this industry. The Electric Storage Battery Company of Philadelphia has acquired all the rights and patents of the Consolidated Electric Storage Battery Company of New York and the Brush Electric Company of Cleveland, O.; the battery patents and all interests in connection with batteries and the goodwill of that branch of the business of the General Electric Company; all the property, rights, and patents of the General Electric Launch and Navigation Company of New York; and the rights, licences, and patents of the Accumulator Company of Philadelphia. These purchases virtually place in control of the Electric Storage Battery Company all its former competitors in the business of supplying storage batteries.

CORRESPONDENCE.

THE COUNCIL OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of the 14th inst., you publish a letter signed by Mr. J. T. Crowe. In this letter that gentleman refers to a committee, "consisting of Messrs. Ansell and Crowe for the cables, Messrs. Leonard and Houghton for the railway telegraphs, and Messrs. Calder and Fletcher for the telephones."

It is not my desire in any way to comment upon the action taken by this Committee as individual or independent men; but, as a member of the Railway Telegraph Engineers' Conference, I emphatically deny that Messrs. Leonard and Houghton ever, by the voice of the railway electrical officers, occupied the position of representatives, or were, by them, invested with power to take any action whatever on their behalf in this matter. At a recent conference of the railway telegraph engineers Mr. Leonard most emphatically stated, in the presence of a large number of railway officers, that, in joining the deputation which waited upon the Council on the occasion in question, he was most particular in emphasising the fact that he stood there—not as a representative of the railway telegraph engineers, but individually—in his own right—as representing himself, and no one else.

Further, on the matter being discussed, consequent upon the reading of Mr. Webb's letter asking for a nomination by the Conference, it was unanimously resolved by those present that no such nomination should be made; but that the selection of any one to fill vacancies which might occur in the Council should be left entirely in the hands of that body. This resolution was accompanied by no condition whatever, and if any suggestion has been made to the Council to the effect that all the railway telegraph engineers "cared about," was "the inclusion of some one of their number," I can only say that no such comment passed, and no authority was given by the Conference of Telegraph Engineers to convey any such expression to the Council. The desire of those present was, that the action of the Council should be perfectly spontaneous, and wholly unfettered.

I cannot help feeling—and in this impression I believe I am strongly supported by the majority of my *confrères*—that to be nominated by a particular party for such a position would be to practically place the individual selected in the position of a Trade Union Delegate.

I have ever looked upon the selection or nomination to a membership of council on any of our learned societies as an honour conferred in recognition of personal worth. Divest it of this attribute, and you rob it, at once, of the honour which the selection otherwise confers. Nothing could, in my opinion, be more unacceptable, more repugnant, than to feel that one's presence is thrust upon a body of gentlemen, welcome or not; nor can I think such a condition would contribute to convenience or comfort in the transaction of business. I, for one, would not for a moment tolerate such a position. Very heartily, very respectfully, I tender thanks to all who supported my nomination. At the same time I shall not fail to ascertain in what sense I have enjoyed the consideration of the Council, and if it should be merely that of a nominee of a party—although that party may be my own *confrères*—and I say this with all due respect to them, I shall not hesitate to ask the Council to relieve me of the honour of such a nomination.

Having, now many years since, filled the post of acting secretary to the Institution—then the Society of Telegraph Engineers and Electricians—I have enjoyed on more occasions than one the opportunity of observing the manifest desire of the Council to bring to the Council table those who were thought best calculated to serve, not merely the interests of the Society, but also the advancement of the profession; and I have not the faintest doubt that the desire of the Council of the present day is, in this respect, fully equal to that which animated the Council at the time to which I refer.—Yours, &c.

Derby, December 15, 1894. W. LANGDON.

A NEW (?) FORM OF POLARISED RELAY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in your last issue of *The Electrician* (December 14th) an illustrated description of a new form of polarised relay by Mr. T. H. Lloyd. Will you kindly allow me through the medium of your valuable journal to correct Mr. T. H. Lloyd as regards the form of this relay being a new one? I designed such a relay in 1882 (see Patent No. 1254, 1882); an illustrated description is to be found in the *Telegraphic Journal*, dated November 25, 1882, p. 412, and I may add also that some time ago the Post Office authorities have made extensive trials and obtained good results as regards speed and sensitiveness with one of my relays I submitted to them for such purpose.—Yours, &c., JULIUS EBEL.

LEGAL INTELLIGENCE.

Shelfer v. The City of London Electric Lighting Company; Meux's Brewery Company v. the same.

JUDGMENT.

In the Court of Appeal on Tuesday last, Lord HALSBURY delivered judgment as follows in this case: The two plaintiffs in this case complain of a nuisance created by the defendants by the vibration of their engines, and the annoyance caused by the carrying on of their electric lighting works. Of the result and gravity of the nuisance no serious denial has been made before us. The two plaintiffs are respectively the lessee and reversioner of the house known as the Waterman's Arms. The considerations which arise are applicable to both plaintiffs, except in so far as one is lessee and the other reversioner. I will deal with this question separately. The nuisance being established, it is said, first, that the defendant Company are authorised by law to carry on the business, and that they have done all that skill and care can effect to prevent any nuisance; that they are in the same position as a railway company, and they are entitled to do what they have done under the authority of the Legislature. If the analogy were a correct one, I should think the defendants had fallen very far short in the proof that they had done all that was possible to prevent a nuisance. A railway company has a definite line of operation within which it may make its works, and if it does all that can be done to prevent a nuisance in that place, the thing having to be done in that place, and the traffic having to be carried on by means of locomotive engines over the line of railway, the Legislature is taken to have sanctioned the proceeding. No such considerations apply here. There is a difference—viz., the object of the legislation and the results. It is not, however, necessary to deal with this part of the case, and I only mention it to disclaim the notion that I acquiesce in the allegation that it has been here proved that it is essential to the carrying on of the electric lighting business in the district in question that there should be a nuisance created. The main question turns on the Electric Lighting Act, 1882, and the Provisional Orders which had become Acts of Parliament. It was boldly contended by Mr. Moulton (counsel for the defendants) that the Provisional Order protected the undertaking, and that if a nuisance were necessarily created by the carrying on of the Company's undertaking such nuisance was authorised and even imposed as a duty on the undertakers. I think it is only necessary to read the Provisional Order in connection with the tenth section of the Electric Lighting Act, 1882, to dispose of that argument. The provision in the Act so far as relates to powers under Provisional Orders runs as follows:—"The undertakers may, subject to and in accordance with the provisions and restrictions of this Act and of any rules made by the Board of Trade in pursuance of this Act, and of any Licence, Order, or Special Act authorising or affecting their undertaking, and for the purpose of supplying electricity, acquire such lands by agreements, construct such works, acquire such licences for the use of any patented or protected processes, inventions, machinery, apparatus, methods, materials, or other things, enter into such contracts and generally do all such acts and things as may be necessary and incidental to such supply." And then in the Order relied on for the authority to create the nuisance comes the words: "Nothing in this Order shall exonerate the undertakers from any indictment, action, or other proceeding for nuisance in the event of any nuisance being caused by them." The general Act only gives them power subject to the restrictions of their particular Order, and the particular Order makes them liable for nuisance. I have also come to the conclusion that the powers given by the 17th section of the Act, read together with the 10th section, are applicable to the execution of the authorised works; and when one considers how frequently the distinction between the execution of the works and the use of them when executed has been the subject of comment and discussion, I think it must be taken that the language used has been deliberately chosen by the Legislature as pointing to the distinction, now well recognised, between the construction of works and the user of them when constructed. But, assuming that there is a nuisance, and that there is no authority justifying it, the question still remains, What is the relief to which the plaintiffs are entitled? But for the provision of Lord Cairns's Act I suppose no one would have doubted that in the state of facts I have now assumed to exist the plaintiff Shelfer would have been entitled to an injunction to prevent the continuance of the nuisance. Lord Kingsdown, in the House of Lords, in the case of the Imperial Gas Light and Coke Company *v.* Broadbent, has laid down the principle in words which comprehend such a case as this, as follows:—"The rule I take to be clearly this. If a plaintiff applies for an injunction to restrain the violation of a common law right, if either the existence of the right, or the facts of its violation, he must establish that right at law, and its violation. I apprehend, that unless there be something special in the case, he is entitled, of course, to an injunction to prevent the recurrence of that violation." But, it is said, and truly said, that the law has been altered by Lord Cairns's Act, and the question is, What construction is to be placed upon this enactment? Undoubtedly it conferred upon Courts of Equity the jurisdiction to award damages which did not exist before. But the question is, Did it mean to interfere with the well-settled principles upon which Courts of Equity were in the habit of interfering in such cases as the present? It seems to me that the defects in the powers of the Equity Courts which were sought to be supplied by that statute, give ample grounds for the provisions of the statute without supposing that it meant to revolutionise the principles upon which equitable jurisprudence had been administered up to that time. The language, of course, is general; the discretion given is necessarily wide enough in terms to authorise a Judge to award damages where formerly he would have given an injunction. But there is nothing in the case which to my mind can justify the Court in refusing to aid the legal rights established by an injunction preventing the continuance of the nuisance. On the contrary, the effect of such a refusal in a case like the present would necessarily operate to enable a Company who could afford to drive a neighbouring proprietor to sell, whether he would or no, by continuing a nuisance, and simply paying damages for its continuance. But while I can agree with neither Mr. Warmington nor Mr. Moulton upon the alternative restrictions which each respectively seeks to place upon the statute, I see no trace of any such intended alteration of the principles upon which equity should interfere with an injunction as would be involved in a refusal for an injunction here. And further, I think the question is here covered by authority of which "Martin v. Price" in this Court is the last example. For these reasons I think the judgment of Mr. Justice Kekewich should be reversed as far as the refusal of an injunction is concerned, and that an injunction should be granted. The point which I have reserved for treatment in respect of Meux's action depends on their interest in the premises. They are reversioners, and the action by the reversioners can only be justified if the reversion is affected. But how is it possible to contend that the reversion is not affected if the walls of the house are so shaken by the nuisance in question that cracks are developed in the building, which experts consider will increase with the continuance, indeed, to increased sources of vibration, by the erection of larger and more powerful engines? I think there is ample evidence here of serious and permanent injury to the reversion by the continuance of the nuisance, and that, therefore, the same judgment ought to be given in respect of the reversion. As the reversioners and the leaseholders represent the entire interest it will be proper, in respect of the assessment of damages for past injuries, to see that the defendants are not made liable for the same damages twice over. The result is that the appeal succeeds, so far as the injunction is concerned, and that, therefore, the judgment of Mr. Justice Kekewich should be reversed in that respect, and the defendants should pay the costs.

Lord Justice LINDLEY took the same view as to the construction to be placed upon the Electric Lighting Act and Provisional Order, and thought there were no circumstances in this case which would justify the refusal of an injunction.

Lord Justice A. L. SMITH also agreed generally with his learned brethren, and was of opinion that this was essentially a case where it was impossible to procure the right to create a nuisance by the payment of damages, as the only basis for such damages must be the purchase of the unexpired portion of the plaintiffs' lease, and that was a course in direct contravention of the law, which held that a person committing a wrongful act was not entitled to ask the law to sanction his doing so by purchasing his neighbours' right to damages.

Mr. MOULTON asked that the action of the injunction might be suspended for a time, as the question was a very serious one for the Company. It was eventually agreed that the defendants should give notice within one month if they intended to appeal to the House of Lords, and that the injunction should remain suspended until the first motion day in Easter term, with liberty to apply.

Muirhead and Others v. Commercial Cable Company.

The judgment in this action was delivered on Tuesday last.

JUDGMENT.

The MASTER of the ROLLS said: This is an action brought on an agreement for certain sums of money payable as royalty within certain times, and the case was tried before Mr. Justice Kennedy without a jury, and the matter related to two patents, one granted in America and the other in England; and it seems to me that it appears to go no further than that it depended upon what was the length of the patent in America when it ran out, and whether the payments were due on the patent if it still existed. I have said that this case was tried before Mr. Justice Kennedy, and I have his judgment before me ; and I am prepared to say that I have never seen a judgment, in my mind, more admirably written. It seems to me to have gone through the whole case consecutively, step by step, to have stated each step in perfect language without any superabundant words, to have carefully considered each point, to have decided each point clearly, and then to have come to his conclusion ; and the judgment is to my mind so admirably written, that I don't know how to add a word to it, and my judgment in this case may be taken really to be the judgment of Mr. Justice Kennedy, to be given in the exact words from beginning to end which he has used, because I don't know how to add to it ; but I must, I suppose, refer to some point in that judgment. Now, from that judgment so described, so clear, so wanting in superfluity from the beginning I have been able to draw my mind to turn to the volumes of words that were poured in upon us in the argument. It seems to me that I prefer plain and simple language to all the clamour. The point, it seems to me, first, as Mr. Justice Kennedy pointed out, is what is the law in America ? It is part of the statute law in the States that every patent granted for an invention, which invention has been previously patented in a foreign country—shall be so limited as to expire at the same time as the foreign patent. There is the law, laid down in plain, simple language in a statute of the United States. And the law, in another part, says that every patent shall contain a short title of the invention or discovery indicating its nature and object. But if the invention shall have been previously patented abroad, the term of the patent will expire within the term of the foreign patent. There is the law. He then goes on to point out what is the American law applicable by way of judicious interpretation of that statute. Therefore, the only question he had to decide was—was the invention here, which was patented in America, the same invention which had been patented in England ? The question is whether the two patents are for the same thing. Well, what are the patents ? The patent in America is for a combination. It is in terms for a combination. It claims a combination ; and it claims one particular combination, exact in its details, exactly described, in the patent and claimed as a combination. And that combination consists in the relative positions of certain things in it, of certain instruments in it which are to do the work, and the patent is for the combination of them by means of placing them in particular positions. It is an American patent. Now you come to the English one. How can it be the same invention unless the English one, which was patented before this patent in America, was for a combination, and exactly the same combination ? It seems to me that one must hold this judgment right, unless you are prepared to say that the English patent was for a combination, and for the same combination. It must be for the same combination, and although the two patents need not be word for word and comma for comma the same, it must be substantially the same. Now, I have not heard it disputed but that the American patent here was, as I have said, and what Mr. Justice Kennedy said it was—a combination of the relative positions of materials. Is the English one so ? To read it and look at it alone it is not claimed that that is for a combination. There is no claim for a combination in it, in terms. But in the volumes of argument at the bar I could not get any clear statement that it was for a combination. It is suggested that it is for a combination, and that that is in the American patent. It seems to me very strange that (1) if it was so it was not claimed, and (2) that it could not be so set out in simple terms. Then this case need not have lasted a quarter of an hour. Well, then we come to the next statement. If the English patent was for a combination, why was it not used as a combination ? The learned judge said that the plaintiffs were entitled to recover if the American patent had not expired. If the matter were left in any doubt, in order to shorten the period of the American patent, the whole burden of proof rests on the defendants, and, the matter being left in doubt, that burden has not been discharged. In my opinion, the appeal ought to be dismissed.

Lord Justice RIGBY, in giving judgment on behalf of Lord Justice Lopes and himself, said that the decision in the case depended as to whether or not the United States patent of 1880 came to an end when the English patent of 1876 expired. He did not think that Mr. Justice Kennedy's findings as to the United States law could be impeached, and he agreed with the learned judge that a test of the identity of the patents was whether a structure made according to the foreign patent would infringe the United States patent. He also agreed that the burden of proving the identity of the two inventions lay upon the defendants, and that the principle of introducing any new patents by implication, any claim not expressly contained therein, ought to be applied with the greatest possible caution. He thought the defendants had made out their case affirmatively, and that there was no room for the application of the principle that where there was a doubt, the doubt should be resolved in favour of the United States patentee. He did not in any way differ upon the law from the learned Judge whose judgment, he agreed, was most admirably expressed, but he did differ from him in the conclusion of fact at which he had arrived. The appeal was accordingly allowed, the Master of the Rolls dissenting.

Grist and Turner v. Fowler-Waring Cables Company (Limited).

This was an action before the Lord Chief Justice and a special jury, to recover damages for alleged breach of a contract to supply them with a telephone cable fit for work similar to that of a telephonic exchange. The defence was that the defendants supplied the cable ordered by the plaintiffs, and were not informed of the particular use to which it was to be put. They further pleaded that the matters in dispute had already been the subject of litigation, which had already been settled.

The plaintiffs' case was that, in July, 1891. they ordered a 12-strand cable from the defendants, which was to be laid across the Cannon-street railway bridge, London, so as to enable the plaintiffs' customers to communicate across the river, as many of them had two places of business. So long as only one customer used the cable at the same time everything worked well, but when business increased and two or more customers used it at the same time there were complaints of cross talk, which the plaintiffs contended was due to induction, arising from the 12 wires being too closely bunched in the cable. The defendants, after investigating the matter, said that the mischief was caused by the manner in which the cable was laid and insulated, and they agreed to put a second cable, which should be suitable. Meantime the cable company had occasion to sue the present plaintiffs in the Mayor's Court for an admitted balance of account, but there was a counterclaim for damages arising from the unsatisfactory working of the first cable. That action was, however, settled. The second cable was laid in January, 1893 ; but, according to the plaintiffs, no complaints had been made made by customers prior to the settlement of the action, nor were they aware of any defects in the cable. On September 11th, however, complaints were made, and it was then found that the induction was just as bad as in the first cable, and that, in fact, the two cables were identical except as to the outer casing, which in the second cable was made of a harder substance than in the first.

Mr. GRIST, one of the plaintiffs, stated that he always understood he was to be supplied with one of the defendants' anti-induction cables. The defendants were fully aware of the purposes for which he required the cable. The first cable was laid on November 18, 1891, and no complaint was made until October 4, 1892. The second cable was laid in December, 1892, or January, 1893, and no complaint was made until September, 1893. Until two or more customers used the cable at the same time, cross-talk would not be discovered. On August 24, 1893, when the case in the Mayor's Court was settled, he was not aware of any defects in No. 2 cable.

Mr. GATEHOUSE, electrical engineer, said both the cables were unsuitable for the plaintiffs' work. There was no provision in either of them against induction. Each wire should be coated with tinfoil or leadfoil and connected to earth. For a short cable that would be enough. The hard casing of No. 2 cable would meet the difficulties as to insulating which occurred in No. 1.

The case for the defendants was that they supplied what was ordered according to the specification. They had no knowledge of the cable being used for any special purposes, and certainly never represented either cable to be an anti-induction cable. As to the settlement of the previous action, they contended that the plantiffs must have been aware of some complaints about No. 2, yet those complaints were suppressed so as to avoid being specifically mentioned in the terms of the settlement, which were to cover the whole of the transactions between the parties.

Mr. A. E. MAVOR, general manager of the Fowler-Waring Cable Co., stated that when No. 1 cable was supplied he was not aware whether it was to be an aërial or an underground cable. No. 2 cable was identical with No. 1, except that it had a hard casing instead of a soft one, the object being to obtain better insulation, as No. 1 had been badly insulated. It had nothing to do with any complaints about induction. In such a cable there was bound to be more or less induction, the only effective means of preventing it being the use of a return wire. Similar cables were in use all over London on the single wire system, otherwise there was bound to be cross-talk. The use of return wires, however, would double the expense. When complaint was first made he thought the cross-talk might have arisen from leakage due to bad insulation. He had written to the plaintiffs promising that the second cable should be a suitable one. It might be suitable to plaintiffs' purposes, and yet not suit their customers who used it. Anti-induction cables would be double the price of these cables. He did not intend them to think that they were to be supplied with an anti-induction cable. The use of tinfoil or leadfoil to prevent induction was out of date. The modern plan was to use double or return wires.

Mr. James Swinburne, electrical engineer, and Mr. H. R. Kempe, of the General Post Office, were called as experts on behalf of the defendants.

KNIGHT, an electrician in the employment of the defendant company, said he had inspected No. 2 cable, but never tested it for the purpose of detecting induction.

Mr. G. NEILL said that when in the defendant company's service he had no recollection of having made statements to the plaintiffs that No. 1 cable would be free from induction. He knew No. 1 cable was, in fact, a cheap cable. Plaintiffs wanted a low-priced article.

Having heard counsel, the LORD CHIEF JUSTICE, in summing up, said the main questions in this action were whether the plaintiffs had any claim in respect of No. 2 cable, and if so, whether that claim was included in the settlement of the Mayor's Court action. They must remember that while, no doubt, there was generally an implied warranty that goods were fit for the purpose for which they were sold, yet if a specific known article was ordered the purchaser was supposed to known what he wanted. A letter of July 22, 1891, would rather tend to show that the plaintiffs were aware of the difference between single lead-covered wire and return-wire cable, for they were asking for a sample of each. It was also remarkable that all parties agreed not only that both cables were perfect of their kind ; but also that in both of them there must be more or less induction. That being the case, it was difficult to believe that the plaintiffs really expected to get a low-priced cable absolutely free from induction. It was also curious, to say the least of it, that no tests had been made for induction, and that no customers of the plaintiffs had been called to complain about the cross-talk. The learned judge then reviewed the evidence in detail, and left the following questions to the jury :—1. Did the defendants undertake to supply a cable suitable for telephonic purposes ? 2. Did they, in fact, do so ? 3. If they did not, what damages ?

4. In the settlement of the Mayor's Court action did both parties proceed on the basis that No. 2 cable was satisfactory, and was it intended by them that the settlement should end all questions relating to both cables?

The jury retired at 11:35, and at 12:45 returned into Court, and answered the questions as follows:—1. Yes. 2. Yes. 3. No damages. 4. Yes.

The LORD CHIEF JUSTICE: It is clear that on those findings I must give judgment for the defendants, which I do, with costs.

Printing, Telegraph and Construction Company of the Agence Havas Limited) v. Beer.

An action was brought before the Lord Chief Justice to recover a second call of £1 each on 930 shares duly allotted to the defendent by the Directors of the Company after application. The defence denied that the Directors were properly constituted when they allotted the shares, and that the defendant was induced to underwrite 1,000 shares in the Company by reason of fraudulent misrepresentations alleged to have been contained in the prospectus. The Company was formed in March, 1893, to work a news agency in France, which was to be carried on by means of certain American patents for the automatic distribution of news, by a transmitter in the central office of the agency, worked on the principle of the typewriter, with receivers at each of the subscribers' houses, which printed the news in "column" instead of in "line" (as in the case of the tape machines). The public did not, however, apply for the shares, and thus 980 were allotted to the defendant. After the case had proceeded for some time, an arrangement between the parties was come to, and the action was withdrawn.

Edman v. Churton.

In an action at the West Riding Assizes, before Mr. Justice Charles, the plaintiffs' the Rev. Ed. H. Edman, Rector of Thornton-le-Moor, Caistor, Lincolnshire, and his son, C. E. Harold Edman, sued the defendant, Mr. T. Harding Churton, electrical engineer, of Leeds, claiming damages for an alleged breach of the terms of a deed of apprenticeship, by the failure of the defendant to properly instruct the younger plaintiff in his business. A counter-claim was made by the defendant for the loss of the services of the younger plaintiff. On behalf of the plaintiffs it was stated that in 1891 the younger plaintiff, who was a minor, was apprenticed to Mr. Churton, to learn the business of an electrical engineer. In 1893 he went home ill, and it was alleged that this was due to overwork, and that he had not yet fully recovered his health. He stated that during his residence with Mr. Churton he had learned next to nothing. He admitted, in cross examination, that no dispute or dissatisfaction arose, except in his "secret mind," at the extent of his instruction, until a dispute arose between his parents and Mr. Churton as to the amount due for his board. His father was not able to pay the amount agreed upon for his tuition. In the course of the dispute a letter was written to Mr. Churton by Mrs. Edman, wife of the senior plaintiff, saying that her son was very comfortable at Mr. Churton's, but that she could not afford to pay the terms for board previously arranged.

After hearing the evidence, his Lordship gave judgment for the defendant, remarking that the case was one which ought not to have been brought, and when, later on, Mr. Churton agreed to relinquish his claim for costs, his Lordship said that the defendant had behaved very handsomely; it was an act for which he deserved the greatest credit.

Employers' Liability.

In the Westminster County Court, on Monday, before Judge Lumley Smith, the action Jeffreys *v.* Pritchetts and Gold was tried. The plaintiff was a workman formerly in the employ of the defendants, electrical engineers, and sued under the Employers' Liability Act to recover damages for personal injuries sustained owing to the alleged defective condition of the defendants' plant. It appeared from the evidence that in October last the plaintiff was in defendants' employ, and was sent in company with other men to assist in installing electric light into a house at Hanover-square, London. In the course of the work he was ordered by the foreman to go on to the roof of the lift for the purpose of completing the work, and whilst he was so engaged the lift gave a very sudden jerk, with the result that he was thrown over and sustained a fracture and other injuries, which would incapacitate him from further work.

For the defence it was urged that the work upon which the plaintiff was engaged was perfectly safe if proper care had been used, and a number of expert witnesses were called to prove that it was a very common thing to work from the roof of lifts when electric light wires were being fixed up.

In addressing the Jury his HONOUR said the question for them was as to whether the absence of a guard rail round the roof of the lift constituted a defect in the plant, and, if so, was there contributory negligence on the part of the plaintiff.

In the result the Jury found for the plaintiff, and assessed the damages at £150, for which amount judgment was entered, with costs.

BOOKS RECEIVED.

"La Galvanoplastie." By E. Bouant. (Paris: Baillière and Sons. 1894.)

"La Réglementation de la Propriété Industrielle." By Th. Wiesemann. (Paris: E. Bernard and Co. 1893.)

"La Théorie de l'Invention." By Th. Wiesemann. (Brussels: chez l'Auteur.)

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices:—*

The 1894 Edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK contains 1,000 closely-printed pages, and several new and useful features have been added. The price of this edition of the Directory and Handbook is now 4s. post free; abroad 5s. **The 1895 edition is in active preparation**, and subscription and advertisement orders should now be sent in.

LABORATORY NOTES AND FORMS.—With the above title, we have in the press a set of Elementary (now ready) and Advanced Exercises (ready shortly) for use in Electrical Engineering classes. These have been prepared in Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is just out, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. net., is now ready.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"ELECTROMAGNETIC THEORY" (Vol. I.), by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application. Vol. II. is in preparation.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"DRUM ARMATURES AND COMMUTATORS."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

TENDERS INVITED.—The Town Council of Great Yarmouth invite tenders for installing the electric light at the Town Hall Free Library and the Great Yarmouth Police Station. Tenders must be delivered to Mr. T. A. Baker, town clerk, by January 2nd.

TENDERS ACCEPTED.—The Gas and Electric Lighting Committee of the Aberdeen Corporation has received the following tenders for the supply and erection of two Willans engines, two dynamos, pipes, &c., recently advertised for:—

Johnson and Phillips, London	£3,850
Mather and Platt (Limited), Manchester	3,820
Electric Construction Company (Limited), London	3,742
Easton, Anderson and Goolden (Limited), London	3,600
Siemens Bros. and Co. (Limited), London	3,578
Crompton and Co. (Limited)	3,493
J. H. Holmes and Co., Newcastle (accepted)	3,300

——— The following tenders have been accepted by the Ayr Police Commissioners in connection with the electric lighting works:—

Boiler-house plant, Messrs. Penman and Co. (Glasgow)	£950	0	0
Engine-house plant, Messrs. Siemens Bros. and Co. (London)	5,940	0	0
Switchboards and instruments, arc lamp posts, &c. Messrs. John Fowler and Co. (Leeds)	988	5	0
Cables and culverts, The Callender Company (London)	1,842	18	9
Transformers and boxes, Messrs. Swinburne & Co. (London)	420	0	0
Meters, Messrs. S. Z. de Ferranti (London)	590	13	0
Travelling cranes, Messrs. Carrick and Ritchie (Edinburgh)	192	10	0

——— Messrs. Hill, Evans and Co., of Worcester, have entrusted the contract for lighting their offices and works by electricity to Messrs. Mann and Sons, High-street, Worcester, local agents for Messrs. B. Verity and Sons.

——— The Sunderland School Board have accepted the tender of Mr. D. Taylor for supplying and fixing the fittings necessary for lighting the Board offices by electricity for the sum of £39. 15s.

——— The Governing Committee of the Enniscorthy District Lunatic Asylum have accepted the tender of Messrs. Curtis and Sons, Middle Abbey-street, Dublin, for the supply and erection of telephonic instruments for use throughout the asylum buildings.

Appointments. Mr. Duncan, a pupil with Mr. C. Faraday Proctor, of Bristol, has been appointed assistant engineer at the Cheltenham Corporation Electric Lighting Works.—The Postmaster-General has appointed Mr. H. Crawley, assistant superintendent at the Central Telegraph Office, London, to be postmaster at Macclesfield, *vice* Mr. Hepburn, resigned.

Vacant Appointment.—The Committee of University College, Nottingham, invite applications for the post of Junior Demonstrator and Lecturer in Physics, at a salary of £120 per annum. Further particulars can be obtained of the secretary, to whom applications must be sent not later than January 11th.

Liquidations.—Mr. John Gourlay, C.A., trustee of the estate of J. and W. Weems, Johnstone, Scotland, and Mr. Alexander Wylie, notifies that on and after Tuesday, the 29th prox., the following dividends will be paid:—2s. in the pound to creditors whose claims have been lodged and admitted since the last dividend was paid; and a second and final dividend of 6½d. in the pound to all creditors whose claims have been lodged and admitted.

——— A petition for the winding-up of Martiny (Limited) was heard on the 5th inst., and, pending negotiations, was ordered to stand over. On Wednesday, counsel for the second petitioners pressed for a compulsory order, although the original petitioners had been settled with. It was stated for the Company that its embarrassment was only temporary, and that eventually the debentures would be redeemed and the creditors satisfied. His Lordship said that if the Company would undertake to pay to the Official Receiver any amounts that might be received he would consent to the petition standing over.

——— Under the liquidation of the Common Petroleum Engine Company (Limited), the creditors and shareholders have elected Mr. George Emdin, C.A., Coleman-street, London, E.C., liquidator, to wind up the Company. The Company was originally formed to acquire an invention for improvements in gas, petroleum, and other hydro-carbon motors, and had a capital of £20,000. The unsecured debts amount to £1,092, and the only asset is a specimen engine.

——— A petition for the compulsory winding up of the South Staffordshire Tramways Company (Limited) has been presented by five trade creditors, and on the matter being mentioned to Mr. Justice Vaughan Williams on Wednesday it appeared that four of the petitioners had been paid, and the Directors offered personally to pay the fifth, the amount being only £12. Mr. Levett, Q.C., for the Electric Construction Company, applied to be substituted for the petitioners, and pressed for an order to wind up. He had a claim for £30,000, although that, no doubt, was disputed. After a long argument it was agreed that the original petition should be dismissed, on the satisfaction of the debts of the petitioners; that the Electric Construction Company should immediately commence an action to establish its claim, the Tramways Company undertaking, pending the hearing of that action, not to interfere with the fund in Court.

New Firm.—Under the style of "Wilson Hartnell and Edmondson," the businesses previously conducted separately by these gentlemen at Leeds and Bradford have now been amalgamated. New premises have been taken in Kirkstall-road, Leeds, and these will shortly be opened and be called the Volt Works. These works are to be fitted up in the most complete manner for the manufacture of both light and heavy machinery, and especially for the construction and testing of dynamos, motors, and electrical plant. The whole of the machinery, including cranes, are to be driven electrically, and the works are to be lighted throughout by electricity.

Reduction in Cable Rates.—In response to a deputation, the West India and Panama Telegraph Company has agreed to allow the team of English cricketers about to visit the West Indies to send 50 words free of charge over the Company's system from the West Indies, and if the efforts of the Company to obtain reduced rates from the other systems traversed by the message are successful, the team will be able to communicate with England at the rate of 2s. 3d. per word, which is about one-fourth of the usual rates.

The Geographical Society.—The premises occupied by this Society have recently been entirely renovated, and in addition to many other considerable improvements the whole edifice has been lighted throughout by electricity.

Forced Draught.—Mr. W. A. Granger forwards his latest circular, giving particulars and illustrations of the Granger patent forced draught apparatus, for which many advantages are claimed, amongst which are great economy, smoke prevention, the preservation of fire-bars, &c. Amongst the users of this arrangement are the Brighton Corporation Electric Light Works and many of the principal engineers throughout the country.

Night-Light Watch Stands.—We have received from Messrs. Siemens Bros. and Co. an illustrated leaflet, showing various ways of adapting their Obach dry cells to night-light watch-stand purposes.

Improvement in Telephone Lines.—Herr Emil Muller, of Berlin, is introducing an improved method of wiring for preventing cross-talk. He attributes cross-talk to leakage currents, and has invented various insulators and supplementary lines for controlling them. The invention has been submitted to the General Post Office and to the National Telephone Company for tests.

Oil Engines.—The Root's Oil Engine and Gas Engine Company send us particulars of their new type of oil engine, which includes a description of the ½ B.H.P. engine now offered. The weight of this engine is 95lb., and it consumes one pint of oil per hour when giving its maximum power, and when speed and power are reduced oil consumption is lowered in proportion. The base of the engine is 6in. square, and the height from the base to the top is 22in., with a 17in. fly-wheel. The engine is hand controlled, and will work up to a maximum speed of 400 revolutions per minute. It is claimed that paraffin or kerosine of 0·8 to 0·845 specific gravity can be used.

The Johnson System of Temperature Regulation.—We have received from the Johnson Electric Service Company of Detroit, Mich., a pamphlet describing that Company's system of heat regulation, in which it is stated that "much time and money have been spent in endeavouring to devise some means of operating valves and dampers directly from a thermostat by means of electricity; and while in some cases it can be done, it is expensive, complicated, and unreliable." This is doubtless because the mechanism required to be acted upon by the electric current is intricate and difficult to supervise, and from the drawings in the pamphlet before us we do not think the Johnson system overcomes this objection. There is no doubt that in the States, where the degrees of heat and cold are acute, some such system may have possibilities of success; but, erratic and unreliable as the British climate undoubtedly is, there is, we think, little possibility of any such system finding a permanent abode in this country. Accompanying the pamphlet are a number of diagrams fully illustrating the system, and the Company will supply copies of the pamphlet to readers interested in the subject.

"Shaydolite."—This is the name given to an article recently introduced by Messrs. Griffiths Bros. and Co. for shading incandescent lamps, &c., with the object of toning down the light and for decorative purposes. "Shaydolite" is supplied in a variety of colours, and can be applied wherever bulbs, globes, or shades are in use. If this varnish is found to stand the heat it ought to be very useful for theatrical and similar work. The aniline blue often used for this purpose becomes dull violet and then red. In some theatres the blue lamps are cleaned and re-dipped about once a fortnight.

Electrical Heating.—In reference to a Note which appeared in our issue of the 14th inst., page 180, Mr. H. J. Dowsing, of Messrs. Crompton and Co., 148, Brompton-road, S.W., writes that the electrical appliances referred to were made by Messrs. Crompton and Co., who have ascertained that the American journal from which our Note was taken obtained the information from a British publication. Mr. Dowsing continues: "Unlike, however, the American paper, *you* mentioned the source from which you gained your information." It is interesting to learn that the wheat-drying chamber, which, we believe, is the first of the kind constructed, is made in the form of a wooden box, containing 19 electrically heated plates which reach about 200 F.; a blower is used to force the air over the plates, and it comes out at a temperature varying from 120° to 170 F., according to the amount of air passed through. This arrangement is to replace a steam heater, and it is believed a considerable saving will be effected owing to the fact that ample power is available from a waterfall near by. Other inquiries for this kind of heating arrangement have been received by Messrs. Crompton, and, in places where fuel is dear and water power plentiful, there will, no doubt, be a considerable field for similar plant. The electrically-heated plate supplied for preventing the clock freezing is fixed to the top or side of the case, and by its use it is a perfectly simple matter to prevent snow and ice accumulating on the face, and so stopping the movements of the hands. This is the first instance that we know of where such an arrangement has been used, and it will be interesting to note the result. Messrs. Crompton have had so many inquiries for new applications of their electrical heating system, that there can be no doubt that a large demand for the apparatus will ensue.

Calendars.—Messrs. Engelbert and Co., of 44 to 47, Bishopsgate, E.C., issue a handy hanging calendar, with monthly tear-offs, copies of which they will be pleased to supply free on request from users or likely users of their commodities.——Mr. S. Howes, of 46, Mark-lane, sends us a neat hanging calendar with tear-off sheets, and those of our readers interested in turbines, milling machinery, &c., can obtain copies of the calendar post free on request.——The Brush Electrical Engineering Company send us a pocket almanack and memorandum book bound in leather.

Ayr.—At the last meeting of the Police Commissioners a letter was read from Mr. R. Hammond, consulting engineer to the Commissioners, on the subject of Board of Trade regulations as to insulation of the high-pressure mains, and Mr. Hammond's suggestions on the subject were approved. The designs for arc lamp posts submitted by Messrs. J. Allan and Sons were approved.

Bath.—A discussion took place at the last meeting of the City Council on the application of the City of Bath Electric Lighting and Engineering Company for the Council's sanction to their application for a Provisional Electric Lighting Order. Mr. E. B. Titley, the Company's solicitor, fully explained the position of the Company, and the facilities it was prepared to offer the Council in the event of their consent being given to its application. A resolution was, however, moved by Alderman Sturges that the consent of the Council be not given; but that the Lighting Committee should be empowered to obtain the services of a consulting electrical engineer to advise them generally on the subject. This resolution was carried.

Bedford.—Owing to the satisfaction felt at the success of the electric light at Bedford the authorities are receiving satisfactory orders for current.

Brechin.—The agreement between the Scottish House-to-House Electric Light Company and the Police Commission has been signed.

Brighton.—At their meeting yesterday the Town Council further discussed the project of the Lighting Committee to practically supersede gas by the electric light throughout the principal thoroughfares in Brighton, including the Marine Parade. A report, dated the 10th inst., was presented by Mr. Arthur Wright, the Council's engineer, in which Mr. Wright says:—

"As the arc-lighting of the principal streets at our present prices will be so little in excess of the price at present paid for gas, and the improvement in the illumination will be nearly as great as that which was effected by the electric lighting of the King's-road, I recommend the Committee to at once make arrangements for lighting the following principal roads and streets by means of arc lamps, viz.:—Queen's-road, West-street, Western-road, North-street, East-street, Preston-street, Old Steine, St. James's-street, Marine Parade, North-street Quadrant, part of Ship-street, and the central valley northwards to New England-road. For the Marine-parade, I recommend the adoption of exactly the same standard and canopy as those which are in use on the King's-road; and in the other wide streets I recommend the use of a standard placed in the margin of the pavement on either side of the roadway, and having a graceful curved arm or bracket from which the lamp would be suspended so as to hang over the roadway. The design of this standard can be decided upon at some later date. For the narrow busy streets I strongly urge the Committee to adopt the system of central lighting; and in my opinion and that of others whom I have consulted, the most elegant and least objectionable way of carrying this method out would be to fix some neat form of angle iron or steel tube arch across the streets, supported by brackets fixed to the walls of opposite houses at a height sufficient to allow a fire-escape to pass. I have no doubt that any necessary permissions may be easily obtained. I think everybody will admit that the central position of the arc lights is the ideal way of lighting narrow streets, and as arrangements can be made for easily lowering them to one side over the pavement for trimming I can see no great objection to the arch method of support proposed. It would involve but little strain and knocking about of the walls of the houses to which the arches were affixed, and it would be decidedly preferable to the alternative system of putting in standard lamps with their necessarily large bases in the pavements of busy narrow streets. The scheme would involve the use of 115 6-ampere arc lamps, 40 of which I propose should be extinguished between 11 and 12 o'clock at night, the remaining 75 being burnt all night. The capital outlay required for the above 115 arc lamps will depend to a certain extent upon the designs chosen for the pillars and arch supports, but I do not think the inclusive cost of the lamp wires, lamps, pillars, and arch supports will exceed £5,200. I estimate the cost of current which will be consumed, carbons, labour, and repairs, at £2,360 per annum. Adding to this the interest and annual instalment for repayment of debt (assuming the debt to be repayable in 25 years) on the cost of the lamps, pillars, &c., the annual charge to the district fund will amount to about £2,660. The above 115 arc lamps will displace quite 257 gas lamps, costing the Corporation £1,874 per annum for gas and attendance. The increased cost of electric lighting will therefore amount to only £786 per annum, and at the same time such an increased illumination will be obtained, that a statement that the relative candle-power will be more than five times that which is at present obtained from gas in no way expresses the improvement. The extra load put on the engines at the generating station by the above 115 arc lamps will not exceed that which is required to supply 1,150 8-c.p. lamps (29 watts). I estimate that the whole of the above work can be completely carried out by the end of September next."

The Lighting Committee have considered Mr. Wright's report, and recommend it for adoption. They propose that the two contracts with the gas company be determined at June 24th and October 31st next respectively, so far as concerns the lamps in the various streets selected by Mr. Wright for the present extension. Finally, the Committee recommend that application be made to the Local Government Board for sanction to borrow £5,200 for electric lighting purposes.

Cairo.—Special steps have been taken to secure the Ghizeh Museum from the danger of fire, and amongst the recent improvements is a complete system of electrical communication from all parts of the building to the fire brigade station and the Ghizeh waterworks.

Calcutta.—The contract for the electric lighting of the Columbia Skating Rink has been entrusted to the India Rubber, Gutta Percha and Telegraph Works Company (Limited). The plant consists of a Silvertown compound-wound dynamo, driven by a 10 h.p. Marshall double-cylinder portable engine. Round the skating surface there are eight lamps of 300 c.p. and two in the centre of the building of 600 c.p. The offices, &c., are lighted by forty-two 16-c.p. incandescent lamps. At the main entrance there is an ornamental iron pillar supporting a 600 c.p. lamp. The whole of the work was carried out under the superintendence of Mr. Walter A. Purdom.

Canary Islands.—The town of Orotavo, in the Canaries, is lighted by electricity, the generating plant being of Swiss make. Motive power is provided by a cascade which exists just outside the town, and which is stated to be of sufficient magnitude to provide power for generating enough electric current to supply the whole of the islands.

Carlisle.—The Gas Committee of the Town Council have decided to ask the Council to apply for borrowing powers for £40,000 for electric lighting purposes.

Church and Chapel Lighting.—Trinity-road Baptist Chapel, Halifax, is now lighted electrically.

Club Lighting.—The Liberal Club, situate in Corn street, Bristol, is now being fitted for the electric light.

Coventry.—At the last meeting of the City Council, on the recommendation of the Electric Lighting Committee, it was decided to supply current for power purposes at 4d. per unit.

Crosby.—The Local Board have adjourned for further consideration the application of the Holloway Electricity Company for the Board's sanction to their application for a Provisional Order for supplying the district with electric current.

Devonport.—At the Borough Council meeting last week the Streets and Highway Committee's resolution to oppose the application of the Brush Provincial Company for the consent of the Council to its application for a Provisional Order was discussed. Complaint was made by several members of the inferior quality of the gas supplied in the district, and surprise was expressed that although there was no possibility of the Council applying for a Provisional Order for power to supply electric current, it was still proposed to oppose the application of the Brush Provincial Company. In the end, however, the Committee's recommendation was adopted, and the application of the Company is to be opposed.

Douglas (Isle of Man).—It is likely that the extension of the electric tram line to Snaefell will shortly be proceeded with.

Edinburgh.—It is confidently anticipated that the works in connection with the Corporation electric supply station will be completed and the current obtainable in the month of March next.

Exhibition Awards.—We have received a long communication from the Magnolia Anti-Friction Metal Company of Great Britain, pointing out the abuse which the undue growth of industrial exhibitions has brought about. From the Company's letter it would appear that a German firm of anti-friction metal makers are trading upon awards stated to have been obtained at the recent Chicago Exhibition, but which were, in fact, never awarded. The same firm are charged with adopting a somewhat similar practice in the case of the Antwerp Exhibition awards, where the firm in question have obtained a silver medal but announce the award as a gold medal. The Magnolia Company point out that this is a case in which exposure is very difficult, but that some steps should be taken to bring the guilty parties to account. In any case the charge made against the German firm in question appears to be substantiated in the communication before us. Surely this is a case in which the assistance of the Chambers of Commerce could be invoked.

Forfar.—Mr. Forbes Waddell, the recently-appointed manager at the Corporation Gas Works, has just prepared a report, in which he states that as the electric light has now been adopted in most of the factories in Forfar the sale of gas has steadily decreased from seven and a-half millions in 1891 to three millions in 1893-4. He proposes several modifications in the plant at the gas works by which he believes the Corporation will be enabled to sell their products at a cheap rate. An interesting question was discussed at the last meeting of the Gas Committee as to whether the Corporation were compelled to supply gas to factories in which the electric light has been installed. Mr. Craik stated that the supply of gas to these factories was peculiarly intermittent. He noticed in the accounts that, while 100ft. or 200ft. were supplied in one month, the supply amounted to 26,000ft. at another period, which seemed to indicate that something had gone wrong with the electric light, and he, therefore, wished to know whether the Corporation had not something to say on the question of supply. The clerk pointed out that the Corporation could not act out of reason, and the matter was ultimately sent up to the Gas Committee for consideration and report.

Halifax.—It is anticipated that the principal streets of this town will be lighted electrically by the 24th inst.

Hotel Lighting.—The Clifton Down Hotel (Clifton, Bristol) is to be lighted throughout by electricity.

Insurance Office Lighting.—The handsome block of buildings now being erected in Cornhill (London, E.C.) for the Commercial Assurance Company are to be lighted throughout by electricity, and the contractors for the work have appointed Messrs. Handcock and Dykes, consulting engineers, for the work. About 600 lights will be used in the installation.

Keswick.—In regard to the application by the Keswick Electric Lighting Company for the consent of the Local Board to their application for a Provisional Order, the matter has been left over for the consideration of the Urban Council.

Lectures.—Dr. J. A. Fleming delivered a Gilchrist lecture at the Corn Exchange, Bedford, last week, to a large audience, under the presidency of Sir Henry Mance, C.I.E. For the first time, the large hall in which the lecture was delivered was lighted by electricity. The lecture was listened to throughout with marked attention, and at the conclusion a hearty vote of thanks was accorded. Gilchrist lectures have also been recently delivered by Dr. Fleming at Coventry, Old Hill, and West Bromwich.

Leicester.—On Wednesday last the Corporation for the first time supplied electric current for private purposes. The business premises of many of the leading Leicester tradesmen were supplied with the electric light. There is still some work to be done before the whole of the wired central area can be supplied, but it is probable that this will be effected very shortly.

Leith.—The extensive premises of Messrs. W. Jeffrey and Son, Market House, Leith, have been fitted throughout for the electric light, which was inaugurated on Saturday last. Arc lamps are used for the exterior lighting, and incandescents throughout the workrooms and offices.——A preliminary test has taken place of the plant, which is now nearly completed, for the electric lighting of the Victoria Dock and the old docks at Leith. The object of the trial was to satisfy the Commissioners, who have under consideration the extension of the lighting to the Albert and Edinburgh docks. Both arc and incandescent lighting are included in the work, which has been carried out by the Brush Company under the supervision of Mr. E. G. Craven, Superintendent for Scotland, at a cost of about £4,000.

Liverpool.—The Lighting Committee of the Corporation recommend the acceptance of the offer made by the Liverpool Electric Supply Company (Limited) to purchase the whole of that Company's undertaking as a going concern, the purchase to take place during the year 1895, instead of waiting until such time as the Corporation can compel the Company to sell their business. It is proposed that the terms of the transfer shall be agreed between the Company and the Lighting Committee, or by arbitration. This resolution has been discussed, and it has been agreed to authorise the Committee to take such steps as may be necessary to ascertain the cost, and to formulate the details of a scheme for supplying all the public buildings and markets in the city with electric light, from stations to be established by the Corporation.

Luton.—The Borough Surveyor's estimate of the amount required to carry out the electric lighting scheme is £10,000. It has been decided by the Town Council to apply to the Board of Trade for a Provisional Order.

Mill Lighting.—The extensive mills at Parndon, Hertfordshire, have been completely fitted for the electric light by Messrs. W. J. Crampton and Co., of Cambridge and Yarmouth. The generating plant is driven by turbine.

Portsmouth.—The third direct-driven alternating dynamo and engine, which is being put down at the Corporation Electric Lighting Works by Messrs. S. Z. de Ferranti and Yates and Thom, will shortly be completed. Christmas Eve is the time fixed for the completion of the work, and, notwithstanding the short time given to the contractors, it is expected that no delay will occur. The existing plant at the station has been for some time past working to its full capacity.

Postal Arrangements.—Special arrangements are made for postal deliveries during the Christmas holidays. Particulars of these arrangements can be obtained at any post office.

Radcliffe.—At the last meeting of the Local Board a discussion arose on the electric lighting scheme. It has been decided to apply to the Board of Trade for a Provisional Order, and to the Local Government Board for powers to borrow the necessary monies for carrying out the scheme. Although it is not anticipated that so large a sum will be required, £20,000 is to be asked for.

Richmond.—At the last meeting of the Town Council the Works Commttee reported that the total cost of the new electric firecalls and materials amounted to £2,322. 9s. 7d., and additions were recommended estimated to cost about £305. The loan authorised and raised for this purpose was for a sum of £1,800. It would, therefore, be necessary for application to be made to the Local Government Board for authority to borrow a further £900 to cover the ultimate cost. In regard to the resolution recently adopted calling upon the Richmond Electric Light and Power Company to make up their deposit, under clause 6 of their agreement, to the sum of £400, an arrangement has been come to by which the Company keep a regular deposit of £50 with the Council, with the addition of such further sums as may be required from time to time when extensions are made.

Scarborough.—In connection with the Castle Hill scheme, the Lamps Sub-Committee has received instructions to obtain tenders for the lighting of certain streets in the borough by electricity.

Southampton.—A letter was read at the last meeting of the County Council from the Southampton Electric Lighting and Power Company asking the Council's permission to the application made by the Company for a Provisional Order to supply electric current within the district. The Company point out that they have carried out all their engagements with the Local Authorities, and have given satisfaction to the users of electric current in the area supplied by the Company. They also agree, if the Corporation decide within six months to negotiate for the purchase of their undertaking, to dispose of the same at a fair price. In discussing this letter a resolution was proposed by Mr. Lemon that no opposition should be made by the Corporation to the Company's application. In spite of an amendment referring the matter back for consideration the resolution was adopted by 18 to 8, with the modification that the period for negotiation for purchase be made twelve months instead of six months.

South Staffordshire Tramways.—The workmen employed on the electric tramcars on the South Staffordshire Tramways have received notice to quit. The whole of the cars are now labelled as the property of the Electric Construction Company (Limited). Regret is expressed that no satisfactory arrangement can be made to enable the cars to continue running, and the inconvenience to the public, especially at Darlaston and Walsall, is considerable.

The Stage.—Previous attempts by the Lithanode and General Electric Company, to introduce novel electrical effects on the stage have led to a considerable increase of business in this direction this year. A quantity of work has been undertaken by the Lithanode Company for several of the leading theatres and places of amusement, including the Lyceum (London), Olympia, Crystal Palace, and the principal theatres in Edinburgh, Birmingham, Manchester, Sheffield, and Portsmouth. This is a branch of electric lighting business for which a considerable amount of business in the near future may be safely prognosticated. The new Queen's Theatre, at Longton, Staffs., is to be lighted throughout by electricity. The new Grand Theatre at Wolverhampton, which was opened last week, is partially lighted by electricity.

Swansea.—At a meeting of the General Purposes Committee of the Corporation a sub-committee reported that at a consultation with Mr. E. Manville, of London, that gentleman had estimated that the cost of lighting the town by electricity would be about £36,750. The report of the Sub-Committee was adopted, and it was decided to put the work under Mr. Manville's supervision, at a remuneration of 5 per cent. on the estimated outlay.

Wakefield.—Councillor Lee, in reply to a question as to the progress made with the electric light question, stated that nothing had been done up to the present, but that a meeting was to be held yesterday (Thursday), when he hoped the question would be discussed in earnest. The question of the site for the sewage works had so far been a barrier ; but as that had now been settled, there was no reason why the electric lighting scheme should not be proceeded with.

Wandsworth (London, S.W.).—The General Purposes Committee of the Board of Works have refused their consent at present to the laying of pipes by the County of London Company.

West Cowes.—Notice has been given by Mr. C. L. D. Reader, trading as Reader and Co., of Bath-road, West Cowes, of his intention to apply to the Board of Trade for a licence under the Electric Lighting Act, to supply electric current within the area of the West Cowes Local Board. The Board, having discussed the notification, asked for further information.

Works Lighting.—The extensive range of buildings at Broadheath, near Manchester, occupied by Messrs. George Richards and Co., are now lighted throughout by electricity. This is one of the largest and most completely equipped machine-making firms in the Manchester district.

Yarmouth.—The Town Clerk, at the last meeting of the Council, produced the formal sanction of the Local Government Board for the borrowing of £1,500 for the purpose of certain extensions of the electric lighting scheme. The Trinity House have complained that certain arc lamps on the parade were insufficiently screened, owing to which the efficiency of certain of the Trinity lights were marred.

COMPANIES' MEETINGS.

New Telephone Company (Limited).

An extraordinary general meeting of this Company was held at the Cannon-street Hotel, on Wednesday, for the purpose of considering, and, if thought fit, passing the following resolution: "That the Company be wound up voluntarily." Mr. J. S. Forbes presided.

The SECRETARY (Mr. W. C. Gould) having read the notice calling the meeting,

The CHAIRMAN stated that the purpose for which the New Telephone Company was created had been served; and experience had shown that the interests of the telephone business, and equally of the public, would be better served by having the complicated and difficult work carried on by one company instead of by two—more efficiently as regarded the public, and more economically as regarded the Company. The undertaking was entered on with the best intentions, and he was not sure that they had not been a little enthusiastic. They had wanted to confer benefits on the public which they themselves scarcely understood, and which they could only comprehend from one side—the side of an impossibly low subscription. This state of things, however, very soon discovered itself. On the other hand, the New Company accepted certain obligations to individual subscribers, and had carried them out loyally; but the time had now come when they thought it would be much better, in the interests of all concerned, that the New Company should be wound up. The places in which business had been carried on were very few, two or three at the outside, and the business itself was on a comparatively small scale. The capital of the New Telephone Company, subscribed and paid up, was very large, and a great deal of it was lying aside absolutely unproductive. They had no intention of risking this capital in perpetuating the evils of the original foundation; they thought they could dispose of it much better by transferring it back into the pockets of those to whom it belonged. This, however, could not be done without liquidation. He did not know whether the shareholders would think that the general grounds he had mentioned were sufficient for the course which it was now proposed to take; but the Directors, being charged with the interests of the shareholders, had determined that it was their duty to propose the winding up of the Company. He therefore concluded by moving a resolution to this effect.

Mr. PARKINSON asked for further explanations. The capital represented by ordinary shareholders outside the National Telephone Company was very small indeed, but he thought it was matter of moment to outside shareholders to be informed of the reasons which had actuated the Directors in coming to the conclusion to wind up. They were aware that the New Telephone Company had entered into negotiations and agreements with the Post Office. The Chairman had suggested that the object with which the New Telephone Company came into existence had been served. To his mind, however, one of the original objects of the New Company was to prevent the telephone business of this country from becoming a monopoly in the hands of the National Company, but he failed to see how this object could be served by the New Company committing suicide and removing the only rival that the National Company had. The New Company had about 1,500 subscribers at Manchester, and he would like to know the intentions of the Directors in regard to that business—whether it was to be continued by the liquidator, sold to another company, or discontinued entirely.

The CHAIRMAN, in reply, stated that a matter of this kind might be determined on other considerations than the question of mere profit and loss, although one knew in commercial undertakings the necessity of keeping in mind this important factor. A careful account had been prepared, showing the working of the New Telephone Company. He did not mean to say that this account might not be challenged on some matters of principle affecting details; but the result of the working of the New Company, according to the account in question, which he was prepared to defend if necessary, showed that from March 22, 1892, to the end of October, 1894—very nearly the term of its existence—a loss of £6,325 was incurred. He had stated that the purposes for which the Company was originally formed had served their turn—certainly, the purposes of the promoters were pretty well served—and the interests of a business like the telephone, which was full of complications, required unity of management and of interests to produce the best results. The working of the New Telephone Company had been carried on with great diligence, but the result had been the loss on working account to which he had stated. Having given a detailed explanation of how this result had been arrived at, he admitted that some of the charges which had been debited to revenue might have been allocated to capital account if the undertaking had been continued, and it had expanded into a great company. The payments which had been made, however, would have had to be made whether they were debited to capital or revenue, and, therefore, the business had been carried on not only for no profit but with the loss mentioned. A large amount of capital was also lying idle at the bank at interest, and this meant so much dead loss to the owners. A great many of the subscribers at Manchester had been taken on a tariff which it was not known at the time meant ruin.

Mr. PARKINSON said he questioned this.

The CHAIRMAN: You may question it, but I do not. A £5 subscription was infinitely less than the actual cost of every subscriber in Manchester at the present moment, and a multiplicity of subscribers for the New Company would have meant more speedy ruin to it. Between 500 and 600 of these subscribers, too, had found the necessities of their business involve their paying not only the £5 to the New Company but also the £10 to the old Company, and therefore these particular subscribers, who had been—he must not say deluded, but persuaded into joining the New Company had had to pay two subscriptions instead of one. In other cases the National Company had been generous enough to afford subscribers the opportunity, for a small additional payment, of enjoying all the advantages of a universal service—a great advantage, which the New Telephone Company could not have given. A great undertaking, like the Ship Canal, whatever the result was in immediate profit, might indirectly so enormously benefit the community as to justify a work which to ordinary commercial people might appear a madness, but in the case of the telephone there was no such underlying principle. A telephone, from its very nature, must be limited to a very small number of persons, and its advantages were so enormous as to make its cost almost count for nothing. The New Company had also surrendered their present licence to the State, and this bargain was now pending and, he had no doubt, would take effect when Parliament met.

Mr. PARKINSON observed that a new licence could then be got by the New Telephone Company.

The CHAIRMAN, continuing, stated that in that case the New Company would enter on a business of a totally different kind, involving many more difficulties than at present existed. The National Telephone Company, who knew more than the New Telephone Company, from their greater experience, looked forward with a certain degree of dread to the complications which would arise when the Post Office did one part of the work and the National Company the other. He repeated that it was impossible for the telephone business, from its peculiar nature, to be carried on efficiently and economically by two agencies; and the Directors were certainly doing their duty to the shareholders and the community in recommending the winding up of the Company, and the getting rid of the danger of future loss. As to what would be done in the future, the liquidator would get in the assets and distribute them as quickly as he could. The contracts which were running at Manchester would, he presumed, be performed, but the liquidator would not enter into new business, as new business would not be liquidation.

Mr. PARKINSON said he dissented from the idea that the telephone business of the country would be in a very much better position if the National Company had no rival. In any case he hoped that the country would not again be plunged back into the same conditions as before prevailing regarding the expense of the service. He asserted that the Mutual Company would not have sold its business in Manchester had the Directors been aware of the intentions of the Goverment with respect to the trunk wires. The working of the Mutual Company was carried on at a profit.

Mr. WALLACE (a Director of the New Telephone Company) seconded the motion. He stated that it was only reasonable for the National Company to have the control of the New Company on account of their enormously preponderating interest in it. The New Company had done some good, because it had quickened the work of the National Company, and he was pleased to see that the National Company were trying to do as much as they could to make their service perfect. He had made money out of the New Company, and he would not desert the public if the National Company did not make their service what it should be. In that case he was offered £1,000,000 to put into the telephone service in order that it might be carried on properly. He had no doubt, however, that this money would not be wanted, as the National Company would endeavour to give the best service possible, and at as cheap a rate, consistently with efficiency, as could be charged.

The CHAIRMAN, in further reply, agreed that competition was very beneficial, as it assured efficiency and economy; but a low rate and an efficient service on the Manchester scale meant ruin. Competition, too, could only be carried out on the condition of a proper reward for the services rendered. A great railway expert, he reminded them, had told a Parliamentary Committee that competition must end in combination. That was what had been done in the present case. The National Company, however, competed with the Post Office at a great many places, and either as regarded rates or efficiency the Post Office, so far as he was aware, could get on no better than themselves. In fact, the very opposite was the case, the Company's service and rates being acceptable to the public. He could quite understand that when everything was new, and they had a limited business, the Mutual Company showed a profit on the figures of the first year, but he did not believe that if he had been the auditor a profit would have been shown by that Company. He was glad to see Mr. Wallace present, who was responsible more than he (the speaker) or his colleagues for the initiation of the New Company. When the £1,000,000 to which Mr. Wallace referred took a tangible form, probably the same courage and judgment which had prevented the capital of the New Company from being lost would save some portion of the £1,000,000, but those who subscribed it would not get such good terms. He then put the motion, which was carried *nem. con* and the proceedings then terminated.

NEW COMPANIES, STATUTORY RETURNS, &c

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1894, pages 274-300, *&c. &c.*]

ALUMINIUM AND GENERAL FOUNDRY SYNDICATE (LIMITED).—This Company was registered on December 5th, with a capital of £10,300 in 10,000 Preference and 300 Founders' shares of £1 each, to purchase inventions for the manufacture of aluminium, and aluminium alloys, and certain metallic alloys and compounds, and of solder to be used therewith, and to carry on the business of mechanical engineers, machine and engineering tool makers, boiler makers, metal workers, and metallurgists.

ALUMINIUM SOLDERING COMPANY (LIMITED).—This Company was registered on December 5th, with a capital of £10,000 in £1 shares, to purchase, or otherwise acquire certain patents and other rights for inventions relating to soldering aluminium.

W. T. AVERY (LIMITED).—This Company has been registered with a capital of £200,000, in £5 shares, to acquire the business of weighing machine manufacturers, heretofore carried on by a company of the same name (now in voluntary liquidation), and to manufacture and deal in weights, measures, scales, balances, machines, and appliances of every kind; and to carry on business as engineers, machinists, &c.

BELL'S ASBESTOS EASTERN AGENCY (LIMITED).—This Company was registered on November 30th, with a capital of £10,000 in £1 shares, to enter into an agreement to be made between Bell's Asbestos Company (Limited), and the Company, and to carry on in China, Japan, the Straits Settlements, or elsewhere the business of purchasing or otherwise acquiring, selling, and dealing in, as agents or otherwise, asbestos goods and articles connected with the utilisation of asbestos.

BENNETT'S IRONFOUNDRY COMPANY (LIMITED).—This Company was registered on December 8th, with a capital of £12,000 in £10 shares, to carry on the business of ironfounders, metal workers, mechanical and electrical engineers. &c.

BRAYTON PETROLEUM MOTOR COMPANY (LIMITED).—This Company has been registered with a capital of £80,000 in 80,000 shares of £1 each, for improvements in hydro-carbon engines, and the inventions therefor, and also any improvements already made, or hereafter to be made, in the said invention; to acquire any other patents and inventions which may seem capable of being turned to account by the Company.

BRITISH LIGHT RAILWAYS (LIMITED). This Company was registered on December 8th, with a capital of £110, divided into 20 shares of £5 each and 10 shares of £1 each, to construct, purchase, lease, or otherwise acquire any light railways, tramways, or tramroads in the United Kingdom; to equip, maintain, and work the same by horse, steam, electric or other mechanical power; and to manufacture, sell, and deal in locomotive and other engines, dynamos, and other apparatus.

COOPERS AND YOUNG (LIMITED).—This Company was registered on December 5th, with a capital of £5,000, divided into 100 £8 per Cent. Cumulative Preference shares of £10 each, and 400 Ordinary shares of £10 each, to acquire the business of Cooper Brothers, Birmingham, and to carry on the business of general metal spinners, coppersmiths, and metal dealers and workers.

ELECTRIC BATTERY COMPANY (LIMITED).—This Company was registered on December 11th, with a capital of £30,000, in £5 shares, to carry into effect an agreement dated December 7th, and made between Harry T. Barnett and Francis J. Moffett (for the Company), having reference to the sale to the Company of certain patents for improvements in primary batteries and motors, and other property therein mentioned, and to carry on the business of manufacturing, working, using, letting on hire, and selling electric batteries, machinery, boats or vessels, apparatus, implements and things for the production, transmission, storage and use of electric, magnetic or other force, whether under the said patents or otherwise. The subscribers (with one share each) are Alexander Gripper, H. N. Godward, Thomas H. Dacres, Francis J. Moffett, William R. Bourke, William J. Catley, and James Fford, 17, Victoria-street, London, S.W. Stephen B. Saunders is the Managing Director for three years.

INTERCHANGEABLE AUTOMATIC MACHINE SYNDICATE (LIMITED). This Company was registered on November 28th, with a capital of £1,000, in £1 shares, to carry on the business of manufacturers of interchangeable automatic coin-freed machines and mechanical apparatus, and of fittings, accessories and parts of the same, and to carry on the business of nickel-platers, electro bronzers, electrical engineers, &c.

JOHN HETHERINGTON AND SONS (LIMITED) This Company was registered on November 29th, with a capital of £300,000, in £10 shares, to acquire and carry on the business of machine makers, iron and brass founders, engineers, &c., at Manchester.

J. GORDON ALISON AND COMPANY (LIMITED). This Company was registered on November 30th with a capital of £10,000, in £5 shares, to acquire the business carried on at Birkenhead and elsewhere by the late James G. Alison, and to carry on the business of engineers, ironfounders, boiler makers, &c.

LOWCOCK, HILL AND COMPANY (LIMITED).—This Company was registered on December 6th with a capital of £15,000 in £10 shares, to acquire the business of electrical engineers carried on by Lowcock, Hill and Co. in Manchester, and to carry on the business of contractors for the sale, letting on hire, erection and maintenance of, also of dealers in and suppliers of electrical engineering and other apparatus, and manufacturers, electricians, suppliers of electricity, and the general business of an electric light company in all its branches. The subscribers (with one share each) are:—George W. Lowcock, George Hill, Joseph L. Kendal, Robert R. Williamson, James Hill, jun., Wilfrid R. Lees, and William J. Fowler.

ROGERS' ARC LAMP COMPANY (LIMITED).—This Company was registered on December 13th, with a capital of £20,000 in £5 shares, to enter into an agreement dated December 12, 1894, between James W. Rogers and Arthur Rogers (for the Company), to acquire and complete the provisional specifications for improvements in arc lamps in the inventions of James W. Rogers, Nos. 9,762, of May 19, 1894; 10,634, of June 1, 1894; 15,360, of August 11, 1894; 17,000, of September, 1894: and another neither dated nor numbered; and to carry on the business of an electric light company in all its branches; electricians, electrical and mechanical engineers, suppliers of electricity for the purposes of light, heat, motive power, or otherwise, electrical apparatus manufacturers, and dealers, contractors for the laying, fixing, and working of electrical works, public lighting contractors, &c. The subscribers (with one share each) are James W. Rogers, Arthur Rogers, T. H. Oswald, Lewis H. Guinness, Arthur Tillyer, J. S. Lobb, and P. J. Nicholls. James W. Rogers is to be the manager.

ROSE AND BIRD (LIMITED).—This Company was registered on December 11th, with a capital of £3,000, in £1 shares, to acquire the business of dealing in incandescent lamps carried on by Thomas A. Rose and John A Bird, in the City of London, and to carry on the business of electricians, mechanical engineers, and manufacturers of, and dealers in, all electrical apparatus, mechanical appliances, &c.

CHARLES SMITH, SONS AND CO. (LIMITED).—This Company was registered on December 11th, with a capital of £10,000, in £1 shares, to acquire the businesses carried on by Charles Smith and Sons (Limited) and by Marley and Buckingham, at Birmingham, and to carry on the business of manufacturers of and dealers in chandeliers, electrical appliances and fittings of all kinds, engineers, machinists.

SMOKE AND FUMES ANNIHILATOR (LIMITED).—This Company was registered on December 15th, with a capital of £120,000 in £5 shares, to carry into effect an agreement between Samuel Elliott and William Arnold, and to carry on the business of manufacturers of smoke annihilators, and other apparatus for the treatment of smoke or fumes, general engineers, ironfounders, machinists, &c.

R. WAYGOOD AND CO. (LIMITED).—This Company was registered on December 5th, with a capital of £60,000, divided into 3,000 £6 per Cent. Cumulative Preference shares and 3,000 Ordinary shares of £10 each, to acquire the business of constructors of and dealers in lifting machinery, and of hydraulic, electrical and general engineers and contractors, and otherwise, carried on by R. Waygood and Co. The first Directors are Henry C. Walker, Charles Day, and Edmund P. Okeden, who are Managing Directors.

ELECTRICAL INVENTIONS COMPANY (LIMITED).—Notices calling attention to the non-filing of the necessary returns having been ignored, the name of the concern will be struck off the register unless a reason for the contrary be sent within a month from December 3rd.

ELECTRIC STORES (LIMITED).—The name of this concern is, we learn, to be struck off the register of joint-stock concerns.

ENGLISH AND COLONIAL ELECTRIC LIGHT COMPANY (LIMITED).—The statutory return of this Company, made up to October 25th, was recently filed. £7 has been paid in respect of the seven signateries' shares taken up out of a nominal capital of £50,000 in £1 shares.

ERNEST SCOTT AND MOUNTAIN (LIMITED).—The annual return of this Company, made up to October 17th last, has just been filed. The nominal capital is £70,000 in £10 shares, of which 5,663 have been taken up. Of these 2,200 have been issued as fully paid. The full amount has been called on 972 shares. A call of £6. 5s. per share has been made on 1,991 shares, and £5 per share has been called on 500 shares, resulting in the total payment of £24,668. 5s., including a sum of £4. 10s. paid on the forfeited shares.

MARCHANT, YOUNG AND CO. (LIMITED).—The statutory return of the above-named Company, made up to October 3, 1893, was not filed until November 26, 1894. 1,785 shares have been taken up out of a nominal capital of £4,000, in £1 shares, and 1,780 of these have been issued as fully paid to Charles T. Young and John E. Marchant. The full amount has been called on the remaining five shares, but has not yet been paid.

CITY NOTES.

AFRICAN DIRECT TELEGRAPH COMPANY (LIMITED). Notice is given that the coupons on this Company's Four per Cent. Mortgage Debentures to bearer, due January 1st next, will be paid on and after that date at Parr's and the Alliance Bank, Bartholomew-lane, London, E.C., where coupons must be left three clear days for examination. Interest warrants will be sent out on the 31st inst., and the Debenture Register will be closed from the 27th to the 31st inst., inclusive.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—The coupons on this Company's second issue of Five per Cent. Debentures issued for payment on the 31st inst. will be paid on and after that date at Parr's Bank, Bartholomew lane, E.C. The coupons must be left three clear days for examination.

BRITISH ALUMINIUM COMPANY (LIMITED).—This Company is registered with a capital of £300,000, in 20,000 Seven per Cent. Cumulative Preference shares of £10 each, and 10,000 Ordinary shares of £10 each. Subscriptions have been invited this week for 15,000 Preference shares, payable 10s. on application, £1. 10s. on allotment, £2 on January 15th next, and the balance at intervals as required. The scientific adviser of the Company is Lord Kelvin, the secretary is Mr. Charles F. Jones, and the offices are situated at 9, Victoria-street, Westminster, S.W. The prospectus states that the Company is formed for the purpose of making aluminium in this country by the electrical process under what are known as the Cowles and Neuhausen patents, and the Company are to acquire mines in the North of Ireland, which, it is stated, will furnish an ample supply of the raw material; ample water-power, at very low cost, for generating electricity, with a suitable site for factory, together with the freehold land and factory of the Cowles Syndicate Company (Limited), at Milton, near Stoke-on-Trent. The Neuhausen Company are at the present time supplying aluminium at 1s. 7d. per lb., and it is anticipated that the British Aluminium Company will be able to lower the cost at an early date. The subscription list opened on Wednesday and closed yesterday (Thursday).

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—Notice is given that the transfer books and register of holders of the Five per Cent. Debenture stock of this Company will be closed from the 24th to the 31st inst., inclusive. A further issue has been made this week of £200,000 Five per Cent. Debenture stock of this Company at the price of £128 per cent. This forms part of a total issue of £400,000, of which £100,000 has previously been issued; £10 are payable on application, £38 (which includes a premium of 28 per cent.) on allotment, £40 on March 30th, and £40 on June 29th next. The first interest upon this issue will be paid on July 1st next, and thereafter half-yearly. The prospectus states that the expenditure made by the Company up to October 31st last amounted in the aggregate to £963,571, and that over £100,000 per annum gross revenue is now being earned by the Company, which has buildings capable of accommodating plant for at least 300,000 8-c.p. lamps at Bankside, and with land still remaining sufficient for all the Company's further requirements. A generating plant with capacity for 150,000 8-c.p. lamps is already in position, the laying of the conduits throughout the City is complete, except such as may be necessary from time to time for service connections. The drawing in of the cables for the complete network will be finished shortly, and is calculated on the basis of an ultimate demand of 400,000 8-c.p. lamps. The whole of the Company's transformer stations for the supply of the City lighting are now at work, and these stations accommodate equipment for the service of 400,000 8-c.p. lamps. The following table shows the progress of the Company since February last, when the first issue of £100,000 Debenture stock was made:—

—	February, 1894.	December, 1894.	Increase.
Estimated gross revenue from private lighting	£51,000	£86,400	£35,400
Estimated gross revenue from public lighting	13,000	13,600	600
Number of 8-c.p. lamps connected ...	72,000	132,846	60,846
Number of customers	1,280	2,674	1,394

The list for the above subscriptions opened on Monday and closed on Wednesday last.

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ended December 16th were £962, as against £909 in the corresponding period of 1893, being an increase of £53. The total receipts for the half-year amount to £21,479, as against £20,097 for the corresponding period of 1893, an increase of £1,382.

ELECTRIC BATTERY COMPANY (LIMITED).—This is the name of a new company with a capital of £30,000 in £5 shares, payable £1 per share on application, £1. 10s. on allotment, and the balance in calls of £1, at intervals of not less than three months. The general manager is Mr. H. T. Barnett, inventor of the "Velvo-Carbon" electrodes, &c. The works are situated at Glover's Island, Richmond. Mr. W. Roston Bourke is secretary, and the offices are at 39, Victoria-street, London, S.W. The prospectus states that the Company is formed to acquire and work a valuable group of patents relating to the manufacture of electrodes, electric batteries and motors; and is to acquire the property and business of the Battery and Motor Company at Glover's Island, Richmond. One of the specialities of the Company is "Velvo-Carbon," regarding which some particulars appeared in our issue of September 14th. A novel feature of the prospectus is the announcement that the Directors undertake that the Company shall not go to allotment unless the amount subscribed allows of a working capital of not less than £8,000. The objectionable waiver clause as to the arrangements made for the flotation of the Company is conspicuous in the prospectus. The list of applications closed on Wednesday last.

ELMORE'S PATENT COPPER DEPOSITING COMPANY (LIMITED).—The report of the Directors to June 30th last says that the Company has already supplied considerable quantities of Elmore tubes to the British War Department, as well as to many of the largest and most important users, and has also secured, and is at present engaged upon, important contracts from several of the leading railway companies, marine engineering firms and others for their next year's requirements. The Company has also received and executed many orders for the more expensive classes of goods which can only be produced by the Elmore process and this branch of the Company's business. The shareholders' meeting is to be held at the Great Northern Hotel, Leeds, on the 28th inst., at two o'clock.

ELMORE'S AMERICAN AND CANADIAN PATENT COPPER DEPOSITING COMPANY (LIMITED).—The report of the year ended March last has been issued, in which the Directors state that "our prospects are greatly improved since last year, owing to the continuous satisfactory progress made at the works of the European companies."

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL COMPANY (LIMITED).—The third annual ordinary general meeting of this Company was held on Wednesday, at Winchester House, E.C., Mr. John MacFarlan presiding. In the course of his remarks the Chairman said the Directors had deemed it advisable that the general meeting should be held as late in the year as possible, in order that they might report that the new plant was actually at work, and give some account of the work of the year and the prospects of the coming year. The loss of £12,076. 8s. 2d. shown in the balance-sheet of the Metal Company did not represent the loss for the year 1893, but for the period since the formation of the Company, and it was all but covered by the profit of £11,750 made by the German and Austro-Hungarian Company in 1894. The year 1893 was one of great anxiety for them. They had but little money, considerable difficulties at the factory, and it was their first full year of working; but a great advance had been made as compared with the year 1893. The total weight of goods sold in 1893 was 25 tons; to December 15, 1894, 69 tons, representing a value of £6,700, or nearly £100 per ton. The increase in the amount of output was progressive month by month. Some of their goods were being made for them at the French Elmore Factory, but with a good margin of profit; and all the best paying work was done at their works at Schladern. With regard to the present position and prospects of the Company, they had cause to congratulate themselves. The recent preference share issue was a success, and was taken up even beyond the Directors' expectations, and other rearrangements of their debenture issues had been satisfactorily completed. The Directors had visited the factory during the year, and the returns each week enabled them to keep clearly in view the state of things there. The articles they were manufacturing were undoubtedly better than those produced by the ordinary process, as was proved by the fact that the Prussian State Railways Department accepted their tender, and had given them the contract for the year 1895, and the German Admiralty continued to give them orders. The orders that had been received from ordinary consumers also showed that when their goods were once tried, they were always approved, as some customers had given from 30 to 45 repeat orders, and they were in addition receiving inquiries from all parts of the Continent. He did not see why a good dividend should not be earned during the coming year.

ELMORE'S WIRE MANUFACTURING COMPANY (LIMITED).—The Directors report that the business of the Company has now been brought to a stage of development upon which the shareholders can be justly congratulated. From July 1st last to the present time, the Company's factory has been hard at work, at first in completing the plant, and later on in manufacturing to orders received, and the factory is now working successfully upon a large scale.

THE FUSION OF FRENCH CABLE COMPANIES.—An extraordinary meeting of the shareholders of the Société Française des Télégraphes Sous-marins, held on the 12th inst., unanimously adopted the various resolutions necessary to the final absorption of the Compagnie Française du Télégraphe de Paris à New York; and the joint concern will be carried on from January 1st next under the name of the Compagnie Française des Câbles Télégraphiques, with a capital of 24,000,000fr.

RICHARD HORNSBY AND SONS (LIMITED).—The ordinary general meeting of this Company was held on Monday, when Mr. James Hornsby, D.L. (the Chairman), said he regretted that he could not meet the shareholders with anything better than a practical repetition of last year's report. The past year opened with but gloomy prospects, and trade was uniformly bad during the first six months, but it was much better during the second half-year, and in some departments they were exceptionally busy. Their oil-engine trade was rapidly growing, and bade fair to shortly repay the heavy expenses incident to the commencement and development of that new branch. They were not satisfied with the profits of the business, and had made considerable changes, others being in contemplation. After a discussion on the accounts, the Chairman agreed that in future fuller details of income and expenditure should be given.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended the 16th inst. amounted to £917. The amount for the corresponding week last year was £634.

PACIFIC AND EUROPEAN TELEGRAPH COMPANY (LIMITED).—Notice is given that the coupons on this Company's Four per Cent. Guarantee Debentures issued 31st inst. will be paid on and after that date at Parr's Bank, Bartholomew-lane, E.C., the coupons to be left with the bank three clear days for examination.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The following telegram has been received from the Company's representative at Rio de Janeiro:—"14th. Purchase passed third reading in Senate yesterday, and sent to President for sanction."

This Company's traffic receipts for the week ended December 14th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited) were £2,937.

WEST COAST OF AMERICA TELEGRAPH COMPANY (LIMITED).—The coupons due the 31st inst. on the debentures of this Company will be paid by Messrs. Barclay and Co., Lombard-street, London, E.C., and should be left three clear days for examination.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company, for the half month ended December 15th, are £2.037, as compared with £2,692, in the corresponding period of 1893. The August receipts, estimated at £3,333, realised £3.376.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Dec. 12.		Price Wednesday, Dec. 19.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 19.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£1,012,880	Stock	9 0	Anglo-American	38	39	38	39	6 2 7	Jan., Apr., July, Oct.	..	..
£2,993,560	Stock	18 0	Do. Preferred	71½	72½	71½	72¼	5 10 4	" "	72¼	71½
£2,993,660	Stock	5/0	Do. Deferred	6½	6¾	6¼	6¾	..	..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	106	102	105	3 17 8	January and July ..	..	..
130,000	£10	4/0	Brazilian Submarine	11	11½	10¾	11¼	5 15 7	Mar., June, Oct., Dec.	11¼	10⅞
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 8 11	June and December	114½	114
10,000,000	$100	$1¾	Commercial Cable Capital Stock	140	150	140	159	4 13 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12½	13½	12½	13½	6 18 6	February and August	13½	13 7/16
6,000	10	10%	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	" "	..	..
12,931	5	1/8	Direct Spanish (fully paid)	4½	4¾	4½	4¾	4 4 3	April and October —	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¼	9¾	9¼	9¾	6 2 7	" "	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	4 3 4	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8½	9	8¼	8¾	6 2 10	Jan., Apr., July, Oct.	8⅝	8⅜
400,000	10	2/6	Eastern	15¾	16¼	15⅞	16⅜	4 1 3	" "	16⅜	16 3/32
70,000	10	6%	Do. 6 per Cent. Preference	16¾	17¼	16¾	17¼	3 9 7	" "	17	16 13/16
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	119	122	119	122	3 5 7	May and November	120¾	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	110	106	110	4 12 7	February & August	..	..
250,000	10	2/6	Eastern Extension	16	16½	16	16½	4 6 2	Jan., Apr., July, Oct.	16¼	16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	118	122	118	122	3 5 7	February & August	..	..
£62,700	100	5%	* Do. 6 p. c. (Austln. Gov. Sub.) Debs. 1900	103	107	103	107	4 15 8	January and July .	—	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	103	107	4 15 8	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	105	108	105	108	3 15 2	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	107%	110%	108%	111%	3 12 6	May and November	..	..
180,227	10	1/3	Globe Telegraph and Trust	8⅝	8⅞	8¾	9	4 17 3	Jan., Apr., July, Oct.	8 13/16	..
180,042	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16¼	3 13 11	" "	16⅛	15 15/16
150,000	10	5 0	Great Northern	21¾	22¼	21¾	22¼	3 18 10	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	106	..
17,000	25	12/6	Indo-European	47	49	47	49	6 8 2	May and November	48½	..
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	102	106	102	106	5 14 10	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	105	108	3 15 6	..	..	—
11,839	8	4/0	Reuter's	3	5	2	4	..	April and October —	3⅛	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	107	111	109	114	5 6 8	" "	111	109½
15,609	10	6/0	West African Telegraph	3	6	3	6	..	January and July —	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	101	104	4 17 7	March & September	103⅝	103½
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	100	105	100	105	7 12 5	June and December	..	..
88,321	10	6d.	West India and Panama xd	1	1½	1	1½	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	5 6 8	May and November	11⅛	10⅞
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	109	112	4 11 4	June and December	111	..
64,242	15	3/0	Western and Brazilian xd	11½	12	11½	12	..	May and November	11⅞	11⅜
33,129	7½	3/0	Do. 6 per Cent. Cumulative Preferred	6½	7	6¼	6¾	..	..	6½	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	5	5½	5	5½	..	..	5⅝	5 1/16
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 16 6	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 16 6	" "	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	112	118	112	118	5 19 2	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 17 1	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	..	..	..
224,850	10/0	2⅜d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	..
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	7/16	9/16	7/16	9/16	..	Yearly	—	..
484,597	5	3/4	National	5⅛	5⅜	5⅛	5⅝	4 15 3	June and December	5 5/16	5 3/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	16	17	15	17	3 15 0	" "	16 7/16	16⅛
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	" "	..	..
119,234	5	3/4	Do. 6% Non-Cumulative 3rd Pref.	5¾	6	5¾	6	4 5 1	..	5 15/16	5⅞
1,000,000	Stock	4½%	* Do. Debenture Stock, 4½% (red.)	110	113	110	113	4 1 3	January and July —	..	..
68,000	5	1/0	United River Plate	1	2	1	2	..	" "	..	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	88	94	88	94	5 6 5	" "	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	13½	14½	14	15	..	—	14⅝	14
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	14¾	15¼	14¾	16¼	3 18 8	..	15 1/16	..
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	132	135	132	135	3 14 1	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	4½	5½	4½	5½	3 12 9	—	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1906	..		..		..	..	..	..
8,322	£5	..	House-to-House Electric	..		..		—	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		—	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		—	January and July —	..	—
45,000	£5	2/6	Liverpool Electric Supply (fully paid)	7⅜	7¾	7¾	7½	—	..	..	—
111,000	5	..	London Electric Supply	⅛	⅜	⅛	⅝	..	..	..	—
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	9¾	10¼	9¾	10¼	2 8 9	..	10 3/16	9⅜
£150,000	Stock	4½%	* Do. 4½% Debs. (Bonds of £10, £20, and £40)	115	117	115	117	3 16 11	June and December	..	..
6,452	£10	..	Notting Hill Electric	7	7½	7	7½	—	..	..	..
19,980	£5	2/6	St. James and Pall Mall	7¾	8¼	7¾	8¼	.	..	8	..
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8½	9	3 17 9	..	..	..
59,900	5	2/0	Westminster Electric Supply (fully paid)	7¼	7¾	7	7½	3 0 0	..	7 5/16	7 3/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2¾	2⅝	2⅜	2⅝	5 11 3	..	2⅝	..
90,006	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2⅜	2⅝	4 11 5		2 3/16	2⅜
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	111	114	111	114	4 0 0	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2¾	3¼	2¾	3¼	—	January and July —	..	..
12,139	5	..	Edison and Swan United	—		—		..	..	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	—	—	..
120,000	2	..	Electric Construction	¼	½	¼	½	—	—	..	..
12,845	2	2 0½	Do. 7 per Cent. Cumulative Pref.	1½	2	1½	2	..	—	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1½	1¾	1	1½	..	—	1⅛	..
20,000	5	.	Fowler-Waring Cables (fully paid)	½	1½	½	1½	.	..	..	..
60,000	10	10/0	India Rubber, Gutta Percha, &c., Works	25½	26½	25½	26½	4 14 4	February & August	26½	25 15/16
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 7 7	March & September	..	—
15,995	£10	6/4	International Okonite Ordinary	..		..		—	.	..	—
16,000	£10	..	Do. 8 per Cent. Preference	—		—		—	December and June	..	—
20,000	0	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	¼	—	¼	.	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	41	43	41	43	5 11 6	March and July .. —	42¾	42½
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July .	.	—
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	—		—		..	..	..	—
41,098	£5	..	Do. Preference (fully paid)	—		..		..	—	..	..
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	8½	9½	8½	9½	5 5 3	..	9¼	9⅛
£30,000	10	..	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1%	City and South London Railway	41	43	42	44	2 5 6	May and November	42¾	42½
7,000	10	6%	Do. 5% Perpetual Preference	13¾	14¼	13¾	14¼	3 10 2	..	..	..
£67,130	Stock	4%	Do. 4 Perpetual Debenture	124	126	124	126	3 3 6	May and November	—	..
37,500	£10	1%	Liverpool Overhead Railway	8½	8⅞	8⅝	8⅞	1 2 10	..	..	..
6,295	10	5%	Do. 6% Preference	13	13¼	13	13¼	3 15 0	..	—	—
£125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July ..	—	—

In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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NOTES.

We publish this week our report of the concluding evening's debate at the Institution of Electrical Engineers on the three electric traction Papers recently read there. Notwithstanding the many interesting remarks which were made by the various speakers, some relating to the social and commercial aspects of electric traction, and others to points of manufacturing detail, such as flywheels and gears, the evening's discussion was, as a whole, somewhat lacking in practicality. We are well aware that there is, alas, only a small fund of practical engineering experience of electric traction in this country; but there is such a fund, though a small one, and we would have liked to have it seen as much in evidence at the Institution as at the Northern Society. The opinions and experience of men who have had to do with the financial conception and general management are, doubtless, exceedingly valuable, and the same may be said with equal truth of manufacturers of electric traction plant. But it is the engineers who have had, day after day, year in and year out, to keep running an electric or other mechanically-equipped line whose experience would have been not merely valuable but invaluable. As Mr. Ferranti rightly remarked, "electric traction requires all the energy of the *whole* electrical industry," and this total energy cannot be said to be available when each man with practical knowledge guards it as jealously as if it were actually, and not merely metaphorically, a pearl beyond price.

There is truth, even if there is not novelty, in the claim advanced by Mr. Gibbings that the use of a system of storage for electric traction may be made to materially improve that forlorn phenomenon, the day load. Mr. Gibbings states his views in a Paper, an abstract of which we publish this week, and the contents of this Paper, but more especially the free and open discussion which followed its reading, are of considerable interest. There is, as we said before, no doubt about the effect of accumulator traction upon the efficiency of the generating plant; but there seems to be room for grave doubt that the scheme would effect any financial improvement. Or, perhaps, it would be more correct to say that it seems that there is no doubt whatever that battery traction has in most cases spelled financial disaster. Mr. Manville has had an unfortunate experience, which seems to justify his assertion that the cost of handling and repairing the locomotive batteries alone is nearly as much as the whole cost of generating the power and using it in a trolley system. There is, however, an important use for batteries in stationary battery houses, where they are more cheaply handled, where their fumes can do less mischief, and where they are not subjected to the jolts and jars of locomotion. An interesting description of a line in which batteries are thus used was given in *The Electrician*, Vol. XXXII., p. 35.

One of the matters on which telephone engineers might—if they would—impart information valuable to the other members of the Institution of Electrical Engineers is the interference which from time to time arises between electric lighting systems and their own system of wires. Knowing how many opportunities they have of bringing up for discussion matters of such general importance, we can only conclude that the reason why they do not is that they lack interest in the Institution, or are restrained by business considerations. We have the more pleasure, in view of this apathy of English telephone engineers, in printing to-day a communication from Mr. R. W. Mix on some curious cases of interference with telephones by electric lighting currents in Odessa. Had Mr. Mix been a member of our Institution in London, and had he communicated these observations to raise a discussion at its meetings during the past year, the Institution would have been relieved from the present clamour to put on its Council certain persons who contribute nothing to its proceedings.

Commercial enterprise has done wonders in overcoming or removing natural obstacles to telegraph construction; but we doubt if it can boast of achievements such as have been accomplished many times by the Indian Government for objects purely military or political. One of these is the erection of a line from Srinagar to Gilgit, just completed over the Rajdiangar and the Burzil Passes in Kashmir. The distance is nominally only 240 miles, but the altitudes throughout are very great, and at several points reach from 11,000 to 13,500 feet above the sea level, where variations of temperature are extreme. Some of the dangers to be overcome or to be guarded against are set forth in an article we print this week from the *Indian Engineer*; but, serious as they look at the outset, they are as nothing compared with the task of maintaining in efficiency a line so constructed and so exposed to vicissitudes of storm and tempest in a wild and barren region, devoid of supplies and almost uninhabited.

In an examination into the limits of applicability of Thomson's law of economy of electrical conductors, which M.

Hospitalier communicates to *L'Industrie Electrique*, the author arrives at the conclusion that the law "is not a general law; it is the solution of one particular case, where the current is constant." Strictly speaking, this is the case; for it is necessary to modify the statement of the law if it is required to fit the case of a variably loaded cable working at constant pressure. But, nevertheless, it must not be forgotten that the required modification does not alter the spirit, but only the letter, of the law. Profs. Ayrton and Perry and many other writers have shown how to modify the ordinary statement of the law so as to adapt it to the conditions of constant pressure networks of conductors. Prof. George Forbes drew up, some years ago, a number of curves and tables which approximate to the general law for three or four special conditions; but the conditions specified in these are not those of general electric supply. Prof. Forbes required that the period over which the expenditure of energy in the cable was considered should be divided into fragments during which the load was either exactly full or some exact fraction. No such convenient arrangement of the load occurs in practice; and the difficulty in adapting the ordinary load curve to the copper losses lies in the fact that those losses are proportional to the *square* of the power transmitted. As the expression of a principle of design, Thomson's law is indeed but "one particular case," for it is identical with the principle upon which all prime costing and engineering design, whether based on experience or on mathematics, is founded.

Obituary.—The death is announced of Pafnutij Tchebitchef, an eminent Russian mathematician. He was a Foreign Member of the Royal Society and of the Académie des Sciences.

Telephonic Communication between Belgium and Holland. Arrangements are in hand for the establishment of telephonic communication between Brussels, Rotterdam, the Hague and Amsterdam.

Professorial Appointments.—Dr. Nernst, who, as we recently announced, was offered a chair at Münich, has declined it, having been informed by the Minister of Education that a Physico-Chemical Institute will be shortly started at Göttingen

French Cable Manufacture.—The firm of Grammont have obtained the French Government order for the 400-mile long submarine cable connecting Majunga (Madagascar) with Mozambique. The cable is to be delivered by February under heavy penalty.

The Intrinsic Brilliancy of Artificial Lights.—According to the *Gas World* the intrinsic brilliancy per unit of area of the filament of an incandescent lamp is 133 times greater than that of the gaseous rival which has appropriated the first half of its name. It seems probable that in this estimate the meshes of the gauze in the latter lamp have been taken as if solid.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
Amoy—Gutzlaff	Nov. 10	Dec. 20.
Lourenço Marques—Durban	Dec. 10	Dec. 21.
Latakia—Cyprus	Nov. 27	—
Aden—Zanzibar	Dec. 21	—
Cadiz—Teneriffe	Dec. 26	—

A Swiss Mountain Electric Railway.—The Swiss Federal Government has recently granted a concession for the construction of a mountain electric railway, starting from near Lauterbrunen, and running viâ Little Scheidegg. The line will be about 12½ kilometres long, and is to be finished within five years. The water power of the Trümmel is to be utilised in generating the necessary electric energy.

Traction Currents in Telegraph Lines.—Some telegraph wires at Belgrade recently came into contact with the wires of the electric street railway system. The street railway current found its way into a number of telegraph offices in Belgrade and in the provinces, doing considerable damage. The worst mischief occurred at the central telegraph office in Belgrade, where a fire was caused by the overheated wires.

Juvenile Lectures.—Prof. J. A. Fleming commenced his afternoon lectures at the Royal Institution on "The Working of an Electric Current" yesterday (Thursday), and will continue them to-morrow (Saturday), and on Jan. 1st, 2nd, and 3rd, at three o'clock. Prof. Vernon Boys will give a lecture on "Waves and Ripples" at the Society of Arts on Wednesday evening, Jan. 2nd, at 7 p.m.

All Heat or No Heat.—Our American contemporary, the *Electrical World*, points to a seeming paradox, where it says: "Heat is a very good thing in its place, but very objectionable when out of place; it is not surprising, therefore, that while some engineers are trying to get as much heat out of coal as possible, others are trying equally hard, if not harder, to get as little heat as possible. The paradoxical part is that both engineers are striving towards the same end; viz., to obtain as much useful energy as possible."

Australian Electric Light and Power Regulations.—We learn by the last mail that an electrical conference has just been held in Melbourne, representatives from all the Colonies, except New Zealand and Queensland, being present. The principal matter discussed was the framing of regulations for electric tramway, electric light and power and underground wires generally. The conference is stated to have been unanimous with regard to the desirability of uniform regulations throughout the Colonies, to secure which legislation will be necessary.

Rühmkorff or Rhümkorff.—Dr. Ad. Heydweiller writes us that Prof. F. Kohlrausch has informed him that this famous Parisian electrician was a native of Hanover, and originally spelt his name Rühmkorff. In Paris, to suit the French pronunciation, the "ü" was changed into "u." The name of Rühmkorff is to-day very common in Hanover. This is substantially the same statement as was made on p. 115 of our issue of November 23rd, by "A German Reader." We think this not very important question may now be considered as settled.

The Scott Flashing Lamp.—According to the *Western Morning News*, after a trial extending over two years, the Scott electric flashing lamp has been pronounced by the Admiralty as unsuitable for the naval service. This lamp was supplied to the battleships "Ramillies," "Royal Sovereign," "Rodney," "Sans Pareil," and "Trafalgar," the cruisers "Æolus" and "Spartan," and the signal schools at the home ports. It has been found that the mechanism necessary to work the shutters, although giving the desired results during a short trial, becomes disabled when the light has been burning any length of time.

The Magnetic Properties of Iridium.—In a Paper communicated to the *Physical Review*, Mr. S. H. Brackett gives an account of some experiments he has made of the magnetic properties of iridium. The samples used contained 98 per cent. iridium, with some platinum, and a trace of phosphorus, but no iron. A bar of the metal 13·3mm. long, 3·2mm. wide, and 0·9mm. thick, when brought into the field of an electromagnet, set itself at right angles to the lines of force, and became permanently magnetised in a transverse direction, and when suspended freely set itself east and west. The permeability of a larger bar was tested, and was found to be unity, and, although the specimen was sharply struck while in the magnetising coil, no induced magnetisation was produced.

Coherers.—According to a note in the *Electrical Engineer* of New York, Dr. Lodge's experience is that a loose carbon contact will act as a coherer, though only as a delicate and troublesome one. Carbon, like platinum and gold, makes far too good a contact usually, without any electrical stimulus; so that a more oxidisable metal does better. He has not found anything stand better in the long run than iron. Brass in air, though at first extremely sensitive, deteriorates with age, becoming too much oxidised apparently, and so making too bad a contact; whereas brass in hydrogen, at first incredibly sensitive, gets too clean ultimately, and declines to make anything but a perfect contact. But iron seems to perennially keep, not over-sensitive, but very dependable and easy to work with.

Physical Society.—An extra meeting of this Society will take place, by invitation of Prof. G. Carey Foster, at the Physical Science Laboratory of University College, Gower-street, on Friday, January 11th. Tea will be served at 4 p.m., and business will begin at 4:30. The following Papers will be taken (not necessarily in the order here given):—"On the Passage of an Oscillator Wave-Train through a Plate of Conducting Dielectric," by G. U. Yule; "On the Heat of Vaporisation of Certain Organic Liquids," by Prof. Ramsay, F.R.S., and Miss Dorothy Marshall, B.Sc.; "The Thermal Conductivity and Emissivity of Brass in Absolute Measure, and the Influence of Curvature on Emissivity," by N. Eumorfopoulos, B.Sc.; "Observations on Emissivity and Curvature," by A. W. Porter, B.Sc.; "Experiments on the Production of Combination Tones," by Dr. C. V. Barton.

The Law of the Magnetisation of Iron.—In a Paper recently published by Dr. Froelich he endeavours to establish the law of the magnetisation of iron; he deduces the constants occurring in his law from a number of different observed results with different irons, and shows how the calculated and the observed values agree; he shows that good magnetic experimental data can always be represented by a formula with close agreement; the various coefficients determined for a number of different irons differ very considerably from each other, and those obtained from one set can therefore not be applied to another. He discusses the various methods for making measurements, and concludes that there is no doubt that the best method for obtaining the magnetisation curve is by means of a closed ring of iron. His conclusions will probably, however, be very much canvassed by other authorities.

The Inventiveness of Outsiders.—It is remarkable, says the *Iron and Coal Trades Review*, how very many of the greatest inventions and discoveries of modern times have been achieved by men who were not themselves trained to the business or profession in which they acquired distinction. Neither Bessemer nor Siemens were trained as metallurgists, and yet they have been acclaimed as the most epoch-making inventors in the whole history of the iron trade. Sir William Armstrong was not trained as an engineer, but as a solicitor, and yet he has revolutionised the art of gunnery and the manufacture of hydraulics. And so with many other modern instances. The so-called practical men are too often incapable of looking all round a subject, and are so wedded to usages and established rules as to look with serious disfavour upon any really novel idea, however meritorious.

Islington Vestry Electric Lighting Station.—At Eden-grove, Holloway, yesterday afternoon, was laid the foundation stone of the central station of the Islington Vestry for the supply of electricity for lighting purposes under a Provisional Order obtained in 1893. The site adjoins the Great Northern Railway, and the land was purchased from the Railway Company at a cost of about £9,000. The central station, which will be built by Messrs. Macfarlane Brothers, from the designs of Mr. A. Hessel Tiltman, is to cost £18,000, and the machinery and plant, including the mains and conduits and public lamps in the compulsory area, will cost £33,000 more. Current will be supplied, it is hoped, by next summer. Mr. Albert Gay, the electrical engineer of the Vestry, is superintending the carrying out of the work. Islington Vestry is the third local authority in London that has undertaken the supply of electricity to the public.

Light Railways.—In accordance with a resolution passed on the 12th inst., the Central Chamber of Agriculture has sent a circular of inquiry to all its associated chambers and clubs throughout England asking them to express their views as to the provision of light railways in their respective districts. They are specially asked to consider whether light railways would be advantageous, and if so, for what class of traffic they would be used; what is the greatest distance of a farm from a railway station; to what extent a light railway would enable farmers to keep less horses; to and from what points it should, if constructed, run; what description of light railway would be best; and whether the ordinary gauge or a narrow gauge would be preferable. Suggestions are invited as to the best means of finding the necessary capital, and it is requested that particulars should be obtained and sent to the Central Chamber of any existing light railway in the district.

A Helmholtz Commemoration.—On the 14th inst., a festival in memory of Professor von Helmholtz took place in the rooms of the Berlin Singakademie in presence of the Emperor and Empress and the Empress Frederick, the festival being under the auspices of the scientific societies with headquarters in the German capital. The hall was tastefully decorated, a prominence being given to a fine bust of Helmholtz. The ceremony was opened by a song composed by von Schütz. Dr. von Bezold then delivered an oration recalling the services rendered to science by the deceased. He warmly praised Helmholtz's personal qualities; although from the very first signalled out as one of the leading spirits of the age, and in spite of half a century of flattering testimonies from the entire scientific world, he ever remained free from pride, and that has enabled us to contemplate his picture without a single afterthought. Herr Joachim then gave Schumann's "Abendlied" on the violin, and Brahm's "Gedenksprüchen" for eight voices terminated the sad celebration.—The Emperor William has contributed 10,000 marks to the fund for the erection of a monument to Helmholtz in the chestnut grove behind the Berlin University.

Setting Slide Valves.—If there is one point in engineering practice that is well established, says a writer in the *Locomotive Engineers' Magazine*, it is that the only sure mode of setting the valves of a steam engine is with the aid of the indicator. No matter how accurately a valve may be adjusted by actual measurement when the cylinder and steam chest are cold, the conditions may be widely different when steam is admitted. Indeed, in the case of an engine attached to a boiler, it is sometimes impossible to adjust the valves so that the engine will work well, except by actual trial when steam is raised in the boiler. There have been cases in which tests with the indicator have shown derangements of valves that were corrected in a few hours, almost doubling the economy of the engines. So far as experience goes, it rarely happens that such a test is made without revealing some defects. Even if these are corrected, there is no guarantee that they will continue in adjustment for an indefinite period, and hence the importance of having engines tested at frequent intervals. The saving of one pound of water per hour in an engine of 100 H.P., assuming that the boiler evaporates 5lb. of water per pound of coal, and that coal costs 24s. a ton, will effect a saving in the amount expended for fuel of about £26 a year, and not unfrequently a reduction of 20 times this amount is produced in consequence of a test.

Liquid Fuel for Boilers.—A Russian manufacturer, living at Moscow, writing to the *Mechanical World* concerning the burning of oil for steam raising purposes, says:—

> "In visiting the World's Fair, one of the first things to occupy my attention was to find a good naphtha burner, thinking it would be a good thing to take back with me to 'backward Russia'; but, to my disgust, in visiting the boilers, I found I had travelled thousands of miles to see that the American systems were copies of long-ago discarded Russian systems. In referring, first, to the supposed best American burner, I will take those exhibited by the National Supply Company. These burners are a direct imitation of the Spakoffsky, worked in Russia as early as 1870 on the Caspian Sea. They are large, clumsy burners, made in several sizes to suit requirements, and are generally called here 'boiler destroyers.' They pulverise the fuel at the expense of a great amount of steam, and give a flame so severe that the boilers have to be shielded by brick arches; otherwise they would soon give out. These protections not only absorb a deal of heat, and rob the boilers of heating surface, but they only last from six to ten days, when they must be replaced—a serious matter in expense and stoppages, more than covering all the would-be economy obtained by using oil fuel. The burners we have in Russia are far more advanced; and the 'Bray' takes the pride out of the Americans in every respect. It requires no fire-brick protection to shield the boilers from injury, and the flame is not severe. It is very simple in construction and management, besides which it is only made in one size, which is about one-quarter the size of those exhibited at the Fair, although it will do more work than those of America. I have seen Babcock and Wilcox boilers fired with the 'Bray' burner without preparation whatever, giving a flame that rolled completely through the boilers. They were merely fixed in the firedoor with the firebars bare, so that they might be turned out from the firedoors once a week to burn chips and shavings when so needed. Although these boilers had been working over four years under these conditions, there was no sign of injury of any kind."

Conduit Ventilation in America.—Some correspondence has recently taken place in the *Electrical Review* of New York on the subject of conduit ventilation. The Chicago Telephone Company, of Chicago, were the first company in America to connect their manholes to the sewer and ventilate the covers. We understand, writes one correspondent, that they have never had an explosion in any of their manholes built according to this plan. They have been in use since 1888, and some of them are in streets where the escape of illuminating gas is so much that it is almost noticeable through the paved streets. All manholes of the Philadelphia Traction Company, more than 4,000 in number, are trapped to the sewer wherever it is possible to do so. They get ventilation in Philadelphia not from the cover being perforated, but from a feed pole, which connects with every third manhole, and gives as good, if not better, ventilation than a perforated cover. Another correspondent states that the Rochester Gas and Electric Company have 358,000ft. of ducts in use on five and one-quarter miles of street with 151 manholes. We have tried stand pipe ventilation, he says, and find we have better success by using perforated covers to the manholes. We are now changing covers to the latter style. In all our manholes we have trap drains into the main sewers; therefore, we are not bothered with water in our manholes.

The Temperature of the Electric Arc.—In a communication recently made by M. Violle to the Académie des Sciences he remarks that M. Moisson had in a previous Paper pointed out that it appeared as if the temperature of the *arc* increased with the current. M. Violle's own experiments with arcs of 1,000 to 1,200 amperes support this view. Photographs of the *crater* showed that its intrinsic brilliancy was the same with 1,000 or 1,200 amperes as with 10 amperes. Examining the spectra of the *arc* and of the positive carbon, M. Violle found a large number of the bands of the spectrum of the *arc* stood out brilliantly against the continuous spectrum of the crater; they were, however, unsteady and varied in brightness, being brighter the greater the current. M. Violle points out that we may well doubt the unreserved applicability of the laws of Kirchoff to this particular case. It is doubtful whether the brilliancy of the bright bands forming the spectrum of a gas are related to its temperature in the same way as are the corresponding portions of the continuous spectrum of a solid body. The doubt is increased when the gas is illuminated under the action of electricity, which seems capable of converting itself into light without heat. On the other hand, if the *arc* behaves like a conductor carrying a current it must be the seat of an evolution of heat proportional to the energy consumed, so that its temperature should increase with the current. In any case the cause which limits the temperature of the crater does not apply to the *arc*. M. Violle tried to determine the temperature of the *arc* by introducing into it a thin rod of carbon. A carbon rod introduced into the *arc* produced between two poles of the same metal burns away differently with different metals, slowly with copper, quickly with zinc; showing, however, a much higher temperature than that of the volatilisation point of zinc. M. Violle points out that it may very well be that in a Geissler tube a very high temperature may exist, the smallness of the mass concerned making the thermic effect inappreciable. M. Violle concludes that the temperature of the *arc* is, generally speaking, higher than that of the positive carbon, and that it increases with the energy consumed.

Niagara.—The following letter from Prof. George Forbes, headed "Niagara To-Day," and dated Niagara Falls, December 10th, appeared in last Saturday's *Times*:—

> SIR: Nearly three years ago you published a letter from this place in which I gave some account of how the dreams of the engineer were in the act of being realised and without injury to the natural beauties of the spot. Three years have passed, my work is ended and it seems natural to continue the narrative and tell what these three years have brought forth. I am perched on the top of a small Eiffel Tower, lately erected, and, casting my eyes up the river over the housetops and beyond the town, I see a new world created. There is a wide canal leading water into that gigantic power house where three turbines are ready to drive three dynamos of 5,000 H.P. each. There is the bridge to carry cables across to the transformer house. Inside the power house the water is carried down pipes 7½ft. diameter into the turbines and then it passes through a 7,000ft. tunnel under the town emerging below the Falls, and capable of developing 100,000 H.P. Far as the eye can reach extend the Company's lands, with here and there a huge factory either now using the water-power, or waiting for the electric supply. One of them uses 3,300 H.P., another 300, a third one 1,500, and that unfinished mill requires 1,000. You can see, far away, the model village for working men, and improved sewage works with drainage, pumps for water supply, electric light, and well-paved streets. There, again, is the dock where ships from all parts of the great lakes can unload, and there a huge expanse of reclaimed land; while the whole is swept by the Company's railway, seven miles long, connecting every factory with the great trunk lines. The power is transmitted by electricity, and the first work is to produce aluminium with 1,500 H.P. New types of machines have been devised for this work, as also for every other purpose. All criticism as to cost of electric works has been swept away by the results achieved, and the efficiency of each type of machine is greater than has been attained before. All the machinery for the first working has been made and tested in the shops, and the last parts are now being set up. The plans for carrying the power to Buffalo, 18 miles distant, are complete. In a month or two factories will be in full operation; in a year Buffalo will be supplied; in two years the same company will be working the Canadian side of the Falls, and in ten years (shall we say?) the whole of the 100,000 H.P. which can be supplied by the existing hydraulic works will be giving power to smokeless manufacturing towns. The period of planning the transmission scheme, of designing the greatest dynamos in the world, and of construction of the first plant now closes. The financial period commences with the new year. The earning of dividends and the ordering of duplicate machinery is the future work of the company. In conclusion, it is difficult for me to say who were the boldest, the capitalists who embarked on the scheme before any plans were matured, or the manufacturers who moved their factories to this field before a single result had been achieved. The action of both was typically American, but their confidence was not misplaced. Their success is now assured.

Water Supplies and Electric Energy.—The rapidly extending use of water power for the generation of electricity at many places abroad has naturally directed attention to the home possibilities in this direction. These, says the *Engineer*, are soon found to be disappointing, the best water-power locations having been long ago utilised for various motive purposes. But, apart from natural sources, there is another and constantly increasing form of water power in the great works completed and in progress, for supplying the inhabitants of cities, towns, and villages with potable water. Here also, however, a very slight amount of investigation shows that though the power represented in many cases by the flow of water, and its fall may be great, the energy capable of utilisation is generally small, and often practically non-existent. For instance, at Glasgow nearly 50,000,000 gallons of water flow daily into the city and suburbs from Loch Katrine, which has an elevation of about 350ft. above the lower streets of the town. The power represented by these figures would, if capable of employment for lighting by electricity, effect a great saving in the Corporation coal bill. But, of course, the water does not run direct from the highest to the lowest point. It runs first into the distributing reservoirs at Craigmaddie, situated some 50ft. below the level of Loch Katrine, and is conveyed mainly in open culverts, so that little power is derivable at its debouchment. From Craigmaddie the water is piped; but some of the natural elevations in Glasgow are over 250ft. in height, with buildings of about 50ft. elevation on their summits; so that in some cases the head of water does not suffice for the supply, and pumping is resorted to. In short, though in some of the lower districts there may be at times an excess of pressure, practically all the energy due to the head and volume of water is absorbed in its own distribution. Very similar conditions obtain in cities like Manchester and Liverpool. There are, however—especially in Scotland—many towns where the gravitation water supplies are capable of furnishing considerable quantities of electrical energy at a comparatively small outlay and without detriment to the water distribution. To cite a case—a small town on Clyde, with reservoirs at over 500ft. above the river level, gives its inhabitants a liberal supply of 600,000 gallons per day. To keep the pressure at the lower parts of the town within reasonable limits, the main pipe is broken 250ft. below the level of the reservoirs, the water discharging into a distributing tank with an amount of energy equal to nearly 100 H.P.—in the meantime unutilised. To have undertaken the construction of the works merely to get this power would have been out of the question; but the instance shows that it may be quite worth the attention of engineers, when laying out new works in hilly districts, to consider the power possibilities of their schemes, as there are no doubt many localities adapted for the combination of a power station and water supply works.

MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 160.)

The Willans Law.—During the discussion† of Mr. Crompton's Paper on "The Cost of the Generation and Distribution of Electrical Energy," read before the Institution of Civil Engineers, Mr. P. Willans published the results of a series of trials of a large Willans engine, made with the object of determining the economy at every load from zero to the maximum. The effect of the condenser and the influence of a change in the cylinder expansion were considered in relation to the economy at various loads. The supreme result was the now famous "straight-line law" which has become better known as the Willans law. Mr. Willans found that the general law of steam consumption in engines of the Willans type, running at constant speed, might be expressed by the formula—

$$W = a + b\,P, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (92)$$

where W is the weight of steam consumed per hour, P is the effective or brake power, and a and b are constants which depend on the type of engine and on the condenser. It is at once seen that this is the form of the Cartesian equation to a straight line, or that if the values of W are plotted on one axis and the values of P on the other axis, the curve of the function will be a straight line *not* passing through the origin.

The ratio of W to P gives w the weight of steam consumed per unit of power per hour. Thus,

$$w = \frac{W}{P} = \frac{a}{P} + b. \quad . \quad . \quad . \quad . \quad . \quad . \quad (93)$$

It is seen at a glance that this expression is of the form

$$x\,(y - c) = \text{a constant},$$

so that the Cartesian curve representing the consumption of steam per horse-power hour will be a rectangular hyperbola, but with the ordinates increased by a constant amount throughout.

Experimenting with a large unjacketed, triple-expansion engine, Mr. Willans found that the following equations represented the total consumption of steam per hour, with and without a condenser, respectively:—

$$\text{(Condensing)},\ W = 249 + 13{\cdot}75\ (\text{B.H.P.}) \quad . \quad . \quad (94)$$

$$\text{(Non-condensing)},\ W = 587 + 13{\cdot}75\ (\text{B.H.P.}) \quad . \quad . \quad (95)$$

The actual curves representing the total consumption of steam in these two cases, assuming the engine to be rated at 100 I.H.P. maximum, are given in Fig. 38. By having taken the results on the assumption that the engine is rated at 100 H.P., although a very much larger engine was actually used, the values may conveniently be used as percentages.

The importance of this remarkable discovery is very great. Not only do the researches thus far show that, whether the engine is fitted with a condenser or no, the consumption follows the straight-line law; but a comparison between the curves for the condensing and the non-condensing engine shows that the two straight lines are parallel; in other words, the effect of the condenser is produced only upon that portion of the consumption which is independent of the power developed. The condenser only reduces the value of the constant a, it does not alter the constant b. The total consumption in either engine is represented by a large weight of steam—larger in the non-condensing engine—which is consumed continuously whether there is any useful work done or no, together with an amount equal to 13·75lb. per hour for each useful horse-power developed. The former weight represents steam consumed in keeping the engine going at the normal speed. But, since the wasted power was only 10 per cent. of the total maximum power—the efficiency at full load being 90 per cent., and the friction constant at all loads—the rate of steam consumption per internally-wasted horse-power was greater than the extra consumption per useful horse-power. This discrepancy is accounted for by the fact that the constant weight of steam had not merely to overcome engine friction; it had also to feed internal cylinder losses, such as initial condensation, radiation, &c. The curves, it will be noticed, are not drawn through values below 10 H.P.; for it would be impossible for the engine to develop less power than this, if it were obliged to run at its full speed.

The ratio of expansion in the three cylinders, in the foregoing trials, was 6·7. In order to determine the effect of a change in the cylinder expansion, but with the same method of regulation for reduced loads, and to determine the relation of the straight lines for the case of two degrees of expansion, Mr. Willans undertook the experiments represented by Fig. 39. It will be seen that the curves, which are both straight lines, converge towards a point on the negative side of the origin. They indicate, therefore, that the gain by earlier cut-off—although, in this case, positive at every load—is greater at the high loads than when the engine is lightly loaded. The reason for this change in the relative value of the two cut-offs is to be found in the excessive expansion which occurs when the triple-expansion engine has its steam throttled down to meet a light load. It would not be difficult to select two points of cut-off by which the two curves might be made actually to cross in front of the origin; representing a condition where the triple-expansion was less economical than the compound engine at light loads. Indeed, there are many types of triple-expansion engine in which the consumption at very light loads is greater with the three cylinders working than it would be if the last cylinder were temporarily dispensed with.

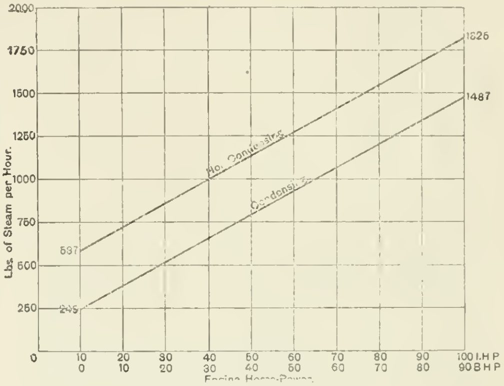

FIG. 38.

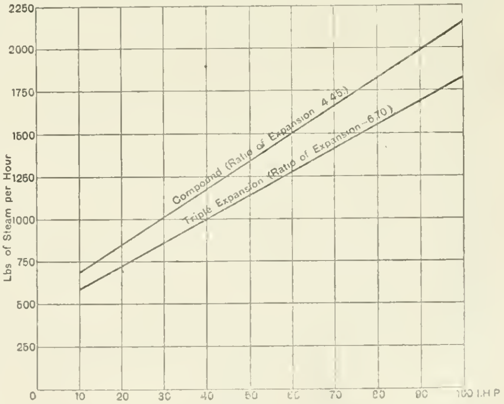

FIG. 39.

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* From a forthcoming work to be published by *The Electrician* Printing and Publishing Company. All rights are reserved.

† *Proc.* Inst.C.E., Vol. CVI.

In order to give a clear idea of the great rise in the consumption of steam per brake horse-power which takes place when an engine is put on light load, the set of curves in Fig. 40 have been prepared from Mr. Willans' data. Curve *a* gives the consumption per brake horse-power hour in a compound non-condensing Willans engine; curve *b* the consumption per brake horse-power hour in a triple non-condensing Willans engine; and curve *c* the consumption per brake horse-power hour, when the same triple-expansion engine is fitted with a good condenser. The financial importance of this set of curves is very great. For it is the brake power which alone can be utilised; and it is the weight of steam consumed for each brake horse-power hour which represents the costliness of the power so utilised. Evidently, therefore, it is of the highest importance to maintain the engines as fully loaded as possible, during the time they are running; as well as to keep down the steam consumption by the use of a condenser.

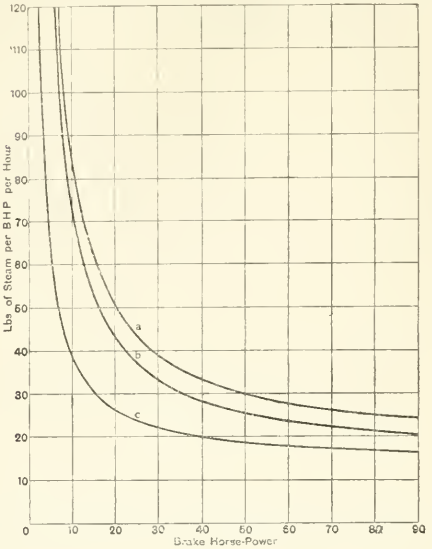


Fig. 40.

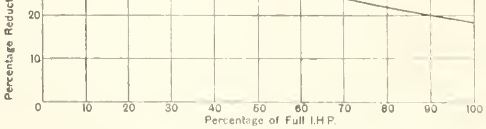


Fig. 41.

The improvement in economy by the use of a condenser takes place at every load; but it becomes of increasing importance as the load becomes lighter. Thus, in the case of the triple expansion engine just mentioned, at full load the introduction of the condenser results in the saving of 338lb. of steam, or 3·75lb. per brake horse-power hour; while at one-fifth load (20 I.H.P.) precisely the same weight of steam will be saved, representing no less than 33·8lb. per brake horse-power hour. Fig. 41 shows the percentage saving of steam per brake horse-power hour, by the use of a condenser at different loads, in the case of this particular engine.

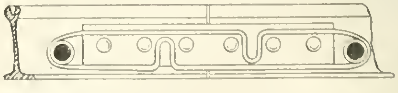
Performance when Overloaded.—It is quite time that the author explained what he means by the phrase "full load." Briefly, the phrase signifies a certain load at which the engine is rated by its maker. It may, perhaps, be defined as the load at which it would be best to run the engine if it always had to run at one fixed load. In this sense the best load is not merely the most economical in steam consumption; but it also takes account of the wear and tear of the machinery, and the cost of repairs, &c. We have now to inquire: What will happen if the engine is run at more than its rated load? There are two sides to the question. Firstly, the engine must be mechanically fitted to stand the higher load without serious stress in its parts, and without the risk of stoppage from seizure of the bearings through excessive friction. The other side of the question relates to the economy of steam. If the Willans law were true for loads above the rated load—*i.e.*, if the hyperbolic curve of economy would run down lower when the engine was made to give out more than its rated power, it would be a clear advantage to run the engine over-loaded. But, to do this, the cut-off would have to be made later, or a higher steam pressure developed in the boilers; and Fig. 39 tells us flatly that if we make the cut-off later we shall tend to increase the steam consumption. Pushed to the bitter end, this would give us an engine without any expansion at all. Clearly, then, the straight line law does not hold for overloading; but, on the contrary, a point will soon be reached where the economy becomes less advantageous. But before this point is reached, the engine bearings may seize! The whole matter is simply a question of rating. The general practice in this country is to rate the engine at its best load. In some European central stations the alternative practice of rating the engine above the most economical load has met with favour. The purpose of this latter practice is to enable the engine to work with the highest steam economy at less than its maximum load, and at the same time to enable the engine to take this load without risk of injury or breakdown. The reason for adopting this plan lies in the fact that in many cases an engine is running for the greater part of its time at a load very much lower than the maximum power it is required to develop. Of course, if an engine is to be rated according to this latter plan, the bearings and other wearing parts must be made amply large for the excess load which the engine may be called upon to develop.

(To be continued.)

THE ELECTRIC TRACTION DISCUSSION AT THE INSTITUTION OF ELECTRICAL ENGINEERS.

The following is an abstract of the discussion which took place on Thursday, 13th inst., at the Institution of Electrical Engineers on the Papers of Mr. H. D. Wilkinson, Messrs. R. W. Blackwell and P. Dawson, and Mr. C. S. du Riche Preller. Speakers who have returned their proofs revised have an asterisk placed against their names:—

Mr. F. F. ROBINSON, in resuming the discussion, said the Papers he had heard left an impression that overhead conductor work had arrived at a high state of perfection, and that but little room for improvement was left in regard to frogs, crossings, insulators, and trolleys. When, however, rail-bonding was touched on, varied, and in most cases unsatisfactory, were the contrivances brought before them. He alluded to the lack of due proportion between contact surface with rail and sectional area of conductor. He would like to draw their attention to a new form of bond (*see* sketch). Briefly, the conductor was made with large tubular ter-



minals, which were roller-expanded into holes in the rail webs; and he might remind them that Mr. Yarrow found by experiment that tubes so treated if they were free would become slightly larger. and the holes if free would become slightly smaller. Tapered plugs might be used to attain a similar effect; but the cost of these in large sizes would be prohibitive, and unless carefully made they would be most unsatisfactory, bearing only on a few points. No fear, he thought, need be entertained that heavy girder rails would be materially weakened by large holes cut near the neutral axis.

*Mr. FRANK LEA said he was glad to have an opportunity to make a few comments upon the subject of electric rack railways, and also to offer a few suggestions with regard to points arising upon the subject. Dr. Preller would confer a benefit upon them if he would give exact particulars with regard to the great saving he claimed for the use of electric rack lines as compared with those operated by steam. In the second place he would be glad if Dr. Preller would give the cost of motor repairs on the Barmen line, which he had mentioned, and which was worked by electricity. Such an item would probably be very large owing to the type of rack adopted. It would be evident to all those who had heard or read Dr. Preller's Paper that he had confined his attention entirely to lines which had no immediate or material connection with adjacent systems. At the present moment, on the Continent and elsewhere, there was a large number of rack railways on main or continuous trunk lines traversing mountainous districts. Those lines had so far been operated by steam locomotives of the combination type, each engine having a double set of cylinders, one set connecting to the adhesive wheel system in the usual way, the other set working the pinions. In this type a very great saving was effected both in capital charges and working expenses, and their advantages in this direction became even more pronounced when electric traction took the place of steam. With regard to the Barmen line, he felt sure that would be of much increased value if it were connected at each end with adjacent tramways, so that the same rolling stock might be used on both the rack and adhesion lines. This would be done by means of electric locomotives of a similar combination type. It was much to be expected that the great extension which seemed likely to be made in this country of light railways or tramways would afford numerous instances where lines of this character would find a considerable amount of employment in the way he had sketched.

* Mr. McGRAW thanked the Institution for affording him the opportunity of speaking. They had done a great deal across the water, of some of which they felt proud, and some of which they called very important work; but they felt very sure that England and the Continent would soon be abreast of what they had done over there, and perhaps would in many ways exceed it. Rapid transit in America was one of the most important industries there, and they confidently looked forward to the time when it would be just as much or more so on this side of the water.

* Major General WEBBER said that it might be remembered that their President was delegated lately by the Institution to attend a meeting at the Board of Trade on the subject of light railways, and that he (the speaker) had the honour of being joined with him in that delegation. Now, in considering this subject, it had struck him that they as electrical engineers had a condition to think of which had not perhaps been brought so prominently before them as it might have been. If light railways, such as suggested themselves to his mind, of narrow gauge, or rather of such a gauge that portable branches could be run into the fields and up to the homesteads as feeders, to be worked by hand—if these were to be used along roads and lines so as to be of real assistance to agriculturists the traffic would probably be small. On some such lines of light rail or train way, along routes which they could all bring to their mind there would not, perhaps, be more than two trains each way per day. He did not know how the electrical engineer was to provide a locomotive to draw those trains ecomically, unless the locomotive was going to carry its own power. It seemed to him that it would never pay to put up a generating station on a line costing £2,000 a mile for the purpose of running two or three trains a day. But he could not help thinking that there they had a future for traction by storage, and it was a point which he believed if studied and carefully thought out and the experience they had already gained applied—he did not think it had been at all fully applied as yet—in that direction they would further this great object of being able to run infrequent trains for agricultural purposes through sparsely populated districts.

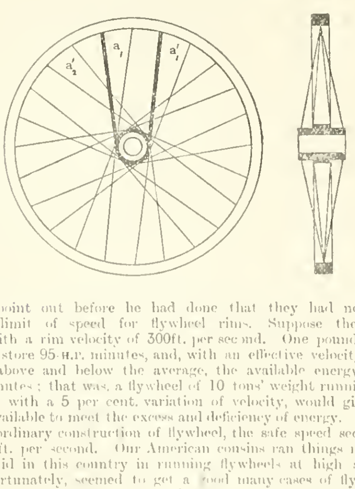
Dr. S. P. THOMPSON said he did not propose to add anything to the technicalities of the discussion that had been going on. When he went over last autumn he had a lively recollection in his mind of the overhead wiring that disgraced America cities on the occasion of his visit nine years before; and he expected, when he remembered that he had to see something that had sprung up in those nine years' that his feelings of disgust at the fashion in which wires were strung overhead everywhere in a reckless way and in every direction would return with some intensity. But he must say that he came home with very different ideas, because our American cousins had mended their ways a great deal in regard to overhead lines. They did not have quite the unsightly arrangement of telephone wires of nine years before; the electric light wires were very much improved and in many cases were laid underground. As one who objected very much to all these networks of wires, he came back with this strong impression—that of all the different kinds of overhead wires one might see, whether in America or in this country, the overhead construction which least disfigured the landscape, was least of an eyesore of all, was the construction of overhead wires for modern tramway work. Having made that statement he would like to say that he thought that not even our American cousins had entirely realised the importance of what they had done in constructing so many thousands of miles of light rails carrying electric tramcars from the centres of population and industry away into the surrounding districts. He meant they had not realised the importance of this thing as a social factor. Anyone who visited. for example. Pittsburgh now. and who knew what Pittsburgh was ten years ago, would see that already the rapid transit from the centre of a thickly populated town to the outlying regions had had a distinct social effect. The workmen, instead of crowding into barracks and tenements, to a very much larger extent lived in little villas each in its own little plot of ground, two or three miles from the centre, where life was more healthy and children much happier, thus returning to the more primitive civilisation of the village instead of to the more desperate civilisation of the populous town, and this thanks largely to the fact that rapid transit was possible by means of electricity. Several other facts struck him in the social bearing of rapid electrical traction, and notably this, that a great part of the lines that were spreading out from town to town and from village to village across the State of New Jersey had been built—at whose expense? By money found, he was told, very largely from two sources, the insurance companies of New York and Philadelphia and the Pennsylvania railroad. Now those two facts were very striking. If there was one body that looked out for a sound sort of investment he supposed it was an insurance company; and if there were any investments that were entitled to respect they were the investments of a railway company. Why should it pay any company like the Pennsylvania railroad to promote tramcar transit by means of electricity? Simply because of this—and our own great railway companies in England would find it out—that it was a distinct gain to the management of a railroad to clear out the local traffic as much as possible and allow the through traffic freer course. He believed we should find this an important factor here, that if we could have electric lines running out from our terminus stations a few miles into the country and feeding the terminus stations it would greatly lighten the main traffic. It was a question whether it was not advisable, having a well recognised gauge for our railways and well recognised style for our rolling stock, in all future schemes to consider a common gauge for electric tramways capable of running on the rails of the heavy railways of this country. That was, of course, a very large question, but it would be a greater disaster if we did not consider it now in all its bearings. We did not want perpetuated in electric traction the same kind of miserable mistake as was made when the battle of the broad and narrow gauges was fought out.

*Mr. CARRUTHERS WAIN thought he had possibly some little excuse in speaking. Owing to circumstances, he had probably had greater experience of electric traction in this country than any other man. This was in consequence of his position as President of the Tramways Institute, and also in consequence of his personal association with the companies which had tried electricity. Gen. Webber and other speakers had referred to storage batteries. His experience with them had not been that overwhelming success which they had all hoped for. The failure of storage batteries in England was due to a variety of causes and not necessarily to the batteries themselves. For example, when they asked an accumulator car to grind its way through snow and ice over a line an inch and a-quarter wide to gauge what could they expect but the exceedingly rapid deterioration of those batteries? And, furthermore, he would ask if batteries were allowed to wear out and were not replaced, and they charged them every journey every six miles what could they expect but that their working expenses would mount up to an alarming proportion, and, therefore, by the ignorant and prejudiced, traction by storage batteries be regarded as a failure? He was speaking of Birmingham. His object as the President of the Institute was to find out the best form of traction. With that view he had experimented with air, fire, and water. He had used steam by means of locomotives travelling on common roads; he had tried compressed air; he had tried, and was trying, oil; he had tried, and was trying, gas; he had tried accumulators of all types, the E.P.S., the Epstein, and the Jarman, on different roads, and he had tried the overhead wire system. In South Staffordshire they had a complete system equipped, he hoped and believed, on a method which would approve itself to those gentlemen who had preceded him, and which to his mind was not only satisfactory from the pecuniary point of view, but satisfactory even to those gentlemen who implored him almost with tears to do nothing in the way of overhead wires that would deface the picturesque beauty of the Black Country. From the point of view of the traveller, of the tramway director, who wished to see absurd and obsolete restrictions removed, who wished to see railway and tramway legislation brought up to date in England, he did hope for the very best possible results from the Board of Trade Conference. *Apropos* of accumulators, he had arranged for a demonstration of the International Electric Storage battery, of which they might have heard, which had been brought under his notice.

* Mr. S. Z. DE FERRANTI said the impression produced on his mind by the various most interesting Papers which had lately been read to the Institution on traction was that whatever other countries had done, we over here had done very little. It was an unfortunate state of affairs, and it might be interesting to consider for a moment what were some of the probable causes which had led to this backwardness. In the first place, he thought they had a very exaggerated idea of the hideousness of an overhead system. The second great trouble appeared to him to be that of fire-escapes. Perhaps in America the houses were too high to make it worth while trying to save people by fire-escapes; but, however that might be, in this country most people he had spoken to had met him with this difficulty, that the wires were in the way of fire-escapes, and therefore an overhead system could not be tolerated. To meet this difficulty he would suggest that electricians should re-invent, re-design and give for nothing to the various authorities fire-escapes which could be worked without interfering with the overhead lines. The next question was that of danger, and that, he thought, was far more fancied than real. No doubt accidents might occur through overhead wires dropping, but they were infrequent and that was not a difficulty which should be set against the immense advantages which would come from rapid traction in our towns. There was another thing which had militated very much against the development of electrical tramways, namely, the obstructions which

had been put in their way. We English had a custom here of always protecting the man in possession. That was to say, if there was an existing industry, say, for example, the telephone industry, the whole legislation tended to protect that particular industry, and to see that the coming one, however beneficial and important, did nothing to interfere with the existing one. Then there was, he feared, a far greater trouble. They knew that everything of a new nature required an immense amount of personal effort and continual work to bring it forward. Electric traction required all the energy of the whole electrical industry, whether they were strictly interested in this particular branch or not. Too much could not be done in this way in order to make matters progress, but he fancied that the primary power in moving people towards pushing electric traction forward was absent in the fact that there were no particular systems, so far as he knew, in this country which were the particular property of different individuals with capital at their command, or different manufacturing corporations. That was to say, it was not the particular business of any set of people to push any particular system of electrical traction, and, therefore, he thought that one of the great inducements—namely, personal gain—was absent in this particular case. He thought that very likely this might have a good deal to do with there not being that great effort made in this country which was necessary to introduce such a thing as electrical traction as largely as it should be introduced. It might be possible a little later on to form some sort of association for this purpose, or for some committee, possibly of that Institution, to be formed which should receive reports primarily from all interested parties; that was to say, people who would be directly influenced by the progress of electric traction, principally manufacturers and people who had something to sell. Then might come the turn of those not directly interested. He reckoned all those there present were interested directly or indirectly. Although they might do nothing in electric traction themselves, they could not do better than help those who were interested in electric traction, because it would tend to an improvement of their own work by filling up the shops of those who did electric traction work, and improving the prices generally for those not particularly interested in this particular branch. He was afraid this question was rather outside the scope of a scientific society, but it had a right there, because anything that conduced to the general spread of electricity must certainly increase the amount of scientific knowledge on the subject.

* Mr. A. SHARP said there was one point in Dr. Preller's Paper on which he would like to make a few remarks. Referring to the effect of the varying traffic, and especially in starting cars, he had said the most effectual remedy was the use of an accumulator battery, which absorbed any excess of supply in the generator over demand in the line, and made up for any deficiency of supply, so that the steam engine and generator could always run at full and constant load. He would like to call attention to the merits of an ordinary flywheel as a means of storage of energy for the particular purpose of electric traction. Energy stored up in a moving body was proportional to the weight and to the square of the velocity, so that if they could increase the velocity of the rim of the flywheel they would get a considerably greater increase in the energy stored. He hoped to point out before he had done that they had not reached the safe limit of speed for flywheel rims. Suppose they made a flywheel with a rim velocity of 300ft. per second. One pound weight of rim would store 95-H.P. minutes, and, with an effective velocity of only 5 per cent. above and below the average, the available energy would be 19-H.P. minutes; that was, a flywheel of 10 tons' weight running at that speed, and with a 5 per cent. variation of velocity, would give 190-H.P. minutes available to meet the excess and deficiency of energy. At present, with the ordinary construction of flywheel, the safe speed seemed to be about 100ft. per second. Our American cousins ran things much closer than we did in this country in running flywheels at high speeds, and they, unfortunately, seemed to get a good many cases of flywheel accidents. Now, the breaking of flywheel was usually attributed to the severe centrifugal stresses on the rim. What were the facts of the case? At the speed he had mentioned, 300ft. per second, the centrifugal stress was less than half a ton per square inch, so that if they could use a rim revolving freely, even cast iron might safely be used. At the speed he had mentioned, of 100ft. per second, the centrifugal was less than half a ton per square inch. But in large flywheels with a small number of arms they had quite a different state of things. Each segment was in the condition of a beam loaded uniformly and supported at the ends; the maximum bending moment on a beam with a given load per foot run was proportional to the *square* of the span. The stress due to the bending moment was much larger than the centrifugal tension, and probably accounted for many flywheel breakdowns. If they doubled the number of arms, the bending moment was reduced by one-fourth; and if the number of arms was quadrupled, the maximum bending moment on the rim was reduced to one-sixteenth, and the safe speed might be considerably raised. Now, the solid disc flywheel to which Capt. Sankey had referred was in this respect very much better than a flywheel made with six or eight arms. The speaker then described a flywheel designed by him, in which he replaced the ordinary cast-iron arms by a number of spokes of mild steel, arranged tangentially, in somewhat the same method as the spokes of a bicycle wheel (*see* sketch.) The bending stresses in the rim being considerably reduced the wheel could be run at a higher speed.



* Mr. J. D. DALLAS said it was not perhaps generally known that one of the principal reasons for the great advance of electric traction in America was on account of the gearing they had adopted. In Richmond (Va.), on the first electric tramroad Sprague placed single reduction gears on his motor, and because that was not successful he arrived at the conclusion that traction was not a success; but when the gearing was altered to double reduction, the road became a great success. But the fault did not lie really with the gear, but with the motor, which was not strong enough to do the work. Double reduction motors then became the vogue until 1891, when he thought nearly every road in America began to operate by double reduction motors. By the introduction of single-gear motors the gear losses, which had amounted to 15 per cent. were immediately reduced to 6 per cent. for all working loads. Many different forms of pinions had been used. Bronze pinions were about as good as could possibly be used for reducing the loss and also for reducing the noise. Hide gears at one time were thought to be excellent things, but were used for a short period only because they rapidly fell to pieces. The next improvement was to laminate the raw hide pinion by successive layers of raw hide and steel. But these, as soon as the edge was slightly worn down, cut the gear like so many saws, and were rejected. At present preference lay between forged steel milled out and bronze. He was in the testing department of Thomson-Houston Company for a long time, and he thought they had come to the conclusion that there were smaller losses from a cast-iron gear than in any other form, the cast-iron being close-grained, and with a considerable quantity of wrought-iron scrap mixed with it. This gave a very strong gear which worked very well. He could give an illustration of the strength of these gears. He once saw a nut dropped by mistake into the gear, which was running at 900 armature speed. The nut was dropped in between the cast-iron teeth and a pinion. No mark could be discerned on the cast-iron, but the nut was very plainly stamped on the steel and the axle-box was broken. Gearless motors were scarcely ever of any use for street traction purposes; it was almost impossible to make a motor which had a satisfactory efficiency. He had heard very little mention of carbon brushes; he saw them used on one of the first roads ever worked in Boston, and where the commutators used before to be torn to pieces in a few days.

* Mr. H. D. WILKINSON, in replying, said that a great deal of ground had been covered in the discussion, and time would not permit of his referring to every speaker. He regarded the discussion that had taken place that evening as having a very important practical bearing, but he must not omit to refer to those speakers who had taken part in the opening of the discussion at the previous meeting. He was much indebted to Mr. Parshall, Mr. Robinson, Capt. Sankey, Mr. Holroyd Smith and others who had contributed to the discussion. Mr. Smith had brought before them points which he had invented and carried through successfully in Blackpool, and he was sure as Englishmen they were proud of this conduit system, more especially as, he thought, there was a great future for a conduit system for cities; but he could not dismiss in the same way that Mr. Smith had done the conduit system to which he (Mr. Wilkinson) had referred as being a practical success in Washington. He was very much struck with that conduit system. He travelled on it and saw it run smoothly and perfectly. Looking into the mechanical details, he saw that the expansion of the copper conductors was well provided for. He also looked at the construction of the line, the manholes, the yokes, and the whole of the arrangements, and he could only say that it gave him great satisfaction, and he thought the Institution should not be kept in ignorance of that particular system. With regard to the remarks which had fallen from General Webber he thought they had opened an entirely new field. Where the traffic was not sufficient to support a central station and to make it pay it seemed it was quite possible, with accumulators charged at intervals, for a line to be brought to practical success. The remarks made on this occasion by Mr. Ferranti, Dr. Silvanus Thompson, and other speakers were well calculated to allay prejudice against overhead conductor systems, and to pave the way for the development of the industry. The remarks which had fallen also from the President of the Tramways Institute were very full of suggestiveness and practical value.

* Mr. P. DAWSON, replying on his own and Mr. Blackwell's behalf, said the time being short they would ask permission to print their answer to to various points raised, and spare them the somewhat lengthy tables which had been compiled. Mr. Mark Robinson had said the financial test was the only real one. From a careful analysis of a large number of electric railway accounts they found that the average working cost per car mile, exclusive only of interest on capital, was approximately 6½d. in America and 5¾d. in Europe, and that the ratio of working expenses to receipts in both countries was approximately 60 per cent. In contrast with this they had the working costs per car mile of the horse and steam tramways as being 10d. per car mile and the ratio of expenses to receipts over 80 per cent.

* Dr. DU RICHE PRELLER said that with regard to Mr. Lea's question as to the comparison between steam and electricity on rack railways, he had stated in a general way in his Paper that, according to his experience and from all the other cases he had had occasion to investigate, the saving effected in electric traction as compared with steam was 50 per cent. That saving applied equally to steep grade lines and to ordinary adhesion lines, to electric cable railways and to rack railways like the Mont Salève line

near Geneva and the Barmen rack railway in Rhenish Prussia. With regard to the difference between steam and electricity as concerning rack railways he might refer Mr. Lea to a very careful comparison he had worked out in a Paper published in *Engineering* early this year, between the Mont Salève railway, which was electrically worked, and the Glion railway, which also was on the lake of Geneva and was steam worked. Those two railways presented entirely similar features. The length was about the same, the maximum grade of 25 per cent. was the same. The total working expenses on the Mont Salève line amounted to 3·2sh. per train mile, and on the steam line they amounted to exactly 6·5sh. per train mile, so that the saving by electricity was 50 per cent. Mr. Parshall made some remark about alternating current, which, he said, seemed not to have very much prospect of success in electric traction. He (the speaker) did not agree with him, and Mr. Parshall himself told him afterwards that the Thomson-Houston Company were going to use three-phase current, transforming to direct-current, on the Portland tramway in Oregon. That, it seemed to him, was an application of alternating current. A further remark he wished to make was with regard to what Mr. Robinson said about direct driving. He had taken care to have some statistics prepared of the Marseilles line, which was precisely a case in point, where the generators were first direct-driven by high-speed vertical double-acting Oerlikon engines, which were afterwards replaced by engines of the Corliss type with rope-driving. These had answered very well indeed, the economy in the consumption of fuel being very considerable. From another remark which Mr. Robinson made with regard to the question of steep-grade lines not touching us in England so very closely, he entirely dissented, because, without going into any question of elementary physical geography he might say it was an absolute fallacy to suppose that there were no steep grades in this country. Leaving aside mountain railways properly speaking, such as the line up Snowdon would be, the first sod of which was to be turned within a day or so, there were plenty of steep grades all the way through from the Land's End and Dover right up to the Highlands of Scotland. He thought Mr. Robinson must have forgotten that there was such a place as Hampstead Heath, where there was a steep grade of at least one in twelve. Then in his own county, in the West Riding of Yorkshire, there was not a single town where they did not get a grade of 5 to 8 per cent., *e.g.*, at Bradford, Leeds, Halifax, Huddersfield, Sheffield and other towns. Moreover, many of the turnpike roads of this country were simply constructed on the old Roman roads, and everybody knew what the grades on the old Roman roads were. On the question of light railways in agricultural districts, Gen. Webber had spoken of lines costing £2,000 per mile and having a service of two or three trains a day. The cost of such lines would be nearer £6,000 per mile, and it would be an absolute mistake to try and run electric trains two or three a day in each direction. The advantage of electric traction according to his experience, consisted precisely in this—that by running motor cars, they could give the people of a district the facility of communication every hour or every half hour. As a typical line of this kind he might mention the electric road railway from the Lake of Lucerne to Stans in Switzerland, of which a full account would be published before long in *Engineering*.

CONCERNING ELECTRICAL FADS.*

BY LOUIS BELL.

The history of applied electricity is not very long, but it furnishes in a comparatively brief space a good deal of amusement for one of a philosophical turn of mind. Just as one may find in the distorted headgear of various recent dates a distorted reincarnation of the fashions of forty years or more ago, so it is very easy to discern in electrical manufacturing, or even electrical engineering, fashions of more recent date again turning up. Electrical installations have been and are largely governed, and in no small degree heeded, by fashions which are followed slavishly without any reference to appropriateness. Just as if all humanity should think it necessary to wear the same sort and size of shoes quite irrespective of comfort.

A fine example of electrical fashion may be found in the long double-truck electric car which at one time used every effort to force itself willy nilly upon nearly every street railroad in the country. The long car filled an important place in the domestic economy of many railroads, and still does so. Nevertheless, its present use is generally limited to roads that really need it, while a couple of years ago it was popular without reference to the merits which it undoubtedly had in the handling of very heavy traffic or of reaching a speed beyond the safe speed of a single truck car. But it was and is heavy and costly, both to build and to run, and no better than a good single-truck car for a large majority of the electric railway lines to be met with throughout the country. One or two prominent well-conducted roads took up the long car for good reason, and immediately a large number of their contemporaries fell into line, and concluded that they, too, must be in the fashion.

Another bit of fashionable *bric-à-brac* introduced about the same time was the slow-speed Corliss engine for railroad plants. It was observed that several prominent, well-engineered installations were driven exclusively by the Corliss engine, and immediately every small road fell into line regardless of its conditions of economy and the load factor of the plant. Now, the Corliss engine is, in its way, a marvellously excellent piece of machinery, and under reasonable conditions of load is hard to beat. Nevertheless, even its best friends could not conscientiously recommend it to a road running three or four cars in a hilly country. This particular fashion was somewhat short-lived, and its effect has now almost passed away; but we shall very likely be treated to a revival before many years have passed, possibly with a few ruffles and frills in the way of storage batteries used for artificially steadying the load.

In fact, storage battery traction has at times raised itself almost to the rank of a popular fad. At one time there were in this country as many as three or four roads swaggering around with a storage battery equipment, and many another road would have followed the example on small provocation. It became quite the thing for town boards and aldermen to bring it up every time the subject of electric traction was mentioned, and it was many a day before the fad died out. It finally expired from pecuniary complications. The writer by no means looks at storage battery traction as a dream entirely beyond realisation, but the widespread and disastrous craze of a few years ago certainly had small cause for existence.

Just now we are being treated to a particularly alluring specimen of novelty goods in the line of direct-coupled dynamos. It is well for those who wax enthusiastic on the subject and extol what to them seems to be the very latest and best in the growth of electrical fashions, to look back to the earlier work of Mr. Edison in this line. The Jumbo dynamo was, for a time, an excellent example of the direct-driven work, and has in several cases done sterling service for more years of life than is the fate of most dynamos.

As large units have been steadily coming into vogue, for the best of reasons, direct driving has become more and more practicable, so that an increase in this class of machinery is natural and proper. It should be remembered, however, that every particular size of dynamo will have a particular speed at which the economy of construction is maximum. Where a given unit can be run at a certain low speed without sacrificing too much in the character of the engine, the combination will be found to be excellent, economical, and in every way desirable.

If space is very dear it may frequently pay to depart somewhat from the line which would be dictated by good engineering for the sake of economising in space. But there is no conceivable reason for a plant located somewhere out in the prairie, with all outdoors at its command, disregarding its well-tried belt-driven equipment for the sake of putting in the latest thing in dynamos.

The solemn truth is that the leather belt is about as economical and efficient a method of driving as human ingenuity has as yet devised, and in not a few cases it will be found, if we search to the bottom of the matter, that a particular direct-driven unit may actually be less efficient than the belted equipment of engines and dynamos for the same output, enough having been sacrificed for the sake of the slow speed of the dynamo to fully compensate for the loss in the belt. This is especially likely to occur where small units are designed for speeds properly fitted only for large units. However, time will do its work, and a little more general experience with the direct-driven fashion will probably convince a good many would-be followers of the error of their ways. We shall then have the direct-driven unit relegated to its proper place in electrical economy, just as the long cars have been.

It would be cruel to drop the subject of fads in electrical practice without paying our respects to the insulated wire exploiter. Any electric light man of a few years' experience can cast a critical eye on his plant, or the plant of his neighbour, and perceive how almost every year there is a special fashion in the brands of wire that are most popular. One will come up in the market, backed by half-a-dozen choice expert tests, and for a year or two will be given a right royal welcome by station managers. Then another brand, quite the proper thing in installation, you know, will show up and have its turn in popular favour. We have now on the market a large number of kinds of most excellent insulated wire; but their excellence and reputation are not the slightest bar to some peculiar make being taken up as a fad, and for a season or two holding sway over the hearts of wiremen.

And so one may go on over a large range of electrical applications and appliances. Many electrical improvements of great merit have been pushed to the front in just the irresponsible sort of way the writer has tried to describe; but the fact that they have been so pushed forward does not stamp them as unassailable patterns of excellence.

Ship Telephonic Communication in Sweden.—On the occasion of the recent visit of the German Fleet to Stockholm the General Telephone Company of that city laid a telephone cable at its own expense between its exchange and one of the war vessels.

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* From *Electrical Engineering*, of Chicago.

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EXAMINATIONS.

Few men are entitled to be listened to with greater respect on the subject of the merits and demerits of examinations, and above all of technological examinations, than Sir PHILIP MAGNUS; and it is on this account that we reprint in the present issue an article contributed by him some few weeks ago to a technical contemporary. If we may judge from this contribution the pendulum, not only of popular but of expert opinion having swung from one extreme to the other, is about to come to rest in that intermediate position between two extremes so congenial to the English mind. And to our thinking the national love of compromise, almost laughable at times, will in this matter, as in most others within the sphere of applied ideas, prove a safe and satisfactory instinct. Thirty years ago the value of examinations was, Sir PHILIP MAGNUS assures us, scarcely questioned; as final and infallible criteria of knowledge and ability examination certificates were held to be unimpeachable. But from this high position in the esteem of the public there was a rapid descent, and the term "examination wallah" soon became synonymous with all that was educationally contemptible. To-day the public verdict upon examinations is tolerably accurately summed up in the words of Sir PHILIP MAGNUS: "All that can be said is that no better way can be suggested, and that they can be made less harmful to the progress of real education than they are sometimes supposed to be, and that in many cases they may become a most efficient means of stimulating careful and thoughtful training, and of generally raising the standard of instruction, and of improving the methods of teaching in any particular subject." This statement of the case, if it errs at all, errs in the direction of over appraisement, and when the pendulum does ultimately come to rest we think it will do so at a somewhat lower level.

Knowledge and education are terms of considerable currency, but extremely poor definition. They have not as yet been standardised; each man is at liberty to apply to them whatever meaning seems good in his own eyes, to the perpetuation of barren discussion and the making of confusion worse confounded. For the purposes of this present article, therefore, education may be taken to mean technical education, or instruction in the technicalities of a trade or profession, and knowledge to mean, not scholastic erudition, but an acquaintance with the chief scientific principles underlying the aforesaid trade or profession, and the relation of these principles to current practice. Thus, the examinations with which we are immediately concerned range from the exalted engineering degree to be granted in future by Cambridge University to the examinational test applied to the humble plumber by the City of London Institute. The subject thus narrowed becomes somewhat more manageable, and it requires neither superhuman sagacity to discover what has given the examination fiend such a firm footing in this particular region of human activity, nor extraordinary perspicacity to estimate examinations both at their true value as tests, and at their exact perniciousness as pests. So far, at any rate, as engineering of all kinds is concerned, there can be but little doubt that the decay of the old system of pupilage, and the rise of the new system of technical tuition has been brought about by the ever-increasing specialisation of the engineering workshop, and the increasing impossibility for mere rule-of-thumb knowledge, engineering instinct, call it what you will, to hold its own unaided against minds with a sound scientific equipment and brains trained to reason accurately.

An engineering diploma we cannot help thinking goes too far. A mere statement, even if engrossed in the most ornate style on a sheet of the very best vellum, that Mr. So-and-So has passed so many years at such or such an institution with infinite credit to himself and satisfaction to his instructors, will only make out at most a *primâ facie* case in his favour in the eyes of a potential employer, and is not in the great majority of instances likely to be made use of to impose on the public. Doubtless the proprietorship of a vellum document of the kind indicated may conduce to conceit; but that is scarcely an argument against examinations, for after all, as the Autocrat once remarked, "conceit is just as natural a thing to human minds as a centre is to a circle." But the right to add after to one's name some mystic letters having an university imprimatur may very well lead the uninitiated to believe the individual to be a veritable C.E., or "certificated engineer," as many read it, although he may not in matters of practical every-day engineering so much as "know a hawk from a henshaw." Considered as tests of practical knowledge examinations even the so-called practical ones are absolutely valueless; but, then, in these days no one really considers them in this light, thanks to the ridicule and to the forcible arguments of the opposition. Regarded as tests of knowledge of general principles, examinations are certainly as perfect a weapon as it is granted to fallible humanity to devise. Indeed, with examiners frequently changed, syllabuses kept abreast of the times, and laboratory and class-room work taken into account as well as, the possible perniciousness of examinations is reduced almost to a mathematical point. To expect the general educational world to regard examinations as "a most efficient means of stimulating careful and thoughtful training, &c., &c.," is probably to expect too much, though we quite agree with Sir Philip Magnus that the "stimulus" of an impending "exam." is an effective modern substitute for Dr. Birch's favourite weapon.

SOME REJECTED ABSTRACTS.

It is difficult to account for the following "Abstracts," but we print them, as they seem suitable for Christmas week, a season ignored by most technical journals. It is possible that a competition has been held by the Council of the Physical Society for a standard pattern of abstract of the new journal. Having come to us by post, possibly by mistake, instead of to Messrs. T*yl*r and Fr*nc*s, we cannot do better than use them for our Christmas number.

1. *The Suppression of Sense in Demented Units.* Prof. R*ck*r.—A herring and a half costing 1·5 pence, the herring-per-penny is obtained. It is not a number, but a thing got by dividing a fish by a disc of impure copper. Its physical nature is investigated, and how the bones got there, and it is hoped an improved herring with no bones may be evolved which will be edible. Another investigation in collaboration with Prof. R**n*ld shows how thin an empty argument may be without bursting, when gently blown upon.

2. *Interference with Alternate Currents.* Prof. A*rt*n and Dr. S*mpn*r.—Transformers are coupled up in a tangle not contemplated by their makers, and queer measurements with queerer instruments of the authors' design are made. The 15 wattmeter method gives the largest number of divergent results to choose from. The authors have also tried the effect of dressing with their legs through the sleeves of their coats, and their waistcoats buttoned down behind, getting results not easily foreseen by the makers. No justification for the authors' interference with alternate currents is given.

3. *The Masslessness of Matter.* Prof. F*tzg*r*ld.—If a massless body is immersed in a frictionless massful medium, any movement will necessitate momentum of the massful medium, and an observer, suitably devoid of sense, will be unable to tell whether the inertia belongs to the matter or the medium. If the matter is porous, the smaller the pores and canals the greater the kinetic energy of the massful ether going through, so that the more massless matter and the less ether there is in a given space the greater the volume energy, which, it will be noted, is transferred in the wrong direction—a great merit. By choosing suitable postulates, and employing the right mathematical reasoning, it can be shown that the effect is the same as if the matter had mass. When a working hypothesis shows the least intention of working, it is the truth. Matter has no mass. Ether, with which we are so much more familiar, has.

4. *The Theory of Dynamos.* Prof. P*rry.—In order to have a mathematical theory of dynamos, data must be assumed; it does not matter what data, as long as they are amenable to mathematical treatment. It is therefore assumed that the output varies as the reciprocal of the speed, and the efficiency periodically with the time, so that it can be expanded in a Fourier's series. A maximum is then calculated which gives the worst dynamo possible. As the results are calculated mathematically, they are rigidly true of real dynamos.

5. *A New Proposal for Uniformity and Simplicity of Nomenclature regarding the Poles of Electro-and Permanent-Magnets by a comparatively Obvious and Easily Learned Mnemonic Rule.* Prof. S P. Th*mps*n.—(This Paper is short, and given in full.) Call north N and south S, and there you are!

6. *Head Splitting Dynamometers.* T. H. Bl*k*sl*y.—Has previously shown that if n central stations, giving different pressures and various frequencies, some being direct-current, are put in parallel through $n - 1$ split dynamometers, the powers developed by each can be measured. Has tried to get engineers to try the experiment, but they do not understand alternating currents, and all refused except Messrs. Brock and Pain.

7. *The Use of Gravity.* Prof. V. B*ys.—g [what is g?, Abstractor] can be measured by letting a useless body fall a known distance and pulling it up suddenly by a quartz fibre and noting its elongation. Proposes, in the interests of science, to carry out the experiment on his own body with a drop of as nearly 9ft. as can be obtained in centimetres. A series of instantaneous photographs will be taken, and a radiomicrometer of small sensitiveness will be used afterwards.

8. *Some South Kensington Weather.* S. B*dw*ll.—Took a chunk of mental fog produced by the discussion on the foundations of dynamics, and tried to dissipate it by electricity. It got tougher.

9. *The Storage of Energy.* Prof. *. L*dg*.—Has taken to heart the homely American warning against monkeying with a buzz saw. Has obtained the equation to a new metal from Dublin, which is as good as getting the metal itself. It is a perfect conductor of electricity, and of magnetism, infinitely elastic, and a non-conductor of heat. It is thus impervious to energy. Difficulties arose in working it, as it could not be melted, as its temperature is unalterable, and cannot even be determined, and no tool will touch it. Bottles and force pumps were made by electrolysis, and energy can be stored. The stoppers are apt to leak, and work oozes out like fumes from an iodine bottle. Energy, being a compressible fluid, has been got in liquid form. The interior being painted with an ether-tight varnish, ether can be pumped in too, and on shaking an emulsion is formed. On stirring a little matter, the mess conducts electrolytically. It is beneath the dignity of a man of science to make money out of his knowledge unless he knows how; but it is hoped Keeley will come forward.

10. *A Short Way with Standard Ohms.* By Tom, Dick and Harry [first, second and third years sample "Finsbury" student]. A Cambridge ohm is coupled to a voltmeter, after the latter has been thoroughly stripped and carefully twisted. The ohm is then made to fit the voltmeter. A first approximation is got by roughly filing the ohm, accurate adjustment being subsequently attained by a liberal use of the finest calibrated sand paper [$10{\cdot}19 \times 10^9$ grains to the square centimetre]; the determination, within 13 per cent., can be made in 7·349 minutes. The students merely press the button and the professor does the rest.

11. *The Specific Gravity of Monoxide of Hydrogen.* By J*ck Sm*th, T*m Br*wn, and J*m R*b*ns*n [first, second, and third year sample "Central" students]. To eliminate errors due to a containing vessel, the substance was used in the solid state. The weight was determined from Messrs. A. and S. Gatti's invoice, by dividing the price (less discount for cash) by the price per cwt. A check weighing was made in the laboratory, the block being slung by chains on the testing machine, temperature being kept constant by wrapping it in demagnetised asbestos saturated with ether. The determinations of mass agreed within the necessary limits of error. The volume was measured by melting it down, and observing the velocity of approach of the stream to a V notch, by means of a new form of ohmmeter. The result, which was communicated verbally to the Society in the authors' reply to the discussion, was not caught by the reporter.

12. *The Mechanism of Electrolysis.* Dr. B*rt*n.—Discusses the convection of charges of electricity in a universe composed, like ours, of frogs' eggs moving on one another without friction. Too deep to be abstracted.

13. *The Efficiency of Transformers.* Prof. J. Sw*nb*rn*.—Has invented a transformer which takes such a large primary current at no load that the addition of the secondary load makes no appreciable difference. It is thus impossible to notice the load, and this is as good as having an efficiency well over 100 per cent. Has also invented a wattmeter which measures twice the loss in other maker's transformers, but ignores that in his own. States that he alone understands real alternating currents.

REVIEWS.

Electric Motive Power. By Albion T. Snell. (London: "The Electrician" Printing and Publishing Company, Limited.)

The substance of Mr. Snell's book has already appeared as a series of articles in this journal. No elaborate synopsis of its contents is therefore necessary. It suffices to say that the complete work is divided into ten chapters, the first eight of which, except one on "The Line and Distributing Mains," are concerned with the theoretical or semi-theoretical aspects of the subject, while the last two are descriptive, and deal with the employment of electric motive power in mining operations, coal cutting, and rock drilling. These applications the author treats of as a specialist, and, consequently, what he has to say about them will interest many practical engineers, both mining and electrical, who will prefer to leave the whys and wherefores to others. It is therefore proposed to review that portion of the book first.

A good deal has been written in a desultory form on the use of electric power in mining, but there is a dearth of connected information up to date and in a handy form. These chapters are, therefore, welcome on this account, besides their intrinsic merits; in fact, after reading them one cannot help wishing they had been greatly extended, even, if necessary, at the expense of some of the other matter. Still, a good foundation has been laid, and since Mr. Snell has shown his ability to deal with the subject comprehensively in the remainder of his work, it is to be hoped that he will regard this as a commencement and in successive future editions expand this comparatively small treatise into a standard work on the employment of electricity in mining.

During the last 20 years mining in the United Kingdom has suffered from the wave of low prices in an even greater degree than other industries, while it has had more than its share of labour troubles. Consequently, while a quarter of a century ago mines were a popular form of investment, and profitable when entered into with circumspection, for many years now the public has given them a wide berth. Money has, therefore, been tight in the mining market, and this means both the minimising of new enterprise and the carrying on of the old with little fresh capital expenditure, and often under circumstances when a moderate further capital outlay would secure a considerable annual saving and increased profit. For these reasons the adoption of electrical methods in mining has hitherto been much slower in this country than it would have been. Fortunately there is now strong evidence that better days are in store for mining enterprise if judiciously undertaken on modern lines. Mining men, too, no longer look on electricity as an interesting toy, or as a thing of the future, but are prepared to accept it seriously. It is the writer's fortune to be personally interested in mining, and he can bear witness to the marked difference in tone amongst mining men in this respect even within the last twelvemonths.

There is no doubt that as yet barely the fringe of what can only be characterised as a revolution has been touched. It is hardly too much to say that as a fresh generation of mining engineers arises, familiar with the rudiments of electricity from their school days, such alteration and development in the manner in which mining is carried on will be gradually effected that present methods will be looked back on as almost barbarian. At the same time it is pleasant to think that the change must be a beneficent one, and that if it diminishes the number of men employed for a given output, it will bring health, comfort, and greater immunity from danger to all who remain; in fact, that it will raise the mining population from a class almost apart, to a level with the other skilled trades, since miners will no longer be occupied in rough heaving and hauling, in a half naked state, but will be engaged for the most part in the manipulation of machine tools requiring both skill and foresight for their advantageous use.

At the same time, electrical engineers will be unwise if they try and force electricity into mining too quickly, and particularly if they ignore the fact, as there is a tendency to do now, that there are other natural agents besides electricity; viz., that it does not follow because a thing can be done by electricity that, therefore, it is, *a priori*, the best or the cheapest way.

The writer agrees with Mr. Snell that the mining motor of the future will be polyphase; unfortunately at present he is unaware of a single polyphase plant at work in this country. When polyphase currents are as well understood by manufacturers as continuous currents are now, and when the out-turn of polyphase machinery is comparable with that of continuous machines now, then polyphase machines should be cheaper to construct than continuous-current machines; and if in the meantime the price of cast steel for magnets can be reduced then the door will be opened for the employment of electricity in many cases where at present the costliness of the plant over other methods places it at a disadvantage. It is impossible to review in the ordinary sense what Mr. Snell says about coal mining, which is the outcome of his experience; and readers will be much better occupied in perusing his remarks themselves than any criticisms which could be made on them.

Returning now to the more theoretical portions of the book, we must take some exception to Mr. Snell's statement in his opening chapter that the electrical power station of the future will be fitted with high-speed dynamos belt driven. No doubt this will be the case to a considerable extent, particularly among the conservative mine owners'; but is not the experience of the day rapidly pointing to the fact that for powers of 50 to 100 H.P. direct coupling at from 550 to 400 revolutions is the most suitable? The writer has been surprised lately at the readiness with which mill owners, who are supposed to form the stronghold of rope or belt driving, have accepted lighting plant with direct coupled engines, while the results obtained are excellent.

Mr. Snell has done wisely in supposing his readers to know the general science of his subject, and in leaving to Mr. Kapp and other writers the task of deducing the fundamental facts underlying the construction of electric plant. The explanations of the fundamental electrical reactions are as yet very incomplete, and the general explanations are much less in accord with the ultimate physical facts that the glib student who can play with Dr. Hopkinson's equations for the magnetic circuit would imagine; but since these equations enable us to design continuous-current dynamos easily, Mr. Snell is right in simply employing them, which he has certainly done in an exceedingly practical manner. It is notable that Mr. Snell is a strong advocate of separate excitation for continuous-current machines in central power stations. This idea the writer has been developing in a series of articles on the governing of steam engines coupled to dynamos; it is certainly the best method where there are several machines, and the variations in pressure are considerable.

In the chapter on "The Line," a satisfactory point is the attention given to lightning arresters. In England we are so little troubled with the effects of thunderstorms, and our transmission of power has been of such comparatively small extent, that the subject has not received the consideration it deserves. Much trouble has arisen in plants sent to the Colonies from this cause, and English firms have had difficulty in meeting the requirements of colonial customers. It appears as if, at any rate in the construction of arresters, our American friends were at present much ahead.

The final point in Mr. Snell's book to demand notice is the large space devoted to a description of single and polyphase methods of working. It is a matter for regret that English engineers should be so behindhand in this field, though an excellent commencement was made by Messrs. Johnson and Phillips in the plant for the Sheba Mines, designed by Mr. Kapp. The fact that within a few months two works on electric motive power have appeared, the first by Mr. Kapp, and the second, the one under review, in both of which a large portion of the space is devoted to the exposition of polyphase working, should convince business men of the solid claims it has on attention. Despite all that has been written on the subject, it is the writer's opinion that our general working knowledge of alternating and phase currents, and particularly the construction of plant, is not much in advance relatively of what the design of continuous-current machines was ten years ago. In another ten years the electrical world will have a knowledge of phase working about equal to its knowledge of continuous-current working now. This will not only be to the advantage of phase working itself, but it will bring us much more intimately into relation with the fundamental physical facts of electric action, and doubtless lead to great developments in other directions.

G. L. ADDENBROOKE.

Forty-Three Graphic Tables. By ROBERT H. SMITH. London: Griffin and Co. 1895.)

Prof. Robert H. Smith is one of the few active advocates of graphical methods of calculation, and a feature of his contributions to this subject is the use of the straight line. In his work on Graphics, of which only one volume and an atlas of plates has as yet been published, the use of curves, which many people seem to think is the beginning and end of graphics, occupies a subordinate position. The volume or atlas before us consists of 28 pages, ruled in squares, 100 squares to each side. A few sloping lines and the necessary scales on the margins are given on each page, and by such simple means, an enormous mass of tabular information is thus given. The object of these diagrams is the conversion of measurements into different units; for example, feet and centimetres, square inches and square centimetres, gallons and litres, ounces and grammes, pounds per square inch and feet of water, pounds per cubic inch, and tons per cubic foot, horsepower and kilowatts, foot-pounds and joules, and thermometer scales, 43 in all. The general degree of accuracy is stated to be on the average one-fifth of 1 per cent. of the whole quantity converted, and ranges from one-tenth of 1 per cent. to 1 per cent. An important feature of these diagrams, as compared with numerical conversion tables, is that they are completely reciprocal.

It must be admitted that such diagrams will not be appreciated by everybody equally. Some people seem to be particularly attached to numerical tables, and will interpolate arithmetically when necessary; others will use a simple table of conversions and a slide-rule; but we have no doubt that after a little practice the present diagrams would be found to be of great utility, especially where a considerable number of conversions of the same kind have to made at a sitting.

PECULIAR TELEPHONE TROUBLES CAUSED BY ALTERNATING CURRENT DISTRIBUTION.

BY E. W. MIX.

The importance of the inductive influence of an alternating current distribution on telephone systems is well shown by some disturbances which developed at Odessa during last summer.

The telephone lines are all overhead, and the apparatus is of the American Bell telephone manufacture. The dynamos in the central station are of two types, one for 40 ∿, and the other for 125 ∿. The primary potentials of the circuits are 1,800 and 2,000 volts respectively. The 40-cycle machines alone had been used for the lighting of the municipal theatre up to the time of the development of the disturbances. The secondary distribution of the theatre was made at 60 volts, and the total energy consumption about 80 kilowatts. It had always been possible to detect a slight induction on the telephone lines passing near the theatre when the 40-cycle dynamos were running, yet the influence was insignificant. When, however, the theatre line was branched on the 125-cycle dynamos, the disturbances were quite important on certain lines running in the neighbourhood of the theatre.

It was at first thought that the source of the trouble would be found to be the induction produced by the overhead primary lines, but the telephone wires most influenced crossed these lines at right angles. The group of about 20 telephone wires most influenced passed from supports on the roof of one building to another about 20 metres high along the side of the theatre, but about 10 metres from the side walls, or fully 30 metres from the centre of the theatre, or, so to speak, centre of gravity of the distribution. The distance between the telephone wires and the primary wires at the point where they cross is about seven metres.

It being thought that the secondary circuits might alone be the cause of the troubles, a temporary load was made up for the secondary circuits in the transformer room by means of water rheostats. The load thus placed on the primary circuit was made even more than the normal; but, under these circumstances, all disturbances ceased to exist.

Investigation as to the arrangement of the secondaries led to the discovery that a great many circuits, and especially those for lighting the four galleries, were made on the loop system;

i.e., where the current enters at one end of the circuit and leaves at the other, for the purpose of assuring an equal potential on all lamps in that circuit. In the gallery circuits, the current enters at one side of the theatre and leaves at the other, so that the effect at a considerable distance from the circuit was the same as if a single conductor were placed around the gallery carrying a current equal to that of the circuit. This current was unusually large on account of the distribution being made at 60 volts only. These four circuits passing around the theatre in this way produced a very strong magnetic field, the axis of which was practically co-incident with the axis of the theatre. This field embraced to a certain extent the group of telephone wires, and gave rise to the trouble.

In order to gain a more definite idea of the extent and distribution of the magnetic field so produced, an exploring coil was made up, consisting of about 100 metres of insulated wire wound up into a coil about 1·20 metre in diameter, and the two terminals connected to a telephone receiver. By carrying this coil around inside and outside the theatre, holding the receiver to the ear and turning the coil in different positions, it was very easy to determine the direction of the lines of force at any point, and the intensity of the noise in the telephone was a good measure of the strength of the field.

When all the circuits were on, the effect was very noticeable on the iron roof of the theatre at a level a little above the group of telephone wires. On the ground outside the theatre and immediately under the wires, the influence was also well marked. It is very likely that the iron roof added to the effects on the telephone wires in concentrating the lines of force which escaped from the edges of the roof and cut the wires near by. The iron roof acts somewhat as a pole piece to the magnetic field.

The same trouble developed at about the same time in another theatre where the wiring of the gallery circuits had been made on the same loop system. Here it was easy to locate the trouble because the circuits were more distinctly separated. The influence was only exerted on two telephone wires which passed over the roof of the building. The instant these loop circuits were switched on, the noise in the telephone was noted. The intensity of the noise in each case had no relation to the load on any other than the loop circuits, so that it was plainly demonstrated that these circuits were the cause of the trouble in both theatres. The remedy in such cases is naturally the suppression of the loop system, and especially in cases where high frequency alternating currents are employed.

The importance of electrostatic induction effects on telephone lines was forcibly brought out by a condition which existed one day, and which was conclusively proven by experiments afterwards. It was found that a new disturbance was set up in a part of the city heretofore unaffected. Here there was a new branch of the primary line installed running parallel to a group of telephone lines for a distance of about 350 metres. The primary wires were on wooden poles about seven metres from the ground, and the telephone wires also on wooden poles about 11 metres from the ground, but on the opposite side of the street, the distance between the two lines being at least 20 metres. There were as yet no transformers branched on this line. The effect was first noticed on a line which ran but about 30 metres parallel to the primary lines and then crossed them at right angles. It was supposed that both primary wires were connected to the line circuit, but investigation showed that one had been by an oversight left disconnected. When the connection was established the disturbance ceased. Here the effect was purely electrostatic. The insulation of the primary line was perfect, so that the disturbances could not be attributed to any leakage to ground.

To more fully determine the extent of the electrostatic influence, the experiment was tried of connecting one pole of the dynamo to a circuit leading out in one direction from the station, and connecting the other pole to a circuit leading out in the opposite direction. By this combination no current was sent out on any of the lines, except that necessary to give them an electrostatic charge. The disturbance set up in almost all the telephone lines of the city was such as to almost completely prevent communication. So long as only one circuit was so connected to but one pole of the dynamo, the influence was just sufficient to enable one to determine that the dynamos were running; but, on connecting the two circuits as described above, immediately the disturbances were set up. The insulation of the lines with the transformers connected was in the neighbourhood of 300,000 ohms. The length of double line of one circuit was about eight kilometres, and that of the other five kilometres. No current could be detected flowing out on these lines by means of the amperemeters, which were fairly sensitive instruments, and where one ampere could have been quite easily noticed.

The conclusions are, therefore, that electrostatic induction is quite as, if not more, capable of creating telephonic disturbances than electro-magnetic induction with high frequencies and potentials, and precautions should be taken to keep the two conductors near together, so that one may neutralise the other. In electrostatic induction the earth, or even buildings, serving as an intermediary conductor of large capacity, tend to increase the area of influence of the electric charges received by the primary wires.

TRANSFORMER PITS.

Although the Board of Trade have not issued any special regulations for transformer pits they have in certain cases sanctioned the use of such pits as part of the system of supply, and have attached certain limitations to their sanction. The following regulations relating to the Huddersfield municipal system of supply, in which underground transformer chambers have been sanctioned, will be of interest just at present:—

The system is a high pressure alternating current supply to converting stations from which a low pressure supply at constant pressure is given to consumers. The converting stations will, as a rule, be chambers below the level of the street. In special cases of large installations the converting stations will be special fireproof erections in the basement or other convenient part of the building.

The chambers below the level of the street will be constructed and fitted as follows:—

(*a*) The chamber will be of ample size and suitable construction.

(*b*) The entrance to the chamber will be no larger than may be required to allow of the entrance of a man or the withdrawal of a transformer, and will be closed externally in the same manner as other street boxes.

(*c*) The covers will be fixed in stout cast-iron frames, to which will be attached an electric continuity therewith strips of metal laid immediately underneath the adjacent pavement.

(*d*) Below the external cover there will be fixed a second metal cover independently supported, free from metallic connection with the external cover, and effectually connected to earth by means of an efficient electrical attachment to the underground iron pipes or metal conduits.

(*e*) Adequate means will be adopted to thoroughly ventilate these chambers, and to prevent any accumulation of gas or water.

The power given to any single converting station will in no case exceed a maximum of 100 H.P. without the written consent of the Board of Trade, and every transformer will be protected by a suitable automatic quick-acting cut-off, which will act should the proper maximum current be exceeded by the amount of 40 per cent. The high-pressure mains will be concentric, insulated with vulcanised rubber, drawn into cast-iron pipes or into paper tubes bedded in bitumen, and protected by a cast-iron casing. The low-pressure mains will be a single cable, drawn into paper tubes bedded in bitumen, and protected by a cast-iron casing, or will be laid in cast-iron troughs, run solid with bitumen, or will be insulated with vulcanised rubber, and drawn into iron pipes.

THE GILGIT TELEGRAPH LINE.*

The construction of a telegraph under ordinary circumstances does not, as a rule, present any engineering difficulties; but occasionally lines have to be erected when the local conditions render such work anything but mere plain sailing, and the line from Srinagar, in Kashmir, to Gilgit is a case in point.

The line to the Gohna landslip in Garhwal was another. The difficulties in this latter case arose from the line having to be put up at an unsuitable time of year in one of the hottest valleys in India, and from a telegraph of a temporary nature designed for the dry season having to be kept working through an exceptionally heavy "rains." Added to this the necessity for placing the wire out of reach of the highest possible flood, which meant nowhere less than 200ft. above the bed of the river, and, consequently, far away from the pilgrim track, made the task of getting the poles in position and the wire carried across the densely-wooded and precipitous ravines a most arduous and trying one. In the case of the Gohna line, however, there was nothing particularly novel to men with experience of the difficulties met with under the varying conditions of Upper Burma, Assam, and out-of-the-way parts of India generally.

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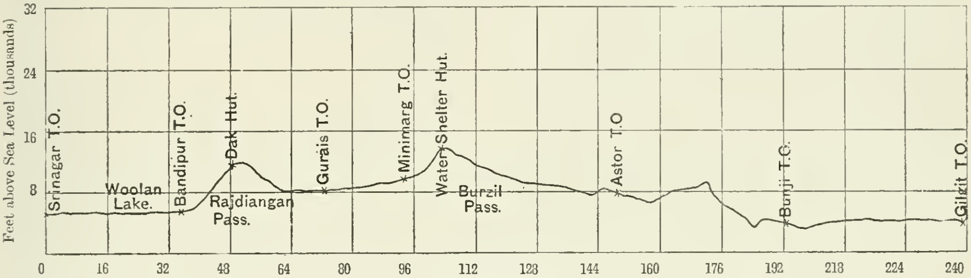
* From the *Indian Engineer.*

The Gilgit line is different, as a glance at the accompanying section of the route will show. The high altitudes crossed, the depth of snow in the passes and the intense cold of winter are such as are not usually met with even in European countries. True, telegraphs have been constructed by the Indian Telegraph Department in Sikkim, and to the different hill stations where snow and cold have to be contended against, but never to the same extent as in the wild, desolate regions traversed by the Gilgit line.

Among the difficulties to be encountered when telegraph lines have to be constructed at high altitudes is, first of all, the cold. The variation of the length of wire in a span owing to change of temperature has the effect of varying the strain ; and, unless precautions are taken, the wire will break merely from the excessive strain due to contraction. It must, therefore, be erected at a tension not greater than one-sixth of its breaking strain, so as to allow an ample margin.

The next thing is snow, which affects a telegraph line in several ways. If the alignment be not judiciously chosen, the whole line, posts, wire, and all may be completely buried under the snow. Although dry snow is a bad conductor, and it is possible to send signals through a wire buried in it for a considerable distance, when the snow begins to melt the conditions change, and the signals fail. Under any circumstances it is an objectionable state of affairs, and one that has to be provided against. To this intent the site for each pole has to be carefully selected, in order to avoid places where snow is likely to accumulate ; where this is impracticable, specially long poles must be made use of.

On the Gilgit line (*see* accompanying profile of line) two high passes have to be crossed—the Rajdiangan, 11,600ft., and the Burzil, 13,500ft. On the summit of the former snow sometimes lies to a depth of 10ft. to 14ft., and on the latter 16ft. to 18ft., and the poles used are 30ft. long. The poles need to be very strong, for the pressure of the snow upon them when planted on a slope is often very great. The use of stays or struts has to be avoided as much as possible, for experience has shown them to be a source of danger from the pressure exerted upon them by accumulation of snow. Moreover, when the ground is frozen hard the post is so firmly fixed that, provided it is strong enough, they are not wanted, especially when there is only one wire to be supported.



Profile of the Srinagar-Gilgit Telegraph Line. [Vertical scale/horizontal scale = 10/1 (approximately).]

Another danger from snow is due to the fact that under certain conditions of the atmosphere it is deposited on the wire, forming a rope of snow several inches in diameter, until the line is broken down by the sheer weight of snow. Dry snow does not adhere ; but when there is a change from rain to snow, or from a mild and moist to a cold and dry condition of the atmosphere, then it does. This is exemplified by the experience of last winter, when it was found that on the Rajdiangan Pass, which is affected by the moisture rising from the Woolar Lake, the snow formed on the wire, causing a break in one place ; while on the Burzil Pass, which, though much higher, enjoys a dry climate, the snow did not adhere, and there was no breakdown.

The danger from wind pressure on a wire thickly coated with snow is greater than from the mere weight of snow. The effect of a high wind on a rope of snow is most disastrous, especially on a line carrying several wires. To guard against this danger on the Rajdiangan Pass a solid homogeneous steel wire of the greatest strength manufactured has been put up over the most exposed section, supported on strong deodar poles planted at short distances apart.

A greater difficulty to be encountered than any so far described is met with in the shape of avalanches, landslips, and mud floods. It is impossible to altogether ensure the safety of a telegraph line against these risks. All that can be done is to take the utmost care in selecting the alignment and the positions for the posts. The route should be first gone over with a native of the country, who should be asked to point out the places where avalanches come down. Information so obtained, though not absolutely reliable, may prove of value ; but the executive officer must rely mainly upon his own judgment after examining the ground most carefully. The track of an avalanche may generally be known by the ground being scoured, and by logs of wood being found in places where no flood could account for them ; by shrubs and grass being bent down towards the bottom of the hill, and by stones being piled up and carried to the opposite side of the valley.

All ravines, if they extend any distance up the mountain, may be considered liable to avalanches, and all depressions should be avoided. It is of importance to select the right side of a valley. The presence of trees of considerable age indicate safety from avalanches and landslips, and they should be freely used as supports, after lopping off the boughs, to prevent their falling on the wire, and to keep the tree from swaying in the wind. The bottom of a valley is never safe ; a telegraph should always be carried well up the hill sides. When a post has been carried away by a landslip or avalanche and a new alignment has to be tried, the general rule may be taken as "Go up higher."

All these difficulties, and more, have had to be overcome on the Gilgit line. The extreme variation of temperature, ranging from the intense cold of the passes to the fervid heat of the Indus Valley, is most trying to the constitution. After leaving Gurais the country is absolutely barren. Every man taken up there has to be clothed and rationed. There is absolutely nothing in the way of supplies to be procured locally, except, perhaps, a little grass. Everything has to be brought up from Bandipur. In order to distribute the stores and cut the necessary track through the heavy forest in many places a large working party is necessary, and to provide them with food and keep them from deserting is no easy matter.

With the best and most carefully constructed line perfect immunity from damage in the winter can hardly be hoped for, and every possible provision for promptly restoring communication when an interruption occurs has to be made. To this end offices of observation are being maintained at Gurais and Minimarg, which, with those at Bandipur and Astor, command the two dangerous passes. In the winter there is absolutely no local labour procurable, and it is necessary to retain permanently sufficient men to form a strong party for interruption duty when required. Every man has to be fully rationed and supplied with warm clothes. Two Europeans are stationed at each office, and everything has been done that will help to render their services efficient and their solitary life, during the months they are cut off by the closing of the passes, as bearable as possible. Each office has been supplied with different patterns of snow shoes, which it is confidently expected will prove of great value, when once the men become practised in their use.

Both the Rajdiangan and Burzil Passes are dangerous to life in winter, and many a poor traveller has met his death on them. The danger of crossing has, however, been much diminished by the erection of shelter huts at comparatively short distances apart, and there should now be no risk to life in the care of a well-equipped party at any time, except, perhaps, when a snowstorm is actually raging. There will, of course, be danger from frost-bite and snow-blindness; but special instructions for guarding against these maladies have been given to all, and with proper clothing and appliances it should not be great.

Some idea of the difficulties that Mr. H. S. Olphert, the telegraph officer who has been engaged in the construction of the Gilgit line, has had to contend with will be gathered from the foregoing, and it remains to be seen from the results of the coming winter whether his labours and the care and forethought bestowed upon the work by the Telegraph Department will be justified ; and a reliable service maintained with this, the most outlying portion of Her Majesty's Indian dominions.

EXAMINATIONS: ARE THEY A MERE NECESSARY EVIL?*

BY SIR PHILIP MAGNUS.

Thirty years ago the value of examinations was scarcely questioned. As a means of testing knowledge they were regarded as practically infallible, and the preparation for passing was considered the best possible kind of discipline and training. The entire faith in the efficacy of examinations no longer exists, and now that more rational views prevail, we wonder, as so frequently happens, that we could have ever held so exaggerated a view of their importance. Yet it is but a very short time since the payments to teachers in our elementary schools depended on the results of the examination of individual pupils. The same system of remunerating science teachers of evening classes still exists, and among the unsettled questions in connection with the organisation of the new University of London the value of training *versus* examination holds a fôremost place. In a very recent speech in the House of Commons, Mr. Acland more than hinted that he would be glad to find, if possible, some subsitute for examination in much of the work of the Science and Art Department, and no one can doubt that examinations are now regarded by many persons of high authority more in the light of a necessary evil than as a valuable instrument of education and a sure means of testing ability or knowledge.

This is not the place for a full discussion of the general question of the purpose and value of examinations in a scheme of education. Such a discussion might have its uses, and perhaps the time has nearly come when a reasonable reply might be given to the vehement protest against examinations which appeared not long since in the pages of a monthly magazine, and which has cast some amount of discredit upon the entire system. But, although in a journal devoted mainly to technical education it might be unadvisable to consider the question in its broader aspects, it may not be out of place to say a few words on the uses and methods of those examinations with which technical students are most concerned.

A noteworthy fact is that, notwithstanding the disregard for examinations of some of the most distinguished scientific and educational authorities, they still appear to perform a very important function in all departments of educational work. We have been told *ad nauseam* that examinations encourage "cram," and that little or no reliance is to be placed upon the results, and, further, that whilst the very purpose of examination is to test acquired knowledge, the acquisition of knowledge is not the real aim of education. One of the advantages of this outcry against examinations is that our system of examining has been very much modified. But, although modified, it occupies a position of no less importance in the machinery of our education than before. The most recently formed educational body, possessing both influence and funds, is the Techical Education Board of the London County Council, and no other means have suggested themselves to this enlightened Board of awarding its junior and intermediate county scholarships than those of examination. Notwithstanding the weight of the arguments adduced by the opponents of examinations, our universities continue to give their degrees on the results of examination, appointments to the Indian and Home Civil Service, to the Army, and to other Government offices are made in the same way, prizes are similarly awarded at schools and colleges, and lawyers and accountants, bankers, architects, and plumbers are restricting admission to their ranks to those persons only who pass a preliminary, an intermediate, and a final examination. It is true that other means of selection have been in some cases, and certainly with advantage, substituted for what is commonly understood by examination. The University of London and other bodies confer their highest distinctions on persons who give evidence, through a thesis or otherwise, of having contributed to the advancement of some section of knowledge; but then the persons who are alone eligible for such distinctions must have already passed certain examinations by which their preliminary qualifications have been tested. At the other end of the educational machine, a system of inspection has been substituted almost exclusively for the examination of individual pupils. But in all grades of intermediate education, and, indeed, for testing qualifications of almost every kind, examinations continue—notwithstanding all the physical, intellectual, and moral evils which are supposed to follow from the preparatory training—to be the chief instrument employed. If we refer to the reports of various departments, annually published, we shall find the numbers of candidates for these examinations go on increasing, and new examinations are being constantly added to the list of those already existing. This is the case with the Examinations of the Science and Art Department, the Oxford and Cambridge Local Board, the University of London, and other bodies.

There can be no doubt that the criticism to which examinations have been subjected has done much to improve the methods by which they are conducted, and to remove some of the objections commonly brought against them. These improvements consist mainly in giving a wide choice of subjects and in the addition of practical tests. The one goes a long way towards meeting the objection that the examination too strictly controls the teaching, and the other helps very much to obviate the evil effects of so-called "cram." It must, however, be at once admitted that examination can, under no circumstances, be made a perfect instrument for selecting the best candidate for certificates, scholarships, or appointments. All that can be said is that no better way can be suggested, and that they can be made less harmful to the progress of real education than they are sometimes supposed to be; and, that in many cases they may become a most efficient means of stimulating careful and thoughtful training, and of generally raising the standard of instruction, and of improving the methods of teaching in any particular subject.

In treating of examinations generally, every person, by a well-known law of logic, founds his remarks upon some particular kind of examination he has in view. The varieties of examination are many. There are competitive and pass examinations; and the so-called evils of examination are admitted to apply less to the latter than to the former. Then too, it is generally recognised that the evils of examination result rather from the abuses to which the system is liable than from anything essentially objectionable in the principle itself. It is impossible in the limited space of a few articles to treat exhaustively of the different kinds and purposes of examination, or to consider in detail the nature of the mental or physical harm which the undue stimulus of examinations may occasionally produce. The persistence and spread of examinations as an instrument of education and a part of the machinery incidental to its organisation may, I think, be taken as an *à posteriori* argument that the advantages counterbalance the abuses; and, if we carefully consider the function of examinations and some of the purposes to which they are applied, we shall arrive *à priori* at the same conclusion.

We may assume that the stimulus of examinations is, on the whole, healthy. There is very little doubt the almost general cessation, in deference to public opinion, of corporal punishment in schools has been rendered possible through the substituted stimulus of examinations. It is quite true that school work has been made more interesting than it was in years gone by, and that the variety of subjects of instruction has given play to individual tastes and mental aptitudes. Nevertheless, in all good work there must be concentration of thought and attention, there must be the putting forth of effort to overcome increasing rather than diminishing difficulties, and some other motive must be found than a love of knowledge, which is in most young persons a feeble passion. This incentive to work is undoubtedly found in the desire to pass an examination which brings its own reward, in the shape of honour gained, or access to some profession or career. But for such examinations, children might be found willing to work at subjects which happened to please their passing fancy; but they would in most cases certainly shirk the pursuit of studies most necessary, as a means of mental discipline, and in laying the foundations of a broad and liberal education. Schoolmasters know the value of such examinations in directing into suitable channels, and in utilising to proper ends, the instinctive activities of their pupils; and, although we hear frequent complaints of the unnecessary multiplication of examinations, of the distraction due to the preparation for different pursuits, we seldom or ever hear school teachers express the desire to be altogether free from the trammels they are said to impose.

In Germany, and now in other countries, schoolmasters have an instrument for stimulating intellectual effort on the part of their pupils which is wanting in England—compulsory military service. No one who has not lived in Germany can realise the efforts which parents make to enable their boys to undergo the one year's instead of the three years' service. This difference depends entirely upon the standard of education of the young recruits. The incentive to work is immense. If the boy at school does not reach the necessary form, not only is he condemned to sacrifice three years of his life to unprofitable employment at the very period when he should be entering upon his apprenticeship, and to mix during that time with uncongenial companions, but socially he is placed in an altogether different category from those who serve for one year only. The influence of such regulations upon the education of the male population of Germany is scarcely realised in England.

Another advantage of the system of public examinations is that the syllabus serves to indicate the general lines to be pursued in the study of any particular subject. The direction thus given to different courses of studies is very often made the chief ground of the protest against examinations. We are told that the freedom of the teacher is interfered with, that he is unable to teach those subjects he knows best, or to which the bias of his mind inclines him, but such only as are prescribed by the examining body, and, further, that pupils and teachers decline to make any excursions outside the narrow path that leads to success at the examination.

From the *Technical World*.

Such complaints would not be made without some show of reason. There are undoubtedly many teachers, authorities of repute in the subject they profess to teach, who are unduly fettered by examination requirements, and are occasionally thereby impeded in their efforts to strike out a new plan or new method of instruction. On the other hand, whilst a few may be thus hindered, the majority are greatly helped by the guidance of the syllabus. It is not a good thing that every teacher should be trusted to try experiments on the pupils of his class, or be left to teach what may seem good to himself rather than what is good for his pupils. No subject is more discussed from all sides than the syllabus of an examination. The master minds and best authorities on the subject are consulted, and the influence which the syllabus is likely to have upon teaching is carefully considered. The persons charged with the preparation of such programmes of study are fully alive to their responsibilities. The scheme of examination may lag for a time behind the latest developments in any special branch of knowledge, but it is not long before the fact is discovered and the syllabus is revised. There are many channels through which teachers may make known their views, and they are not likely to be slow in doing so. Indeed, the preparation and revision of such schemes are necessarily left in the hands of teachers and experts of the highest rank, and the criticism of such schemes by other teachers—by those actively engaged in instructing the students to be examined, should be rather invited than avoided. But there is no surer way of indicating the best course of study to be pursued in learning any particular subject than by the publication of a syllabus of examination. If, at times, there is a disposition on the part of the authorities *quieta non movere*, a new examiner, by the questions he sets, very soon awakens teachers to the recognition of there being something wrong in their methods, and the revision of the programme follows. Much of the improved method of teaching geometry and chemistry in our schools is undoubtedly due to the change made in the character of the questions set by new examiners for the London matriculation. Some injustice on such occasions may have been done to a few candidates, although even to them it may have been an ultimate advantage to have been sent back for another year ; but new life has been by such means infused into the teaching in hundreds of schools, and thousands of pupils have benefited by it.

It is not the fault of the examination, but of the teacher, if the examination is too prominently brought before the eyes of his pupils as the end and object of their intellectual labour. The teacher may show due regard to the requirements of the examination without making success at the examination the one apparent purpose of his instruction. To study question papers in order to see the kind of questions an examiner is likely to ask, and to practice pupils merely in answering questions, is not teaching, but "cramming" in its worst aspect. But then the teachers who would so degrade instruction would discover some other device to avoid the labour of real teaching if the necessity of preparing candidates for examination did not exist. Working from a prearranged syllabus involves no such degradation of teaching. On the contrary, every teacher ought to think out carefully his course of lessons, and keep as strictly as possible to the prepared scheme. Whether he works from his own scheme, or generally in accordance with one prepared by others, is immaterial, provided only the sequence and subjects of the lessons have been approved by the most competent authorities as applicable to the class of pupils to be taught.

On the question of "cramming" one word must be said. It is so easy to cast obloquy by giving things bad names, that one is disposed at times to take up the cudgels in defence of the abused. There is a large amount of bad teaching fostered, it must be granted, by the examination system, which is rightly called "cramming," teaching which does not aim at intellectual training, nor tend to the development of the pupil's faculties. But there is also very much teaching, which is called "cramming," which is really methodised instruction—instruction which proceeds on logical principles, and develops in the pupil the power of orderly acquiring and arranging ideas, and of clear and concise expression. Apart altogether from the value of the actual knowledge acquired, the intellectual habits, which regular and systematic instruction directed towards a particular end engender in the young student, are a permanent possession, to which many a successful man is ever willing to acknowledge his indebtedness. Even the capacity of retaining in the memory, and of being able to present in the examination room a large amount of acquired knowledge, part of which cannot be expected to remain, is by no means without its uses ; and many a man in after life is thankful for the facility of thus acquiring, and even of thus forgetting, which the discipline of preparing for an examination may have created.

And this leads one to recognise the moral value of the steady work and long-sustained effort which preparation for an examination necessitates. Except to the very few, to whom the search after knowledge is in itself an end, and who take what is, after all, a selfish delight in learning, the inducements are many, which distract the young, in what position soever they may be placed, from the laborious studies which must be pursued to satisfy the requirements of the modern examiner. Can anyone doubt that the sustained effort to make a distant goal so regulate one's life that one abstains from various forms of pleasurable excitement, and renounces all sorts of gratifying amusements, while the mind is subjected to the stern discipline of hard thought, is calculated, altogether apart from the secondary influences created by the extension of one's range of knowledge and power of research, to permanently improve the character and to exercise a deep and lasting influence for good upon the moral fibres of one's nature ? Such incentives to prolonged effort are, of course, more needed in our youth than as age advances, and it is in this period of our life that the examination proves a useful motive force. It may be said, and is often said, that the thirst for knowledge should alone suffice. But it does not. Where men want knowledge for a particular and immediate use, they will spare no effort to obtain it. But the young do not always want the kind of knowledge imparted to them. Indeed, knowledge is not the primary end of education, but rather the intellectual and moral habits which the acquisition of such knowledge develops. The knowledge, too, is valuable, although its value may not always be perceived ; but the machinery of education is complex, and knowledge is by no means the only or the most important product. Now, examinations are serviceable by supplying an active motive for learning, and for learning such subjects, and by such methods as may be useful for the purposes of real education.

In the detailed work of instruction, examinations play an important part, which every good teacher at once recognises. Not only is the teacher himself able to judge of the success of his own endeavours by the examination of his pupils, but the effort of the student to express in words, or to explain to others what he thinks he knows, is in itself a very useful, if sometimes a disappointing, exercise. Now the examination, particularly the written examination, does serve to test the student's accuracy of knowledge of the subject. It shows him his weak points. It corrects his too often sanguine belief that he knows what he has learnt, because he seemed to understand it when it was explained to him. Such examinations as those to which I now refer, may be, and are generally, conducted by the teacher ; and, in order that they may yield their full educational value, it is important that the pupil's mistakes should be subsequently explained to him. Clearly, when thousands of candidates are examined by some external body, distinct from the teachers themselves, this subsequent explanation is difficult, if not impossible, and some part of the value of the examination is consequently lost. But the examination is nevertheless useful, and may be made still more so, both to the teachers and the taught, if supplemented by detailed reports from the examiners on the manner in which the several candidates have acquitted themselves. But the best means of supplementing the information which an independent examination affords is by means of a subsequent inspection of the entire working of the class, and on the relative importance of inspection it will be necessary to add a few remarks later.

The improvements which have gradually been introduced into the methods of examination, and which go far to remove the objection that they fetter the freedom of the teacher and encourage the mere exercise of memory, have consisted, as already stated, in widening the choice of subjects and of questions, and in testing the practical skill or ability of the candidate in addition to his acquired knowledge. One of the distinguishing features of examinations of late years has been the wide range of subjects covered, and the carefully considered groups of subjects from which students may select their questions. This is seen in most school and scholarship examinations, and has recently been recognised in the matriculation and degree examinations of the University of London. The Science and Art Department has carried the principle almost too far in allowing candidates, including school children, to present themselves in some one or more of different branches of knowledge, without reference to that grouping and combination of obligatory and optional subjects which encourage width of culture and systematic study, and give, at the same time, free play to the bent and bias of the student's mind. It has been the aim of the City and Guilds of London Institute to admit great variety into its examination questions, so as to leave each teacher free, within certain limits, to give instruction in accordance with the wants of his pupils or his own preferences, but to require at the same time a certain sequence of study and co-ordinated knowledge of the subject of examination. No arrangement of parts of a subject, as suggested by an external body, may be quite as satisfactory as that which the best teachers, if left to themselves, might adopt ; but, granting that examinations are useful as a discipline, and are an essential instrument in education, the system of offering a choice of groups of subjects, and of questions in each group, diminishes to a great extent the objectionable element in them, which arises from the alleged interference with the teacher's freedom.

The other improvement consists in the introduction of some sort of exercise which tests the student's skill or power of applying his acquired knowledge, rather than the strength of mere memory. In science examinations this exercise consists of work to be done in the chemical, physical, or biological laboratory; and it not only serves to test the candidate's ability to practically apply his knowledge, but enables also the examiner to ascertain that the candidate has received practical instruction. In technological examinations, exercises to be done in the workshop serve the same purpose. It is difficult to understand how the operation of "cram" can defeat the ends of examination when such tests are applied. It may happen, and in some science subjects it has happened, that candidates have been *drilled* into the performance of certain laboratory operations which it was expected the examiner would require. But it is the examiner's fault if he cannot sufficiently vary his requirements to render futile such attempts to deceive him. If, in order to satisfy the examiners, students have to show greater accuracy of work and more careful manipulation than would otherwise be needed, the practice involved must be set down to the good of examinations. The main difficulty in practical examinations is to make the conditions sufficiently similar for all candidates, and to secure time enough for the actual work. But these difficulties, which in various ways are more or less completely overcome, are incidental drawbacks, affecting only the amount of help which the teacher and student may derive from the discipline of examinations, but not altering the fact that such practical examinations are in themselves useful, and obviate almost entirely the evils of "cram."

In practical examinations the difficulty of time is a serious one, and it is a question worth carefully considering whether such examinations might not be extended over two or three days. The examiner's choice of exercises is certainly restricted by the necessity of giving such only as can be completed in a few hours. One way of enabling the examiner to know more of his candidates capabilities that can be ascertained from the results of the examination is to submit the record of their work in the class room, laboratory, or workshops, as shown in their notes of lessons. Another method is to allow the candidate to present a specimen of his best work, executed at his own leisure, without the hurry and excitement of a time examination. Both these methods are open to the objection, less serious than is often thought, that the candidate may have been assisted in his exercises or notes. But if even the practical test, with or without such additional safeguard, is not an infallible means of selecting the best candidates, it is sufficiently good for classifying candidates and judging of their general proficiency; and the gain to the student of being obliged to put forth in a given time his best efforts is a very real gain, helping him to see for himself his own weakness, and encouraging him to endeavour to achieve better results.

As in the case of written examinations, so in practical tests the exercises given to candidates serve to indicate the kind of laboratory work which students should practise, and to keep the teaching at a high level. It is found that guidance is quite as much needed in practical work as in oral lessons. Indeed, laboratory and workshop instruction is still in so experimental a stage that teachers need all the help they can get from the results of others' experience. Those who have carefully watched the action of examinations have seen how frequently it happens that examiners are able, by means of the questions and exercises they have set, to accelerate the introduction of new and improved methods of teaching, and to direct into fresh channels the thoughts and energies of teachers. It must not be supposed that examinations are useful only as a means of classifying pupils, and of selecting the most fitting for appointments, scholarships, and other prizes. In the hands of the best teachers, and controlled by the most competent authorities, they become, in many ways, a valuable instrument of education, serving to stimulate students to higher efforts, and rendering available, for the ordinary mass of teachers, the results of the labours and investigations of the best thinkers.

In the reaction which has followed the over-estimate that was formed some years since of the value of examinations, there is some fear than an exaggerated importance may come to be attached to inspection. Till very recently the system of inspection was restricted to elementary schools. Nearly all persons occupied in secondary education have entertained a very strong objection to State inspection. Their dread of Government interference was mainly due to the fear that any pecuniary assistance they might receive from the State would carry with it the right of the Education Department to inspect their work. This aversion to the inspector's visit did not result from any fear of honest criticism of their methods, nor from any consciousness of imperfections which they wished to conceal, but from a belief that the inspector would be clothed with an authority to which his qualifications would not entitle him, and that teachers would be subjected to unnecessary interference in their work. It must be admitted that a system of inspection of secondary schools might be carried so far as to justify this alarm on the part of teachers. Nevertheless, head masters are willing to admit the advantages of some kind of inspection as supplementing examinations; and in seeking the aid of the universities they have shown their appreciation of its value. There can be no doubt that inspection is a great aid to examination; but it cannot altogether, as some people think, take its place. Mr. Acland has signalised his connection with the Science and Art Department by the appointment of a number of specialists as science inspectors, and we may expect greatly improved results in the aims, methods, and appliances of science teaching through these appointments. But Mr. Acland is too profound and cautious an educationist to believe that the occasional visits of an inspector can take the place of the examination of individual students, which has hitherto been undertaken by the Science and Art Department. The inspection of classes may, and no doubt will, serve to prevent some of the abuses to which the system of mere examination, with its attendant grants of results, has been exposed. It will tend to secure more efficient teaching. It will enable teachers to profit by their mistakes by discovering the cause of the failure of their students in examination. It will bring home to the central authorities the deficiencies of schools in apparatus and teaching appliances. It will help to associate more closely practical work and lecture instruction, and will be the means of establishing a more intimate connection between the examinations and the teaching. All this and more he may expect from the inspection of classes; but it will not take the place of examination, nor would its value as a part of the machinery of education be comparable with that of examination if it were possible to substitute it.

No system of inspection, unless it includes the examination of individual students, can be trusted to adequately show the results of the teaching throughout the whole class, nor can it satisfy the public that due attention has been given to the weaker members of the class. In the inspection of classes the personality of the inspector may count for too much. In public examinations the peculiarities of the examiner have to be reckoned with; but the effect of this is toned down by the necessity of conforming to the syllabus—the product of many minds—and by associating together two examiners who should be jointly responsible in determining the results. Indeed, the functions of examination and inspection are distinct. The one has more immediate reference to individual students, and the other to groups of students. In the combination the value of each is best seen.

One of the most important facts in the theory of education is the recognition of the difference in degree of applicability of different methods to different grades and kinds of instruction. Taking *examination plus instruction* as an instrument of education, we find that the values of these two terms separately vary in the relation of the whole expression to elementary, secondary, and university education respectively, and even to the different kinds and degrees of secondary education. But, except in the case of very young children, teachers will continue to welcome the healthy stimulus of examinations, for which, so far, no suitable substitute has been found.

In these few pages I have not attempted to exhaust, nor even adequately to treat, the complicated question of examination in its relation to education. I have endeavoured only to show that examinations have a value of their own, and that they are necessary without being necessarily evil; but what I have been more desirous of showing is that the whole subject is deserving of very careful thought and consideration. Of this we may be assured, that the advantage which teachers may derive from the guidance and stimulus of examinations must be lessened by the distracting influence of competing systems of examinations; and that the good they do may be increased by bringing into ever-closer relation, by means of inspection or otherwise, those who examine and those who teach.

ON THE COMMERCIAL POSSIBILITIES OF ACCUMULATORS FOR TRAMCAR TRACTION, CONSIDERED AS A MUNICIPAL UNDERTAKING.*

BY ALFRED H. GIBBINGS.

When the subject of electric traction is seriously approached, the usual course of procedure and investigation is to consider the relative intrinsic merits of the different systems, apart from the very important question of the conditions under which the method is to be employed. Each of the three forms of electric traction—namely, the underground channel or conduit system, overhead wires or trolley system, and accumulators—has its own very able exponents in the technical press and elsewhere; but, unfortunately, the majority of the writers are themselves interested in the system which they advocate, and for this reason such Papers cannot be considered to have the same value as if the authors had been entirely disinterested experts. I am safe, perhaps, in admitting that the overhead wire or trolley system has proved a greater practical and financial success than either of the others. The recommendation to adopt accumulators which I ultimately submitted to the Corporation of Hull was based upon an entirely new departure, in the working out of which I have been very interested. My object in bringing the subject before your notice in this Paper is that my reasons and conclusions may be fully discussed, in the hope that a new light may be thrown upon municipal undertakings. I have come to the conclusion that the secret of success lies not so much in the adoption of any particular method of electric traction, however superior, as it does in enlisting and utilising services which other enterprises can be made to contribute. Separately, they may be only just paying their way; but, combined, it will probably become possible to make an exceptional success of both.

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* Abstract of a Paper read before the Northern Society of Electrical Engineers, December 10, 1894.

The basis on which I now propose to consider the subject of my Paper has for its essential feature the possibilities in economical management and working which are within the power of municipal corporations. I will now proceed to a short general analysis of the combination of refuse destruction, electric tramway service, and electric lighting on the low-tension system. It is now a generally admitted fact that, given modern improvements for the generation of steam, some power can be obtained from refuse destruction. The publication of Mr. Charles Jones's book on refuse destructors has thrown light upon a subject which has hitherto been neglected by engineers, while the popular articles by Mr. Thomas Thomlinson have brought new possibilities before the electrical engineer. To sum up the whole of the evidence contained in Mr. Jones's work, I find that out of 50 destructors at work, destroying from 3½ tons to 10 tons per cell, the power obtained varies from 5 H.P. to 7 H.P. per cell. This power has been generated under conditions for raising steam which have had to be, and will always have to be, modified and made compatible with the complete destruction of the refuse from a sanitary point of view. The question, therefore, arises, What is the best use to which this power may be put? Hitherto, it has found its solution for the most part in the working of mortar-mills and stone-breakers, or as a subsidiary power to an electric lighting station, possibly producing sufficient power for day-load purposes. These applications, however, while their advantages are not denied, do not use one-half of the available power for the simple reason that most destructors are in operation the whole of the 24 hours and the hot gases are at night perforce turned into a by-pass flue, and so far wasted. Under every scheme which is at present being tried there is as much power lost as utilised; but in the scheme to which I wish to draw your attention this evening the whole available power is laid under contribution day and night without intermission as far, of course, as the usual engineering considerations will allow.

In the town of Hull, about 250 tons of miscellaneous refuse are destroyed weekly. This is a small quantity compared with that of other provincial towns. A large portion is composed of dry shop refuse, such as paper, straw, wood, and ashes, while it is not an infrequent occurrence to have to destroy whole ship cargoes of condemned fruits, vegetables, and fish. From observations taken I am well within the mark in estimating that with the necessary alterations to the present destructor we could obtain a continuous power of 45 I.H.P. This 45 I.H.P. would give at least 40·5 E.H.P. at an efficiency of electrical machinery of only 90 per cent., or a continuous output of 400 amperes at 75 volts; for it must be borne in mind that under the scheme I am unfolding the electrical machinery would be designed to always work at full load. This arrangement would be amply sufficient to charge batteries of 25 cells, always keeping a certain number of batteries in parallel, according to the rate of charge. Of course, the number of batteries and their size would depend upon the size of car to be propelled, and I have already pointed out that the power at the destructor station can be supplied continuously for 24 hours. This would be equivalent to doubling the capacity of the plant, as the batteries charged during the night would meet the requirements of the tramcars for half the succeeding day. This power would charge a sufficient number of accumulators to run from about one-half to three-quarters of the trams, according to whether the service consisted of 12 or more trams in the hour on the different routes. The remaining portion could be conveniently and economically provided for by supplying another charging station with power from the machines at the central electric lighting station, which machines would be available for this purpose during the day or night, excepting only at the time of maximum demand.

I may mention a few of the disadvantages (and consequent expense) attendant upon many systems which do not occur with the use of accumulators: (1) irregular demands upon the generating plant, (2) greater wear and tear of the machinery, (3) capacity of generating plant must be equal to all possible demand upon it, (4) plant standing idle when cars are not running, (5) stringent requirements of the Board of Trade as to insulation and periodical tests, (6) greater original outlay of capital, (7) impossible to economically use the power which the electric lighting station might contribute during the day, (8) inability of the refuse destructor station to supply the whole of the power required, hence (9) necessity to erect independent central generating station to supply additional power required, (10) for reasons contained in (8) and (9), very little, if any, advantage in point of economical working would arise from the aid of the refuse destructor.

The foregoing list of disadvantages is serious enough; but, over and above all these, I may point out that the power from a refuse destructor when applied to an overhead or underground system would only complicate what is merely a simple scheme. In fact, it would be more economical to put down one complete generating plant for the tramcars, appropriating the destructor power to some other purpose, where, as I have already mentioned, the whole power obtainable, as calculated in horse-power hours, would be turned to more remunerative account. The most serious item to be considered is, after all, that of capital expenditure. A heavy original outlay runs away with so much of the profit in the case of municipalities in providing interest and sinking fund. Now, the capital expenditure, be it observed, for the complete equipment of accumulator cars is usually from 50 per cent. to 75 per cent. only of that required for the overhead cable system, according to the track mileage. If the accumulator system can be arranged and worked so that the entire depreciation of the accumulators can be written off per annum out of lower working costs than are possible with either of the other systems, then it is clear that traction by accumulators would be the most highly remunerative system of any form of traction yet devised.

I now proceed to consider a far more important matter—namely, the advantages arising from charging accumulators for electric traction by means of the available and otherwise idle plant at a low-tension electric lighting central station. These advantages are based upon the following fact: the cell charging can be stopped at the hour when the heavy lighting load comes on, and the full capacity of the plant can then be used for lighting purposes. This, at the first glance may, perhaps, appear a very small advantage; but its full significance consists in the fact that it provides a day load for the central electric lighting station. I have no need to here describe the *modus operandi*; suffice it to say that low-tension central stations are designed for charging accumulators, and by means of independent connections those machines not running in the day or night time could be employed in charging separate accumulators for the tramcar service. As the electric lighting load came on so the different machines would be transferred from the tramcar plant to the main switchboard and *vice versâ*. The question now is, What does this arrangement actually mean both to the tramcar and the electric lighting enterprises? The tramcar enterprise would benefit in many ways—viz.: (1) less capital would be required, not having to provide independent dynamos and engines; (2) there would be, of course, correspondingly less interest and sinking fund liabilities; (3) such expenditure as would fall under depreciation of plant, repairs, rents, rates and taxes, wages of boiler and engine attendants, &c., would be equitably divided between the electric lighting and the tramcar concerns; (4) the management of the tramcars whilst under the supervision of an official and staff would also be controlled by a separate committee which would act conjointly with the electric lighting committee. It must be quite clear, therefore, that co-operation must very largely reduce the working costs of a tramcar system. The cost per unit, whether we calculate per horse-power hour, per car mile, or on any other basis, must be greater where the whole cost of management and working has to be borne by the tramcar service alone than will be the case where by using the resources of the electric lighting plant handsome profits are made in what I may term "spare time." To what extent this co-operation might be developed it is difficult to say, but the fact that each enterprise would save considerable expense to the other is perfectly obvious.

With regard to the electric lighting concern, the acquisition of a substantial day load is of the utmost possible consequence. For the purposes of this Paper it will be better to assume that this department merely charges (as an electric lighting enterprise pure and simple) for the current which it can generate and sell. That is, I do not wish to complicate what I have to say by assuming any arrangement between the electric lighting and tramcar committees with regard to sharing the proportions of the costs under the various items common to both enterprises. It will be sufficient if we assume that: (1) the electric light committee retain their independent position, and make a definite charge per unit for all current supplied; (2) that this output is merely considered as a day load.

I will give actual figures from the working of the electric lighting station at Hull. These may be absolutely depended upon, as we weigh all coal, all ashes, and measure everything consumed. The units generated and delivered are checked in four ways: (1) by

Aron meters in the circuit from the dynamo to the switchboard, (2) by the working out of daily load curves taken from readings on the ammeters, (3) by Edmondson meter in the main omnibus bars between the switchboard and the several feeders, (4) by quarterly comparison of the consumers' meter readings. All these we find agree within a small percentage. Our lightest weekly output during this summer cost us 0·97d. per unit delivered (not generated), including coal at 14s. per ton, and oil, water, waste, and all stores. Our heaviest weekly output during this winter has cost us 0·60d. per unit for the same items. Now, with regard to the standing charges if we multiply the heaviest weekly output by 52, or, in other words, if we assume the maximum weekly output as the average weekly output, I find that the proportionate cost of the standing charges comes to 1·84d. per unit. Adding both these costs together—that is, the generating cost and the standing charges cost—we get: generating cost, 0·60d.; standing charges cost, 1·84d.; total, 2·44d. as the representative total cost per unit for one week, and I have no need to add that I only wish the figures were true for every week in the year. The maximum electrical power used during this model week was 450 for an average of three hours per day, or 9,450 electrical horse-power hours out of a possible 75,600. Now a minimum number of small cars—say 30, averaging 10 E.H.P. each—would give (neglecting charging losses) 300 E.H.P., which for 90 hours in the week is equivalent to 27,000 electrical horse-power hours, or an increased output of at least three times the usual quantity. As the power required by the tramcars would not vary with the season of the year, but would remain fairly constant, it is possible that this supply would form by far the largest factor of the output for some years. You will at once see my object in giving you these figures. The generating cost, of course, will remain the same—viz., 0·60d.—but the standing charges cost will be reduced to one-third, and the gross cost per unit becomes 1·21d. only for all current generated. This figure gives us a very high efficiency; in fact, the very highest efficiency which has ever been obtained from any electric lighting central station in the United Kingdom, or, I venture to say, anywhere in the world. This demonstrates clearly what the co-operation of accumulator cars will do for an electric lighting station, and it may be definitely stated that the combination guarantees a better load factor for every week throughout the year than is obtained by the highest weekly output of the electric lighting alone. It would mean that an enormous profit would accrue to the electric lighting business itself if only 3d. per unit were charged, and the first possibility which is immediately suggested is that of the great reduction which might be effected in the usual price per unit for current. But we must not forget that this possibility is essentially due to the creation of a magnificent day and night load. I am of opinion, therefore, that the standing charges rate should not be divided equally between the tramcar and the electric lighting concerns, but in the inverse ratio of their demand in units throughout the year. In thus charging the users of the electric light with the larger proportion of the standing costs, it would be possible to confer a still greater benefit on the traction enterprise by bringing the whole of its charges to within 1d. per unit. This price, which includes interest and sinking fund, capital, wages, and power, as far as the generating machinery is concerned, will be found to be a much lower figure than has ever been obtained with any system.

The foregoing arrangement does not necessitate that the traction accumulator cells should be charged at the electric lighting central station. The nearer the charging depot is to the central station so much the better, in order to avoid loss in transmission and outlay in cables, but it is not an indispensable condition. A special set of cables could readily be laid to any convenient spot. The system of low-tension supply will generally allow and admit of additional cables being easily laid to any point within the area of distribution. You will have observed that the arrangement therein suggested is essentially based upon those facts of which we as engineers are certain. I have endeavoured to entirely eliminate dubious or insufficiently tested possibilities, such as thermal storage, and I have avoided the unnecessary procedure of basing my proof upon comparisons of the working cost per car mile of the different systems, as such figures are generally misleading, and in most cases do not form any proof at all. Admitting and including the heavy depreciation of the accumulator plates, it has been my object to show how accumulator traction can be worked cheaper and more satisfactorily than the other two systems. Hence my ideas are placed before you rather in the abstract than in the concrete. With reference to my figures representing the power obtainable from our refuse destructor, or, for that matter, from any other refuse destructor, providing the requisite quantity of refuse is present, I merely wish to point out that Mr. Jones, of Ealing, estimates for the same number of cells, destroying the same quantity of refuse as at Hull, a continuous power of 50 I.H.P., while I have placed my figures at 45 I.H.P. The refuse at Hull is, in fact, of a drier and more combustible nature than that at Ealing, so that my estimate may be taken as well within the mark. I have had the advantage of seeing the Ealing destructor works, and my assertions, therefore, may be taken with every degree of assurance.

DISCUSSION.

Mr. MANVILLE: I must congratulate Mr. Gibbings on his excellent Paper. It has given me great pleasure in hearing it read, since it bears upon a subject of great interest to me, and I had the honour of escorting Mr. Gibbings and his Committee over the only tramway system worked on the principle advocated by Mr. Gibbings in the United Kingdom. I feel a very special interest in the subject, as I have for a long time been endeavouring to persuade various local authorities to put up destructor plants in connection with central lighting stations. As long ago as 1892 I placed a complete scheme of this nature before the Vestry of Shoreditch, who adopted the report, but, so far, have not carried it out. But I am pleased to say that since that time another important local authority, whom I am advising, has resolved to erect such plant, and I am, in fact, at present proceeding with the preparation of the plans and specifications for the carrying out of the work; and the scheme in question is almost directly similar to that referred to in Mr. Gibbings's Paper, since it provides not only for the erection of a large electric generation station in combination with a dust destructor for electric lighting purposes, but also I have specific instructions to arrange the generating station so that the current produced by it may be easily utilised for supplying the tramways. I cannot agree with Mr. Gibbings as to the evils he states would result from the use of separate boilers in a destructor, from the remainder of the boilers required to make up the full maximum load required by the station; for, in fact, in my opinion, there is no necessity for any boilers to be used, however large the load of the station, within wide limits, excepting those through which the hot gases from the destructor are passing; and in the scheme I have referred to I am arranging for the erection of four boilers, each capable of evaporating water for 250 H.P., or a total of 1,000 H.P. Each boiler is arranged with two large destructor cells, one on each side of it, and the flues from the destructor cells are so arranged that the gases pass underneath the tubes of the boilers immediately over the fire bars. Then, as at heavy load times, the gases from the destructor will be quite inadequate to raise the total amount of steam required, an extra amount of steam will be generated in the boilers by the addition of coal burnt on the firegrate of the boiler; thus, under these conditions, it will be seen that whilst all the gases from the destructor are used for the steam production to their fullest extent, the boilers can always be worked up to their full power by the burning of so much coal as will make up the difference. The fronts of the boilers and the fronts of the two furnaces accompanying them are so arranged on the same plan that they can all be attended to by the same body of stokers.

I will not, however, dwell on the destructor portion of the question raised in Mr. Gibbings' Paper, for, in the main, I am in hearty accord with him on the subject. I only regret, however, that he has taken for example a slow combustion destructor such as that used by Mr. Jones at Ealing as a typical furnace from which to generate steam. In such a furnace but a tithe of the power that might be realised is realised, and I have little hesitation in expressing the opinion that with the quantity of refuse to be disposed of in Hull, in place of 45 Mr. Gibbings might rely upon attaining 120 effective horse-power on the average. I am afraid that I must seriously join issue with Mr. Gibbings as to the economical use of what I may term locomotive accumulators for running tramway cars. I am actually running the only system of locomotive accumulator traction in use in this country, and, as you all know, experience in such a matter is worth a great deal of theory, and I can only tell you that with all the care that is used in running this system, that with all the economy that is practised, that with all the facilities at my disposal for inducing economical working, we have never yet been able to even make ends meet, although receiving very high receipts per car mile; and I feel I must say that if there is anything unsatisfactory in tramcar running it is the use of accumulators carried in tramcars themselves. The cost of running a tramway system in this manner under most circumstances is simply prohibitive. It is not, as I have often heard people say, the cost of the depreciation of the accumulator plates themselves. We have found that accumulator plates do not cost us more than 1¾d. per car mile, whereas our total cost of running exceeds 9d. per car mile; and if the expenditure directly due to the use of accumulators were eliminated from the system—that is to say, if the tramcars were run directly off conductors, overhead or underground, the cost would barely exceed 4½d. per car mile, so that if we add the cost of the renewal of the accumulator plates, 1¾d., to this 4½d., we get a total cost of 6¼d., and there still remains the large balance between this 6¼d. and, say, 9¼d. the actual cost of running, and this 3d. is absorbed in the extra cost of labour in handling the accumulators, cleaning them out, and so forth, and the extra depreciation of the car bodies due to the fumes from the accumulators, which therefore cost a great deal more to keep in repair than in a direct system. It must, therefore, be obvious to you all, that if you had your accumulator plates costing actually nothing in themselves, the cost of handling them and making good the damage they do would prohibitively raise the cost above that of other systems, and from these figures you will get a good idea of the insignificance of the fuel question as compared with the other question. We find, as a matter of fact, that we use as nearly as may be a Board of Trade unit generated in the generating station for every car mile run, and this Board of Trade unit does not cost more than 1·2d. to produce, and therefore the energy used costs less than half the extra expenses in handling the accumulators and repairing the cars. I fancy that this statement will clearly show you that we can hardly hope for satisfactory results from accumulators carried in the tramcars themselves, but I do not wish you to think for a moment that I am opposed to the use of accumulators in connection with a tramway system. On the contrary, I think they will become an integral part of every electric tramway system; but I would have them not carried in the tramcars themselves, but used in the station, in which position they will last very well, and the heavy extra expense of charging and handling, and the repairing of the car bodies, will disappear; and there will also be the advantage of reducing the size of engines and dynamos, so that they will be working at their most economical load all day long, the accumulators making up those big peaks in the loads that in big tramway systems occur for a few minutes only at a time, and the whole generating system will be worked on a more satisfactory basis than heretofore. Such a system as this has been erected by Messrs. Mather and Platt in the Isle of Man, and is the first exemplification of what I believe to be the most important step in promoting the spread of electric tramways. Then, as regards the combination of a tramway station with an electric light station, so as to place upon the latter that day load which will produce the marvellous decreased cost of current pointed out by Mr. Gibbings, surely these stationary accumulators will be at least applicable for this purpose as the locomotive accumulators. In connection with the Local Authority I have before mentioned, I have received instructions to lay out the electric lighting station in such a manner that the current it produces may be sold to the tramway company during 21 out of the 24 hours of the day to run their tramcars. It will be necessary for the tramway company to have a set of accumulators at their generating station large enough to run the whole of the tramway system during the time of heavy load in the electric light station; but during the whole of the day and greater portion of the night the output of the electric light station will be available for directly running the tramways and charging accumulators. The generating plant of the tramway company will then consist of two or three motor generators transforming the current supplied from the electric lighting station to one suitable for running the tramway. One or more of these motor generators will be used during the daytime for directly supplying current to the tramway conductors, and the other for charging the battery of accumulators; and when the time of day arrives when the lighting station must cut off its supply of current to the tramway station, then the accumulators will be used for running the whole system. In this way I think the heavy day load may be given to the central lighting station, which will achieve Mr. Gibbings' results, and at the same time the tramway system may be run as efficiently as would be possible under any circumstances. I notice Mr. Gibbings lays lays stress on the fact that a low tension system can be more advantageously employed in the central lighting station if power is to be provided for the running of the tramways. In this point also I cannot agree with him, and I think all of you know that an alternating-current motor with continuous-current generator attached would make an almost ideal motor generator when running in conjunction with accumulators from which the fields of the alternating-current motor might so easily be magnetised, and I must therefore maintain that an alternating system of supply would be equally applicable with a continuous system for use in this connection. I will not take up any more of your time beyond again congratulating Mr. Gibbings on having brought before our notice a subject than which none can be more important to central station engineers, comprising as it does a means of reducing the cost of current for electric lighting, so that in most cities it could be supplied at a cost certainly lower than gas.

Mr. **FERRANTI**: I have listened with the greatest possible interest to Mr. Gibbings' Paper, and more especially to that part of it which refers to the combined use of central supply stations for doing the ordinary lighting and charging of batteries for power purposes. The picture which Mr. Gibbings has drawn of the great advantages which may result from such an arrangement makes one feel quite pleased with the great economic possibilities in this direction, but on the other hand we have just heard that Mr. Manville has found it practically impossible to make ends meet upon a complete system of electrical traction by storage, and no matter how cheaply the current may be produced by the method which Mr. Gibbings has described, that it is impossible to do anything very satisfactory upon this plan. Apparently the cost of handling and maintaining the batteries comes to nearly as much per car mile as the total cost of working an overhead system, and therefore even if Mr. Gibbings got his electricity for nothing for charging the batteries, according to the information which we have had laid before us, it does not look as though it would be of any value. Of course, improvements will no doubt be made, but they will have to be very vital ones before this trouble can be got over. Assuming, however, that traction by batteries could be worked commercially if the batteries were charged by current cheaply obtained from the lighting station, you would then have to remember that the plant at the lighting station could only be relied upon for a short number of hours out of the 24, as you would have to leave sufficient margin for the continuous heavy load which is experienced on a few days in the winter of every year. If it were not for this difficulty no doubt the use of batteries for assisting ordinary supply stations would have been very largely gone in for, but practice appears to have shown that the cheapest thing which we are able to do up till now is to generate the electricity by dynamos as it is required.

Mr. **HOLROYD SMITH**: I may say that this is the first time in the whole of my experience, although I have been looking for it for a long time, that I have heard a straightforward expression with regard to the cost of working tramcars by means of accumulators. I have seen statement after statement put out to the world, which after falling into the hands of the public have created an impression not altogether reliable, but Mr. Manville has been very frank in giving us a few figures as to cost per car, &c., confirming, nay, even going beyond, the statements I have from time to time made, based on calculations and careful observation of what others have done; for I fully admit that in battery traction I have been content to profit by the experience of others. I have not wasted time and money on experiments that I felt sure could not yield economic results. If accumulators had shown any possibility of their being really better than the other systems I should have adopted them long ago. But there is one thing which I should like to protest against; namely (the hope has so far been father to the thought), that statements have gone out from interested experts in the electrical world that have been readily taken up by the outside world and have led tramway directors, town councillors, and others to suppose that batteries about the size of a hat were going to be placed under the seats of a car and drive it all day long, and this has got such a firm hold in the public mind that it has been a serious hindrance to the progress of electric traction.

Mr. **JOHN HESKETH** congratulated Mr. Gibbings on uttering what they believed to be the cry from all central stations: "For goodness' sake give us a day load; we want it, and, if we can get it by accumulators, let us get it; but, by all means, let us have a day load." Some people say, "at whatever cost." He thought that, taken on that view, the scheme proposed by Mr. Gibbings an excellent one; but, taking other circumstances into account, he was afraid he could not agree with him. He had had the pleasure of seeing one of the principal lines on the Continent worked on the accumulator system, and he at the time wondered how it was that, with accumulators of the certainly excellent type which they had, and with the skilled staff and every possible modern convenience, they should still make a loss; but he did not wonder long, for when he got to the station he found one large group of men attending to batteries, another group attending to repairs, and still another attending to cars, &c.; altogether, he should say there were about 100 men in the station at that time charging and attending to batteries, &c., for 20 cars. One had not to look far for additional expense, and he therefore did not agree that the running expenses in connection with the accumulator traction were in any way on the same lines as the direct system. Mr. Holroyd Smith, he believed, asked for some figures in reference to comparative capital costs, and he was pleased to be able to give these. He had got out schemes for running a line on the overhead, conduit, and accumulator systems, based on the same footing, and had found that the accumulator plant cost £5,000 more in capital outlay than the other two, and he therefore thought that the point raised by Mr. Gibbings was scarcely borne out.

Mr. **GIBBINGS**, in reply, mentioned that the system which he had set forth and advocated in his Paper was simply that which had appeared to him to be most advantageous to the town of Hull—that is to say, that he had found the conditions in Hull peculiarly suited to that particular kind of traction on account of the level roads and the situation of the Central Electric Lighting Station. He did not mean to say that very much profit would be likely to accrue to the tramway enterprise at the present time, but matters were certainly progressing in the direction of the improvement of accumulators; but the great advantage which would arise would be from the electric lighting enterprise, because the price could be so reduced that there would be a great many more people who would be induced to go in for the electric light. Of course, we have to decide every case on its own merits. He might mention that Mr. Manville misunderstood his remarks with regard to separate boilers. He did not mean different sets of boilers would have to be employed at the destructor station for the destruction of refuse and generating electrical energy respectively, but the boilers at the destructor station were distinct from those at the electric lighting station. With reference to the Birmingham Electric Tramway, this was the only instance in this country of accumulator traction on a larger scale, and they had, therefore, no other place with which a comparison could be made.

In reply to Mr. Ferranti, Mr. **GIBBINGS** said that he had already stated in the Paper that his remarks were rather in the abstract than in the concrete, and therefore the possibilities set forth in the Paper would, of course, only hold good where conditions and circumstances were favourable. To Mr. Hesketh's remarks as to the line which he saw on the Continent, while they did not have much bearing upon the combination suggested in the Paper, he would point out that Mr. Hesketh's observations were antithetical to the Rev. Laurence Sterne's, inasmuch as this was one of those things which they did *not* manage better in France than at Birmingham.

ANALYSIS OF ELECTROLYSED PIPES.[*]

BY JOSEPH RIGGE (OMAHA).

When, a few weeks ago, I was requested to analyse some electrolysed scraps of pipes which had been badly corroded under the action of the electric-trolley current, I had no idea of the extent of damage done to water pipes, gas pipes, and telephone cables. I determined, however, to give the subject all the attention at my command, and have come to the conclusion that we are confronted with a new destroyer of our service pipes which demands immediate attention and an efficient remedy. In the hopes of, perhaps, making a useful suggestion, I submit this analysis for consideration.

The State of the Case.—The difficulty does not arise from the alternating lighting plant, but from the direct railway motor system, in which the current leaves the generating dynamos at the power house, and by means of feeders is distributed to the trolley lines, carried down the trolley arm to the car-motors, where it does its work; then escapes by the wheels to the rails, by which it is expected to return to the generators. This would be the case if the rails presented the best home conductor. But the rails offer so much resistance at the joints that the current naturally passes through the damp earth to the water, gas, or cable pipes in the vicinity, and runs along these good metallic conductors until the rails again present an easier return to the home station. Where it leaves the pipes to pass back to the rails, the current keeps eating away the pipes, carrying away with it minute particles of metal. In a short time little holes mark the places where the electricity escapes. These grow larger and corrode the pipe, giving it the appearance of being "pox marked." The fact of the rapid corrosion of our underground iron and lead pipes along the route of the electric trolley cars is undeniable. In proof I refer to the ends of broken pipes in the office of our Board of Public Works. That electricity is jumping the rails to water and gss pipes and back to the track was abundantly evidenced by the volt and ammeter tests made by a party of competent electricians, to which the writer was kindly invited, on May 11th last.

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[*] From the *Gas World.* Abstract.

At the Nicholas-street power house the difference of the potential of the water pipe over the rails where they entered the station was from $3\frac{1}{4}$ to 6 volts, and the quantity going to waste 30 amperes, making No. 18 wire so hot that it could not be held in the hand, and driving a $\frac{1}{2}$ H.P. motor attached to the water plug. At the Custom House, on Sixteenth and Dodge-streets, enough current is leaving the street car rails for the water pipes and the moist foundation to corrode them before the building will be finished, and to fire the neighbouring buildings. Even on Capitol Hill, where the ground is dry, a current of from 4 to 9 amperes, at a voltage of from $1\frac{3}{4}$ to $3\frac{1}{2}$, works its way from the terminal rail to the water plug.

In some instances of pipe corrosion, a spot of greater or less extent is singled out by the current and weakened until it becomes detached like a chip. These electrolysed nodules are extremely light. Four samples examined by me gave a specific gravity of 2·36, 3·06, 1·88, 1·54; the latter resemble coke in weight and appearance. Bearing in mind that the specific gravity of cast-iron is 7·00, we may naturally inquire what has become of the iron, and what changes have taken place? This question was referred to me for solution. In order to follow the most rational method it occurred to me to subject these nodules to the same electrolytic action which they had undergone.

The Analysis.—We have under our streets an extensive plating battery in constant operation, of which the water pipes are presumed, in our case, to be positive, the rails negative, and the intervening moist earth the solution. Acting on this underlying principle of electrolysis, a nodule, upon which the trolley current had done its work, was weighed and suspended in dilute hydrochloric acid, while at a distance of a few inches was the pole, consisting of a platinum plate connected with the water pipe. On closing the circuit a flow of electricity could be seen passing from the iron nodule through the solution towards the platinum, carrying with it into the solution particles of iron, as could be seen by the decomposition of the solution into hydrogen and chlorine, the hydrogen escaping by the negative pole and chlorine combining with the free iron to form iron chloride. The liquid was occasionally renewed and tested for iron, till after five days it gave no further reaction with sulpho-cyanide of potassium, thus indicating that the nodule had no more iron to give. After drying it was weighed. The loss of weight was 56 per cent. Now, if the piece of electrolysed iron had lost all its iron, the solution of iron chloride had gained, and therefore should contain as much. This was actually the result, titration by potassium bichromate being the method employed.

The nodule deprived of its iron retained its former shape, but was extremely light and frail. It was, in fact, but the ghost of its former self. Was it carbon? Analysis gave 29 per cent. graphite, 13·37 per cent. silica, and 1·15 per cent. manganese, with traces of sulphur and phosphorus; hence the complete analysis of the electrolysed pieces of cast-iron pipe would be—

Iron	56·17	Specific gravity, 1·88
Graphite	29·00	
Manganese	1·15	
Silica	13·37	
Sulphur, phos.	—	
Total	99·71	

Compare with this the composition of a fair sample of (grey) cast-iron:—

Iron	90·58	Specific gravity, 7·00
Uncombined carbon graphite	3·70	
Silica	4·14	
Manganese	0·83	
Sulphur, phos.	small	
Total	99·25	

We can now readily understand how, under the action of electrolysis, our city service pipes have much of the iron, their backbone of strength, corroded away, leaving behind in its place a frail shell of graphite iron, incapable of sustaining even the ordinary pressure of the mains. That the above results appear to be warranted is confirmed by an analysis of the earth around the electrolysed parts. Several samples of earth were found to have gained as much iron as the pipe had lost.

It should be borne in mind that the above analysis is not intended to be a representative one of all similar spots of corrosion. Three other samples examined gave varying percentages of iron and graphite, one being so very light, unctuous to the touch, incombustible, and of such greyish black metallic lustre that I would almost call it pure graphite. It was a good conductor of electricity, burned like the carbon of an electric lamp, marked paper like a soft lead pencil, and coated a platinum dish with unctuous black of stove polish. All the other samples marked paper like black lead, and had more or less of the preceding proportions.

But the question, Where does the excess of carbon come from? is not so easy of solution. The fact that the samples of corroded pipes in the City Engineer's office are corroded in particular places may be owing to defects in the casting. As these contain more carbon, the current singles them out for electrolysis.

Of the corroded lead cables I have not seen any samples, but from the description given they would appear to be simple cases of lead corrosion occurring in the presence of air and moisture, and possibly decaying substances, such as manure, the electric current furnishing the warmth. The result is white lead incrustation.

What is the Remedy?—1. It has been suggested frequently to reverse the trolley current. That would no doubt remove the evil, if it were safe and possible.

2. It was proposed, and I think has been tried here, that the insulation of underground pipes and cables might be sufficient. That is impracticable. Where there is electrolysis there is leakage.

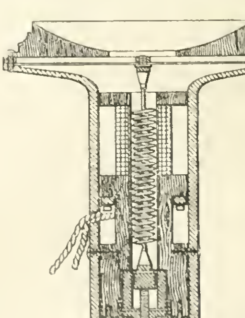
3. The only practical way which suggests itself to me is to keep the current in the rails by electrically welding the rails together all along the line, and to each other, thus preparing an unobstructed broad metallic conductor for the homing current. This is being done in Brooklyn.

The next best method would be to band the rails securely to each other with a 1in. copper wire. A cross-band of the same thickness should connect the two lines of rails every 100ft., wherever the earth is sufficiently moist to render an escape to the pipes probable. In addition it is very necessary to have a heavy metallic connection between the return rail and back to the generators. If, besides, in the danger district, the rails are connected at frequent intervals with all pipes and cables along the track, there is every reason to expect an abeyance of the evil. Wherever this plan has been tried it is pronounced successful.

As we cannot, however, force the current to take one path exclusively when others are open to it, and as $\frac{1}{100}$th of a volt difference of potential between the pipes and the damp earth surrounding them has been found sufficient to induce electrolysis, I would suggest that frequent voltage measurements should be made all over the line, even after some plan has been adopted, and that such changes in the return conductors be made as the measurements may indicate.

THE OHNESORGE TELEPHONE.

Herr W. Ohnesorge, of Frankfort, has recently introduced a telephone presenting some novel features. Telephones with wire cores have hitherto been distinguished for their precise working, but have had the disadvantage of rendering sounds very faintly.



Herr Ohnesorge discovered that if the spiral iron wire forming the core project from the coil by a certain amount, the strength of the sound is increased in a manner quite out of proportion to the difference in position. The discovery is utilised in the instrument, of which the annexed cut shows the details.

The spiral spring forming the core is of steel or iron wire, thoroughly hardened, and with the turns just so far apart as not to touch. This spring is of such a size as to permit free movement inside the tube of the bobbin without touching the sides, and is made of wire 1mm. in diameter. The one end is fastened to a sounding board in front of the telephone, while the back end, projecting behind the coil by about the length of the latter, is fastened to an adjustment screw, which regulates the tension on the spring.

Such an instrument speaks loudly and clearly, and renders song or musical tones perfectly. Steel wire speaks less loudly than hardened iron wire, and magnetising the spring also increases the volume of sound; the latter course is necessary if the instrument is to be used as a transmitter. It is found that if in the centre of the spring, or at several equidistant points the adjacent turns are more widely separated than the average, the sound is also increased, and the spring appears to oscillate sideways as well as longitudinally; and the same effect is produced by putting the spring skewed in the coil. The telephone is very simple, cheap, and easily regulated.

CORRESPONDENCE.

REFINED APPARATUS AS AN INSTRUMENT OF SCIENTIFIC EDUCATION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The discussion on Prof. Ayrton's paper on "A Student's Experiment and its Teaching," which appeared in your columns last week, raises the vexed question of technical education with all its side issues, and these latter seem to have drawn the attention of the speakers from the main object of "education," which is primarily the general mental development of the student, and not the fitting him for any particular branch of scientific work.

Now, in the development of the body, while not disheartening the learner by giving him tasks beyond his muscular strength and acquired skill, the trainer does not encourage him in a false estimate of his powers by setting him feats which require an undue amount of assistance in their performance. It is just this undue assistance which is given by highly-finished apparatus, and, therefore, while the advanced student—who is well aware how much help he is receiving—may benefit from the use of appliances which mechanically minimise the difficulties of the experiment, it is extremely doubtful whether the beginner does not gain more by performing (unaided by such appliances) experiments which yield less scientifically accurate results, but require more mental effort on his part. A little manly enthusiasm for his work, and courage gained from difficulties overcome, are worth more as a start in life than much acquaintance with refined apparatus, and these are just the qualities which can only be inspired by the personality and example of the teacher.—Yours, &c.,

G. H. Robertson.

30, Hemstall-road, West Hampstead, N.W.

"NEW FORM OF POLARISED RELAY."

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In justice to Mr. Ebel, will you kindly permit me to explain that I have taken the earliest opportunity of examining the specification of his patent, and find, with the exception of a few minor details, that the two instruments are, in principle, identical. This affords another example of similar conclusions from separate and independent experiment. My only surprise is that such a useful and simple instrument is not more widely known.—Yours, &c.,

T. H. Lloyd.

THE COUNCIL OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Mr. Langdon's letter on this subject is, of course, strictly accurate; but it does not deal with the issue at all. Not only Mr. Leonard, but all the other members of our small Committee, made it clearly understood that we were acting in our individual capacity, and were in no way "delegated" by any larger bodies. Indeed, except in the case of the railway telegraph engineers, who appear to have a council of their own, there is no organisation which would give us the authority of delegates, but the Committee was certainly *representative*, and that was all we claimed for it. It is hardly gracious of Mr. Langdon to cast reproaches on the bridge which carried him over, for he may be very sure that but for the Committee and the strong support it received from all quarters, the Council would have had no thought of admitting a railway representative to the high honour which Mr. Langdon now so worthily holds. As a matter of fact this question was taken up more keenly and heartily by railway telegraph engineers in all parts of the country than by any other class, and even within the last fortnight we have received more letters and offers of continued support from these gentlemen than from all the other sections put together.

I fear that Mr. Langdon has missed the point of my letter (my fault, no doubt), and he as certainly missed the *raison d'être* of our Committee. We did not aspire to the functions of dictators, nor did we expect to "nominate" members to the Council, and no such suggestion ever came from the ever-courteous Secretary of the Institution. Our Committee was formed to draw attention to the neglect of cable, railway and telephone interests, to obtain the inclusion on the Council of representatives of these branches of the profession, and, if possible, to obtain a change in the permanent composition of the Council. The Council did us the honour of asking our views as to suitable members to represent these interests; but that was an act of courtesy on their part, and quite unexpected on our part.

Unfortunately, cable members and associates of the Institution are at a great disadvantage. Numerically strong, they are not only unorganised, but from the fact of their distribution all over the world they are hardly capable of organisation, and few have any voting powers at all. We are greatly in need of some society like the Council of Railway Telegraph Engineers, and anyone who can suggest a workable plan to this end would confer a benefit on us.

In the meantime this question may rest in peace, but when next year's election comes round members who sympathise with our views would do well to hold their voting papers until they know whether any action can be taken to further the interests we have at heart.—Yours, &c. J. T. Crowe.

IRON LOSSES IN TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your Note you attempt to justify your insulting remarks about "alternate-current experts" by pointing out that "most of the statements in your abused Note have been literally fulfilled."

As the statements were clearly ironical, literal fulfilment is exactly what ought not to be put forward as justifying them.

Probably your disingenuous course was the only alternative to a frank apology.

Kindly publish this letter as a further protest.—Yours truly, W. M. Mordey.

London, December 26, 1894.

[Mr. Mordey also writes us as follows:—"I have just noticed that there is a printer's error in the article published on Friday. In the fifth conclusion 'not' is omitted. It should read, 'When the iron is *not* allowed.' I did not notice it in the proof. You will find in my original that the word was inserted. Kindly insert a correction in next issue."]

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I wish to endorse the protest raised by Mr. Mordey to your editorial references to "transformer makers and alternate-current experts." I think your remarks entirely uncalled for, especially seeing that the subject matter in question was the work of an "alternating-current expert."

The communications since received show how entirely unjustifiable your remarks were, and support the protest more strongly than anything I can write.—Yours, &c.,

London. Charles P. Sparks.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices :—*

The 1894 Edition of "The Electrician" Electrical Trades' Directory and Handbook contains 1,000 closely-printed pages, and several new and useful features have been added. The price of this edition of the Directory and Handbook is now 4s. post free; abroad 5s. **The 1895 edition is in active preparation**, and subscription and advertisement orders should now be sent in.

Laboratory Notes and Forms.—With the above title, we have in the press a set of Elementary (now ready) and Advanced Exercises (ready shortly) for use in Electrical Engineering classes. These have been prepared in Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is just out, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"The Work of Hertz."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. net., is now ready.

"Electrical Engineering Formulæ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready ; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"Electromagnetic Theory" (Vol. I., second issue), by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application. Vol. II. is in preparation.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready ; price 7s. 6d. (abroad 8s.). Prospectus on application.

"Drum Armatures and Commutators."—By Mr. F. Marten Weymouth, is also ready ; price 7s. 6d. (abroad 8s.). Prospectus on application.

Tenders Received.—The Electric Lighting Committee of the Coventry City Council have received tenders for electricity meters from the Westinghouse Company, General Electric Company, Mr. C. A. Müller, the Electric Construction Company, Messrs. Chamberlain and Hookham, and the British Thomson-Houston Company. The tenders have been referred to Mr. Hammond for report.

Appointments Vacant.—The electricity department of the Vestry of St. Pancras require an assistant engineer at the Regent's Park central station at a salary of £3 per week. Some particulars are given in our advertisement columns, and applications have to be sent in to Mr. Albert E. Pycraft, chief clerk, Electricity and Public Lighting Department, the Vestry Hall, St. Pancras, London, N.W.

——— The Committee of University College, Nottingham, invite applications for the post of Junior Demonstrator and Lecturer in Physics, at a salary of £120 per annum. Further particulars can be obtained of the secretary, to whom applications must be sent not later than January 11th.

——— A leading electricity supply company requires an engineering assistant. Some particulars will be found in our advertisement columns.

——— The Postal Telegraph Department at British Guiana require an assistant electrician. Applicants must fulfil the conditions set out in an advertisement elsewhere. The salary is £300 per annum with travelling expenses. Applications have to be sent in to Mr. W. H. Preece at the General Post Office up to January 7th.

Death.—Mr. Thomas Ide, of the firm of T. and W. Ide, the well-known glass manufacturers, of Glasshouse Fields, Ratcliff, E., died at Hope Lodge, South Woodford, on Friday last week, aged 62.

Bankruptcy.—Claims against the estate of Messrs. Austin and Myers, manufacturing electricians, of 7, Florence-terrace, Armley, Leeds, must be sent in to Mr. J. Bowling, Official Receiver, Leeds, by January 5th.

Liquidations.—It is announced that in order to carry out the provisions of the previous scheme for the reconstruction of the "Medical Battery Company (Limited)," which is the latest phase of the Harness Belt concern, creditors are required to prove their debts by January 15th. Proofs have to be sent in to Mr. C. J. Stewart, senior, Official Receiver and Liquidator, 33, Carey-street, Lincoln's Inn, W.C.

The "Commercial's" Third Atlantic Cable.—When the cable steamer "Faraday" left Messrs. Siemens Brothers and Co.'s works off Woolwich with the Commercial Company's third Atlantic cable on board, included in her equipment was an up-to-date special correspondent, and this gentleman has written an interesting account of the laying of the cable, copies of which the Company will be pleased to supply. The "Faraday's" progress is neatly illustrated by a series of process blocks.

The Crypto Works Company.—This well-known firm of cycle makers have turned their attention to the manufacture of electric motors. They have issued a price list of motors from 10 h.p. down to the very smallest. These motors, which are offered to the trade only, are wound for 60 and for 105 volts. Alternate-current motors, starting resistances, small dynamos, hand and foot driving gear, and hand-fed arc lamps are illustrated and described in this well got-up list.

Catalogues.—We have received two pamphlet catalogues of the electrical and mechanical plant and apparatus dealt in by Messrs. Cadiot and Co., of 44, Rue Taitbout, Paris. The larger of the catalogues comprises some 44 pages, and is profusely illustrated with almost every kind of small motor and engine, including electromotors, oil, gas, steam and hot-air engines, turbines and windmills. The supply of very small motors is a speciality with this firm. The second catalogue gives a description of the firm's electrical fittings and appliances. Tables of prices are appended to both catalogues.

Calendars.—The Direct Spanish Telegraph Company send us a handsome hanging pad calendar with tear-off day-by-day sheets. The design is pictorial—and Spanish.

Barry Dock.—Included in extensions now in course of construction by the Barry Railway Company the Directors invite tenders for the construction of a new railway, about one mile in length, across Barry harbour.

Brighton.—The report of the Lighting Committee in connection with the considerable extension about to be introduced in the electric lighting of Brighton was not allowed to pass at the last meeting of the Council without a final shot from those who, from some unexplained cause, are against the extension. Mr. Councillor Wishart hoped the "horrible light" would not be adopted for their narrow streets, and further expressed the opinion that "the light was totally unfit for business purposes." Mr. Councillor White hoped that "if the light was to be put on the Marine Parade the Council would light the road instead of the heavens." Mr. Alderman Reeves proposed that the matter should be discussed that day six months, and Mr. Councillor Broadbridge recommended the Committee to wait another twelve months. As a set-off against this opposition, the Committee, which is composed of gentlemen with a large interest in the prosperity of the town, think the time has come when the ratepayers should receive the benefits to be gained by the streets being better lighted. Mr. Councillor Stafford believes that the present scheme of extension is only the beginning of a much larger scheme, and that the time is coming when the price to be charged for electric current will be so low as to make it obtainable for every street, alley and passage in Brighton. Already some discontent is felt that the Committee's scheme does not embrace a larger lighting area.

Church Lighting.—The venerable parish church of Eastbourne has now been completely installed for the electric light, 75 lights being used. The work has been carried out by the Eastbourne Electric Light Company.

Country House Lighting.—On the occasion of a ball given at Wynyard Park, in honour of the *début* of Lady Helen Stewart, a brilliant display of the electric light was given. The ordinary installation at the Hall consists of about 1,200 incandescents, and this was supplemented by a very considerable number of incandescent and arc lamps.——The residence of Mr. E. Pike, at Queen's-road, Southport, has recently been fitted for the electric light by Messrs. Patterson and Harford. The generating plant is erected in an outhouse at the rear of the premises, and is driven by the latest type Crossley gas engine. Included in the plant is a battery of E.P.S. K type cells. About 170 incandescents are used.

Dewsbury.—At the last meeting of the Town Council the minutes of the Gas and Lighting Committee were approved. These minutes include details of appointments made at the electric lighting station, the order for six additional arc lamps and pillars from Messrs. Crompton and Co. at £23 per lamp, and a further extension of electric lighting mains for Bradford-road.

Electric Bait for Deep-Sea Fishing.—With the title "Results des Campagnes Scientifiques," the Prince of Monaco is shortly publishing in Paris an account of his own and his co-labourers' discoveries while at sea in his yacht during the past five years. One of the attractions of the book will be the description of the apparatus employed by the Prince in order to lure the denizens of the deep into captivity. This apparatus is Prince Albert's own invention, and is modelled after the lobster trays used on the coast of Italy and the South of France. It is constructed of wire netting and iron in such a manner as to readily entice the fish to enter, but with special devices to prevent their getting out. The electric lamp hanging from the top of the apparatus proves a powerful fascination for the fish. Current for the light is supplied by "Bunsen" cells.

Electric Organs.—Worcester Cathedral is to be provided with a new and very powerful organ, to which Mr. Hope-Jones will adapt his method of tone production by electricity. The cost of the instrument is to be £3,000.

Exhibition.—It is intended to hold an electrical and inventions exhibition on a small scale at Salisbury about the end of January. No charge is to be made for space, but a commission is to be charged on all goods sold.

Glasgow.—The handsome building erected on the site of the Athenæum in Ingram-street for the Glasgow Post Office work is now complete. The whole of the top suite of rooms and offices are to be used for the Telegraph Department. The building is lighted throughout by electricity, from plans and estimates prepared by Mr. W. H. Preece. The generating plant is erected in the basement of the new block, and consists of three 80-I.H.P. Willans engines and Crompton dynamos. The boilers are Lancashire type, and have been supplied by Messrs. Penman and Co., Strathclyde-street, Glasgow. These are fitted with Vicars stokers. The wiring of the building and the supply of lamps and fittings have been carried out by Messrs. D. and G. Graham. The installation includes 500 16-c.p., 40 25-c.p., 23 32-c.p., and five 200-c.p. incandescents and 58 arcs. New plant has been provided for the pneumatic tube tube service, and the engines for this part of the work have been supplied by Messrs. Davey, Paxman and Co. The work has been carried out under the supervision of Mr. E. Ashton, superintendent of telegraphs for the western district of Scotland.

Hampstead.—Many of the leading tradesmen in this district are now being supplied with electric current for lighting purposes, the mains having now been laid as far as Gayton-road. The light is attracting much attention, and the tradesmen who have fitted their premises are reaping the benefit of their enterprise.

Harrow.—As a result of the recent discussion of the Local Board's electric lighting scheme, and after further consideration, it has been resolved to transfer the Provisional Order granted some time back to the local authorities over to Messrs. Crompton and Hawtayne, the Board to receive its expenses in obtaining the Order. The terms upon which the Order has been taken over is the payment to the Board of £300 and an agreement to sell the plant and business to the Board after seven years, if that body then decide to light the town themselves. It is considered probable that the new Council will accept the offer now made.

Leeds.—The form of agreement between the Yorkshire House-to-House Company and the Leeds City Council for the supply of electric current to the Town Hall and municipal offices was at the last meeting of the Council discussed, and in order that some minor points should be settled, was referred back for further consideration. It was also decided to discontinue the use of arc lamps round the Town Hall.——A Bill deposited at the Private Bill Office on behalf of the Corporation provides for the construction of further tramways, the motive power being "either animal, steam, or other mechanical power, including electricity." The Bill contains particulars of eight contemplated lines, all of which are being laid as double lines, and the period of their completion is five years from the passing of the Act. The Corporation asks for powers to borrow for these works and for relaying the existing tramways £213,000.

Maidstone.—Notice has been given by a member of the Urban District Council that at the next meeting he will propose that the electric lighting Order obtained by the Council shall be put up for tender. The mover (Mr. Morling) contends that the town should have the benefit of the money which has been spent in obtaining the Order.

Presentations.—Mr. A. B. Blackburn, chief engineer to the Electric Construction Company, Wolverhampton, presided last week at a gathering at which presentations were made to Mr. R. Johnston, chief of the office staff, on the occasion of his marriage. A concert followed, at which a large number of the Company's staff were present.——The former employés of the Brighton and Hove Electric Light Company, a concern whose business has now been taken over by the Brighton Corporation, presented the late secretary and general manager, Mr G. S. Hawes, with an illuminated address, marble clock, &c., at Brighton last week.

The Stage.—An effective display, in which the electric light takes a leading part, is to be seen at several of the leading London music halls, in which the Leamy Troupe give a most artistic exhibition, aided by clever mechanism and illustrated by the electric light. After some preliminary trapeze work, the three performers mount a revolving trapeze, on which two of the artistes circle round with ever-changing pose. "All of a sudden electricity flashes forth from innumerable coloured bulbs, and bicyclists and bicycle wheels are enveloped in electric light. The main frame of the revolving apparatus is suspended from the roof, and is surmounted by a bicycle. Within this frame revolves a square, the under bars of which support the two trapezes upon which the troupe perform." The movement of the pedals completes the circuit, and current is supplied to the lamps. The apparatus is the invention of Mr. Leamy, and the performance is attracting much attention in music-hall circles.

Swansea.—A scheme for providing a metallurgical school for the borough of Swansea has been under consideration by the County Council, and an application has been made for a Government grant of £5,000 towards the scheme.

Ulverstone.—A discussion took place at the last meeting of the Rural Sanitary Authority as to the application made by the Windermere and District Electricity Supply Company for the consent of the Authority to the Company's application for power to light the district by electricity. The Electric Lighting Sub-Committee reported that a meeting had been held and the Company had been requested to formulate the offers made to each authority in the district as to the terms upon which the Company were prepared to supply current, and the Committee had resolved that the new District Councils be advised to appoint committees to receive and consider these terms. The Committee recognised the importance of the negotiations, and regretted that the constitution of the new local authorities will much increase the difficulties of dealing with the matter, which must be settled before the meeting of Parliament.

Worcester.—The Watch Committee at their meeting this week discussed the question of lighting some of the leading thoroughfares electrically, and the estimate prepared by the City Engineer showed that the electric lighting of Stanley-road, Vincent-road, and Cecil-road would cost £460, this sum including 11 street lamps. The amount at present paid to the gas company for lighting the streets is £24. 4s. per annum. As the mains will pass near the workhouse it is probable that the new Board of Guardians will agree to light the building by electricity, and it was, therefore, decided to defer further consideration of the matter for the present.

Smoking Concert.—The City Athletic Club, which is associated with the staff of the City of London Electric Lighting Company, will hold a smoking concert at the "Falstaff," Philpot-lane, Eastcheap, on Friday, January 11th, at 7:30 p.m. An excellent programme is provided.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

November 24, 1894.

22,827. J. Brock, A. E. Wareing, and F. Hurter. London. Improvements in and relating to the treatment of solutions of chloride of zinc for the purification thereof for electrolytic purposes.

22,842. J. Lorwa and P. Feys. London. Improvements in automatic circuit breaks for electric currents.

November 26, 1894.

22,856. H. C. Haycraft. London. Instruments for measuring the frequency of alternating or periodically varying electrical currents.

22,880. R. M. Trille. Jersey. Electric arc lamps.

22,883. G. Binswanger and E. Stanley. London. Improvements in electrical measuring instruments.

22,890. A. Taylor. London. Improvements in apparatus for the manipulation of electric or limelight boxes, scenes, curtains, and wings operated by electric current.

22,918. T. B. Grant. London. An improved form of gas or electrically-heated iron.

22,919. T. B. Grant. London. An electrically-driven hydro-extractor.

November 27, 1894.

22,965. W. P. Thompson. Liverpool. Improvements in, or relating to, electrically heating metal or other conducting bodies, or welding metals electrically. (Charles Lewis Coffin, United States.)*

22,966. W. P. Thompson. Liverpool. Improvements in, or relating to, the production of compounds applicable for such uses as for paints for electric insulating and waterproofing as substitutes for vulcanisable rubber and gum compounds, and for other purposes. (William Griscom, junr., United States.)*

22,973. C. S. W.-Brown. London. Improvements in, and relating to, storage batteries.

22,985. E. Oldenbourg. London. Improvement in the means of fastening to incandescent electric or other lamps and globes any shade or ray diffuser.

23,012. H. E. Walter. London. Electric signalling systems.*

November 28, 1894.

23,083. J. T. Thompson and A. Slatter. London. Electrical and mechanical appliances for abstracting shives, &c., from casks and other vessels and examining them inside.

23,086. R. Kennedy. London. Improved electric traction system and apparatus therefor.

23,098. W. K. Partington. London. Improvements in the feed regulating mechanism of electric arc lamps.

23,099. W. S. Cottis. London. An insulator to prevent vibration or humming, and also loss of current or insulation by atmospheric leakage caused by spiders and the like web spinning under flange or shed.

23,117. L. P. Hulin. London. An improved electrolytic process and apparatus for obtaining rich alloys of the metals of the alkalies or alkali earths and the production of halogen. (Date applied for under Patents, &c., Act, 1883, Sec. 103, May 5, 1894, being date of application in France.)

November 29, 1894.

23,159. E. L. Levetus. Birmingham. Improvements in and relating to electric brushes, and such like.

23,160. E. L. Levetus. Birmingham. Improvements in and relating to primary batteries, and such like.

23,177. A. G. New and A. J. Mayne. London. Improvements in dynamos.

23,198. L. P. Hulin. London. Process for the treatment of certain metallic alloys for the manufacture of elements for voltaic batteries and caustic alkalies, or other derivatives. (Date applied for under Patents, &c., Act, 1883. Sec. 103, May 7, 1894, being the date of application in France.)

23,203. W. T. Burbey. London. Improvements in the application of springs for electrical switches, and other purposes.

November 30, 1894.

23,219. G. M. Harris. Bray. Improvements in the method of fixing electric arc lamps with special referance to ease and safety for adjustment trimming, &c.

23,250. E. S. d'Odiardi and Eva S. d'Odiardi. London. Improvements in gauges of electric exhaustion, positive and negative, caused by surroundings, buildings, or atmosphere.

23,279. F. King. London. Improvements in electrically-propelled carriages for common roads.

December 1, 1894.

23,294. E. Grahame. London. An improved electrical lamp.

23,297. N. Van der Stein and A. Schnellen. London. Improvement in and relating to an apparatus and a method for causing chemical changes of gases and mixtures of gases by dark electric discharges.

23,354. E. J. Preston, of firm of J. Stone and Co., and A. B. Gill. London. Improvements in and connected with the electric lighting and heating and also the ventilation of railway carriages and other vehicles.

December 3, 1894.

23,398. R. M. McDonald and A. McDonald. Glasgow. Improvements connected with electric batteries.

23,441. J. C. Fuller and G. Fuller. London. Improvements in and connected with galvanic batteries.*

23,444. A. Mantel Rieter and E. Meyer. London. Improvements in or relating to targets and electrical indicators therefor.*

23,472. C. Adams-Randall. London. Improvements in telephony and apparatus connected therewith.

December 4, 1894.

23,480. J. J. Pye. London. A combined mat and electric alarum contact.

23,485. F. L. Berner and F. Griffin. London. Improvements in or relating to secondary batteries or accumulators.

23,494. S. P. Thompson. London. Electric alternate current quasi-polarised relays, indicators, and cut-outs.

23,505. J. Macfarlane. Glasgow. Improvements in electric light fittings.

23,510. A. Dalziel. Glasgow. Burglar-proof electric fastener and combination lock.

23,525. C. P. Ehmann. Manchester. Improvements in or applicable to electric switches.

23,529. G. Lyon and H. Bevis. London. Improvements in connections for electric lighting and power.

23,553. L. Wagner and J. Marr. London. Improvements in apparatus for the electrical treatment of beer or other liquid or material.

23,565. A. Bergthiel and R. A. Marples. London. Improvements in apparatus for transmitting and controlling work from an electromotor.

December 5, 1894.

23,656. F. W. Schlindler. London. Improvement in or relating to electric heating and cooking appliances.

23,661. J. W. Willmot. London. Improvements relating to electric telegraph automatic transmitting and receiving instruments.

23,668. W. J. Davy. London. Improvements in electric impedance or choking coil.

23,669. The Cowper-Coles Galvanising Syndicate (Limited) and S. O. Cowper-Coles. London. Improvements in or connected with the electrodeposition of zinc upon iron.

23,679. La Société des Cuivres de France. London. Process for the manufacture of metallic articles by electro-deposition. (Date applied for under Patents, &c., Act, 1883, Sec. 103, May 22, 1894, being date of application in France.)

23,680. A. M. Clarke. London. A process of and apparatus for making compressed electrolytic copper, applicable also to other metals capable of being deposited by electrolysis. (La Société des Cuivres de France, France.)

23,685. Siemens Bros. and Co. (Limited) and G. W. Perry. London. An improvement in brackets for telegraph poles.

23,688. G. Platner. London. An improved charging material for galvanic elements.*

December 6, 1894.

23,697. A. B. Woakes. London. Improvements in the construction of electrodes.

23,745. G. A. J. Telge. London. Improvements in electricity meters.

23,748. F. M. Newton and T. Hawkins. London. Improvements in or connected with dynamo-electric machinery.

December 7, 1894.

23,825. J. Brockie. London. Improvements in electric arc lamps.

23,854. R. Wood. London. Improvements in systems of electrical distribution.

23,858. F. H. Nalder, C. W. S. Crawley, and A. Soames. London. Improvements in the construction of instruments for measuring electric currents.

December 8, 1894.

23,866. T. Thompson. Leeds. Automatic electric fog signal.

23,936. J. R. Shearer. London. Improvements in electrical fire and burglar alarms.

December 10, 1894.

23,970. A. Anderson and J. Marinius Anderson. Glasgow. Improvements in electric conductor supports.*

23,988. R. W. Inman. London. Improvements in electric lighting devices.

24,002. I. H. Parsons. London. Improvements in the manufacture of armatures for electric bells.

December 11, 1894.

24,021. W. D. Reid. London. Combined terminal box and cut-out or fuse box.*

24,075. T. D. Hollick and F. W. Hollick. London. Improvements in regulating electric dynamos and motors.

24,076. B. Hoffman. London. Improvements in and relating to telegraphic transmitting and receiving apparatus.

24,098. G. E. Church and G. W. Ettenger. London. Improved construction of joints and connections for metallic tubular structures, such as are used for the under frames of railway carriages and waggons, girders and frames for bridges and buildings, and for tubular poles for electrical conductors for masts, railings, and the like.

December 12, 1894.

24,176. W. J. Fryer. London. An improved reversible switch wall socket and plug.

24,173. H. H. Lake. London. Improvements in and relating to electric motors and to the distribution of electric energy. (H. Gutmann, Germany.)

24,194. E. A. Parson and H. Millar. Philadelphia. Multiple electric fuse box.

24,195. H. M. Paine and A. R. Brandly. Philadelphia. A mode of controlling magnetic energy.*

24,198. A. J. Marquand, E. Hancock, and D. Lowdon. London. Improvements in electrical resistances and in processes for rendering inert, or electrically non-conducting, substances electrically conductive.

December 13, 1894.

24,234. P. Korber. Glasgow. Reflectors for electric lighting.*

24,266. A. Bergthiel and R. A. Marples. London. Improvements in apparatus for starting alternating current electromotor boilers.

24,285. A. G. New and A. J. Mayne. London. Improvements in and connected with electric systems for lighting trains, and for other purposes.

24,291. F. A. von Alimonda and N. von Alimonda. London. Improved means for securing the terminal wires to carbon and other electrodes.

December 14, 1894.

24,297. W. McChleary. Glasgow. An improved porous cell for an electric generator or battery.

24,369. J. T. Brierly. Liverpool. Improvements in or appertaining to electric bells or alarms.

24,372. Sigmund Sinauer (of the firm of S. Hoffnung and Co.). London. Improvements in shade holders for gas, electric, and other lamps. (The Utility Shade Company, U.S.A.)

24,374. F. Clouth. London. Improvements in the insulation of electric wires or cables.*

December 15, 1894.

24,385. J. Perry. London. Improvements in electric supply meters.

24,431. Siemens Bros. and Co. and G. W. Perry. London. An improvement in tubular posts for telegraphic and other purposes.*

24,440. W. B. Shaw. Liverpool. Improvements in devices for joining or connecting telegraph and telephone wires, and for other purposes.

24,441. W. F. Ostwald. London. Method and apparatus for preventing sparks in electrical apparatus.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1893.

21,420. Longsdorf (Hewett). Primary batteries.

21,434. Schindler. Electrically-heated ovens.

21,958. Lake. Electric lighting apparatus for bicycles, &c.

22,674. Haddan (Rignelle). Electric batteries.

23,231. Anders and Kottgen. Micro-telephones.

23,472. Nalder and others. Electrical measuring instruments.

24,471. Baron Kelvin. Electric supply meters.

24,965. Latimer. Electrotype printing plates.

1894.

249\. King. Electric switching apparatus for electrically-propelled vehicles.

294\. Thompson (Kustermann). Type printing telegraphic apparatus.

437\. Lake (MacTagart and another). Girder clamps and hangers for supporting pipes, electric conductors, &c.

444\. Northcote and Verity. Electric light fittings.

690\. Hampson. Electric railway signalling apparatus.

908\. Williams and others. Heating hydraulic machinery by electricity.

916\. Harrison. Electric measuring instruments.

923\. Deakin. Electric fuses.

1,115. Essinger and Harden. Electrical circuits.

1,433. King. Advertising by electric lamps.

1,657. Holt. Communicating electricity to vehicles.

2,487. Hall. Secondary batteries.

2,800. Soleau. Incandescent electric lamp fittings.

3,080. Theerman and others. Fixing electric call bells.

3,859. Thompson (Ulmer). Electric gas lighting apparatus.

4,177. Thompson (Schneider). Reel device for fire hose, electric cables, &c.

12,877. Lake (Williamson). Electrically controlling steam machinery.

12,972. Doubrava and Donat. Electric arc lamps.

13,358. Lake (Roberts). Electrolysis.

16,851. Thompson (Enholm). Electric railways.

17,313. Losch and others. Electric motors.

17,281. Still. Converting alternating into direct currents.

17,365. Braham. Raising and lowering electric or oil floor standards, &c.

18,288. Riordan. Secondary batteries.

18,339. Acheson. Carbons for electric lamps, &c.

18,522. Pendleton. Electric arc lamps.

18,910. Jensen (Cappelen and another). Electrolytical vessels.

19,191. Von Alimonda, F. and N. Galvanic batteries.

19,185. Stevens and Kestevens. Electric switches.

19,186. Rowand. Electric thermostatic fire alarms.

19,517. Wende. Indicating the lamp hours of electric lamps.

19,742. Theerman. Electrical switches.

20.241. Lake (Clark). Alternating current motors.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "The Electrician" Electrical Trades' Directory and Handbook, 1894, pages 274-300, *&c. &c.*]

ANDREWS' FOREIGN SYNDICATE (LIMITED).—This Company was registered on December 22nd, with a capital of £4,000, in £1 shares, to acquire by purchase the patented inventions of Mr. Joseph D. F. Andrews and John C. B. Andrews for improvements in electric conductors, and joints therefor, for electric lighting, and for other purposes; for that purpose to carry into effect an agreement, dated December 7th, made between J. D. F. Andrews, J. C. B. Andrews, and the Company. The subscribers, with one share each, are:—Egerton H. E. Hensley, Henry T. Staves, Henry W. Ball, Wm. Goslett, Thomas T. C. Parker, John S. C. Callingham, and John Baltus. The first Directors are to be appointed by the subscribers.

FOREIGN AND COLONIAL ARC ACCUMULATOR COMPANY (LIMITED).—The annual return of this Company, made up to December 7th, has been filed, and shows that the whole capital of £1,000, in £1 shares, has been taken up, and 993 of these issued as fully paid. The full amount has been called on the seven remaining shares, but without result.

GENERAL ELECTRIC COMPANY (LIMITED).—The annual return of this Company, made up to November 27th, was filed on December 15th. Out of a nominal capital of £85,000, divided into 7,000 First Preference, 1,000 Second Preference, 4,000 Ordinary, and 5,000 Third Preference shares of £5 each, 6,525 First Preference, 1,000 Second Preference, 4,000 Ordinary, and 1,400 Third Preference have been taken up and allotted. All the Ordinary and Second Preference have been issued as fully paid. The full amount has been called on the First Preference and Third Preference resulting in the total payment of £39,625.

GENERAL ELECTROLYTIC PARENT COMPANY (LIMITED).—The first annual return of this Company, made up October 25th, and recently filed, shows that the whole nominal capital of £24,000, in £1 shares, has been taken up; 18,000 of these have been issued as fully paid, and the full amount has been called on the remainder, resulting in the payment of £5,000, and leaving £1,000 in arrears.

GORDON ELECTRIC TRACTION COMPANY (LIMITED).—The annual return of this Company, made up to December 18th, was filed on the following day. The whole nominal capital of £2,400, in £10 shares, has been taken up, and 60 of these have been issued as fully paid. The full amount has been called on the remainder, resulting in the receipt of £1,800.

GREAT WESTERN ELECTRIC LIGHT AND POWER COMPANY (LIMITED). The statutory return of this Company, made up to October 22nd, was filed on October 25th following. The seven signatories' shares have been taken up out of a capital of £1,000 in £10 shares, but nothing has as yet been called on them.

HEMMING AND CO. (LIMITED).—The statutory return of the abovenamed Company, made up to October 24th, has been filed; 1,229 shares have been taken up out of a capital of £25,000 in £5 shares. Of these 1,000 have been issued as fully paid, and the full amount has been called on 89 shares, £4 per share on 100 shares, and £3 on 40 shares. The full amount of £965 has been received in respect thereof.

PONTYPRIDD ELECTRIC LIGHTING COMPANY (LIMITED).—The solicitors to this Company have written stating that the concern has never done any business, and desiring that the name be struck off the Register.

F. H. ROYCE AND CO. (LIMITED).—This Company filed its statutory return, made up to October 16th, recently. The nominal capital is £30,500 in 30,000 Ordinary and 500 Deferred shares of £1 each, and of these 12,933 Ordinary and all the Deferred shares have been taken up. Upon each of these shares the full amount has been called and paid, or they have been issued as fully paid.

CITY NOTES.

ANGLO-PORTUGUESE TELEPHONE COMPANY (LIMITED).—Coupons No. 14 of the First Mortgage and No. 9 of the Second Mortgage Debentures of this Company will be paid (less income-tax) at Parr's Bank, Bartholomew-lane, London, E.C., on and after January 1st.

BRITISH ELECTRO-CHEMICAL AGENCY (LIMITED AND REDUCED.)—Notice is given that a petition for confirming a resolution for reducing the capital of the above Company from £75,000 in £10 shares to £50,000 divided into 2,500 vendors' shares of £10 each, and 5,000 ordinary shares of £5 each, is now pending in the Chancery Division of the High Court of Justice, and that the list of creditors of the Company is to be made out to February 1st next. Messrs. Spreat and Bullivant, 27, Nicholas-lane, London, E.C., are solicitors in the matter.

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ended December 23rd were £968, as against £952 in the corresponding period of 1893, being an increase of £16. The total receipts for the half-year amount to £22,447, as against £21,049 for the corresponding period of 1893, an increase of £1,398.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—Letters of allotment and regret in the recent further issue of £200,000 debenture stock have been posted.

ELECTRICITY SUPPLY COMPANY FOR SPAIN (LIMITED).—Notice is given that 25 Five per Cent. Prior Lien Bonds have been drawn for repayment, and will be paid off, with interest to date at the offices of the Company, 15, St. Helen's-place, E.C. on January 1st.

ELMORE'S PATENT COPPER DEPOSITING COMPANY (LIMITED).—The accounts of this Company for the year ended June 30th last show a loss of £10,435, increasing the debit balance to £31,953.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended the 23rd inst. amounted to £938. The amount for the corresponding week last year was £604.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company have received from their representative in Rio de Janeiro the following telegram:—"26th. Budget Bill, containing purchase clauses, signed by President of Republic on Christmas Day."

The traffic receipts for the week ending December 21, 1894, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,141.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Dec. 19.		Price Monday, Dec. 24.		Rate per Cent. Yielded.			Dividend Due.	Business Done During Week Ending Dec. 24.	
								£	s.	d.		Highest	Lowest
			TELEGRAPHS.										
£1,012,880	Stock	9 0	Anglo-American	38	39	38	39	5	2	7	Jan., Apr , July, Oct.	..	..
£2,993,560	Stock	18 0	Do. Preferred	71½	72½	71½	72½	5	10	4	„ „	72¾	72½
£2,993,550	Stock	5/0	Do. Deferred	6¼	6¾	6½	6¾	..			..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3	17	8	January and July	..	..
130,000	£10	4/0	Brazilian Submarine	10¾	11¼	10¾	11¼	5	15	7	Mar., June, Oct., Dec.	11⅛	11
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4	8	11	June and December	..	..
10,000,000	$100	$1¾	Commercial Cable Capital Stock	140	150	140	150	4	13	4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12½	13½	12½	13½	5	18	6	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	19	20	19	20	5	0	0	„ „	20	..
12,931	5	1/8	Direct Spanish (fully paid)	4¼	4¾	4¼	4¾	4	4	3	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¼	9¾	9¼	9¾	5	2	7	„ „	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	4	3	4	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8¼	8¾	8½	8¾	5	2	10	Jan., Apr., July, Oct.	..	..
400,000	10	2/6	Eastern	15⅞	16⅛	15⅞	16⅛	4	1	3	„ „	16⅛	16
70,000	10	6%	Do. 6 per Cent. Preference	16¾	17¼	16¾	17¼	3	9	7	„ „	16 15/16	16 15/16
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	119	122	119	122	3	5	7	May and November	..	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	110	106	110	4	13	0	February & August	..	..
250,000	10	2/6	Eastern Extension	16	16½	16	16½	4	6	2	Jan., Apr., July, Oct.	16½	..
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	118	122	119	123	3	5	1	February & August	122	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	107	103	107	4	15	8	January and July ..	—	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	103	107	4	15	8	„ „	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	105	108	105	108	3	15	6	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	108%	111%	109%	112%	3	11	9	May and November	111	..
180,227	10	1/3	Globe Telegraph and Trust	8¾	9	8¾	9	4	17	3	Jan., Apr., July, Oct.	9	8 15/16
180,042	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16¼	3	13	10	„ „	..	..
150,000	10	5 0	Great Northern	21¾	22¼	21¾	22¼	3	18	10	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4	12	7	March & September	..	..
17,000	25	12 6	Indo-European	47	49	47	49	6	8	2	May and November	..	..
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..			„ „	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	102	106	102	106	5	15	5	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	103	108	3	15	6	..	..	..
11,839	8	4/0	Reuter's	2	4	2	4	..			April and October	..	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	109	114	110	115	5	4	4	„ „	114½	112
15,609	10	5/0	West African Telegraph	3	5	3	5	..			January and July	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	101	104	4	17	7	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..			January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	100	105	100	105	7	12	5	June and December	..	..
88,321	10	6d.	West India and Panama xd	1	1¼	1	1¼	..			..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	5	6	8	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6	0	0	„ „	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	109	112	109	112	4	11	4	June and December	..	..
64,242	15	3/0	Western and Brazilian xd	11½	12	11	11½	..			May and November	11½	11¼
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..			..	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	5	5½	4¾	5¼	.			..	5 5/16	5
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5	16	6	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5	16	6	„ „	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	112	118	112	118	5	19	8	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5	17	8	March & September	..	..
			TELEPHONES.										
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..			..	2½	..
224,850	10/0	2⅞d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..			May and November	⅛	..
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	7/16	9/16	7/16	9/16	..			Yearly	..	..
484,597	5	3/4	National	5⅛	5⅜	5⅛	5⅜	4	15	3	June and December	5 5/16	..
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3	15	0	„ „	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3	15	0	„ „	15¾	15½
119,234	5	3/4	Do. 5% Non-Cumulative 3rd Pref.	5¾	6	5¾	6	4	5	1	..	..	..
1,000,000	Stock	4½%	* Do. Debenture Stock, 4½% (red.)	110	113	110	113	4	1	3	January and July	..	..
58,000	5	1/0	United River Plate	1	2	1	2	—			„ „	..	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	88	94	88	94	5	6	5	„ „	..	—
			ELECTRICITY SUPPLY COMPANIES.										
40,000	£10	..	City of London Electric Lighting (fully paid)	14	15	14	15	..			—	14¾	14 9/16
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	14¾	15¼	15	15½	3	18	8		15⅛	15 1/16
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	132	135	132	135	3	17	5	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..			—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	4½	5½	4½	5½	3	12	9	—	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..			..	..	..
8,322	£5	..	House-to-House Electric	..		..		—			—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		—			..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		—			January and July	..	—
45,000	£5	2/6	Liverpool Electric Supply (fully paid)	7⅜	7½	7 5/16	7 7/16	—			..	..	—
111,000	5	..	London Electric Supply	⅛	⅜	⅛	⅜	..			..	..	..
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	9¾	10¼	9¾	10¼	2	8	9	..	10 3/16	10
£150,000	Stock	4½%	* Do. 4½% Debs. (Bonds of £10, £20, and £40)	115	117	116	118	3	17	9	June and December	..	..
6,452	£10	..	Notting Hill Electric	7	7½	7¼	7¾	—			..	7⅜	..
19,980	£5	2 0	St. James and Pall Mall	7¾	8¼	7¾	8¼				..	8	7 15/16
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8½	9	3	17	9	..	.	—
59,900	5	2/0	Westminster Electric Supply (fully paid)	7	7½	7¼	7¾	2	18	1	..	7⅜	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.										
90,000	3	1/6	Brush Electrical Engineering	2⅜	2⅝	2½	2¾	5	8	8	..	2 9/16	..
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2⅜	2⅝	4	11	5		..	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	111	114	111	114	4	0	4	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2¾	3¼	3	3½	..			January and July	..	..
12,139	5	..	Edison and Swan United	—		—		..			..	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..			..	—	..
120,000	2	..	Electric Construction	¼	½	¼	½	..			—	..	..
12,845	2	2/0	Do. 7 per Cent Cumulative Pref.	1½	2	1½	2	..			—	.	..
91,105	2	10/0	Elmore's Patent Copper Depositing	1	1¼	1⅛	1¼	..			—	1⅛	⅞
20,000	5	..	Fowler Waring Cables (fully paid)	¼	1⅛	½	1⅛					..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	25½	26½	25½	26½	4	11	4	February & August	26½	..
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4	7	7	March & September	..	—
15,995	£10	6/4	International Okonite Ordinary	..		..		..				..	—
16,000	£10	..	Do. 8 per Cent. Preference	—		—		—			December and June	..	—
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	¼	—	¼				..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	41	43	41	43	5	11	6	March and July	41½	..
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4	11	9	January and July	..	..
37,514	£5	..	Woodhouse and Rawson Ordinary (£3 15s. paid)	—		—		..			..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		—		..			—	..	..
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	8½	9½	8½	9½	5	5	3	..	..	.
£30,000	10	..	Do. Preference	..		..		..			..	..	..
			RAILWAYS AND TRAMWAYS.										
£630,000	Stock	1%	City and South London Railway	42	44	42	44	2	5	6	May and November	..	..
7,000	10	5%	Do. 5% Perpetual Preference	13¾	14¼	13¾	14¼	3	10	2	..	13¾	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	124	126	124	126	3	3	6	May and November	—	..
37,500	£10	1%	Liverpool Overhead Railway	8⅝	8⅞	8⅞	9	1	2	3	..	..	..
6,295	10	5%	Do. 5% Preference	13	13½	13	13½	3	15	6	..	—	—
125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3	10	2	January and July ..	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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NOTES.

We gladly take this opportunity of thanking the central station engineers and others who have rendered possible all the statistical gymnastics and tables and maps, which appear in our present issue, by courteously and promptly supplying us with the necessary data corrected up to date. We can only hope that the uses we have made of the figures supplied will prove of some interest and assistance to the suppliers.

Whether Sunday's explosion in the Euston-road was indirectly caused by the electric supply, by the mere existence of a conduit into which gas could penetrate and be ignited non-electrically, or whether it was more intimately connected with the electric supply, and was due to ignition of an explosive mixture by an electric spark, can hardly be settled even by a Board of Trade Inquiry. In some respects this accident is of greater importance than the recent one in Cannon-street, since it appears to be attributable to no mistake or carelessness, but occurred during the ordinary conditions of working. Some means are, we understand, provided for ventilating the St. Pancras conduits, but no account of the method has been divulged. Prof. Henry Robinson, the consulting engineer to the St. Pancras Vestry, alluded to it at a meeting of the Society of Arts, but declined to describe it. Gas has been found in other low-pressure conduits, and occasionally in large quantity in the Notting Hill district, but regular inspection and careful ventilation have prevented any accidents.

The nature of the gas must remain unsettled for the present. Ordinary coal gas can be completely deodorised by filtering it through a few feet of certain soils, and cases of fatal poisoning have been due to such a removal of the warning smell. The evidence against the gas company not being complete, though one of the company's inspectors reported an escape in the immediate neighbourhood about a fortnight ago, the next most common gas has been chosen by newspaper paragraphists to account for the explosion. Marsh gas undoubtedly exists in sewers; but a little further evidence that an explosive mixture can escape from a sewer into a neighbouring conduit is required. Ordinary sewer gas is, of course, perfectly harmless, as far as explosion is concerned. When bubbles of hydrogen have been actually seen in formation by electrolysis between the conductors in a conduit, we shall be ready to admit that leaky gas pipes are not always to blame. But we cannot wait until the physical properties of sewer gas have been investigated, or until a genuine case of explosive electrolytic gases has been discovered. In the meantime the public naturally want somebody to do something. If the regulations already provided by the Board of Trade for public safety under the Electric Lighting Acts are not sufficient, others can be easily added; but, before this is done, serious attention must be paid to systematic ventilation. The questions as to whether the gas gets into the conduits from leaky gas mains or as to how the spark is produced are of minor importance. As we go to press we learn that the inevitable Board of Trade Inquiry is to be held on Thursday next. This Inquiry will, no doubt, thoroughly ventilate the whole question, would that it could do the same for the conduits.

The insulation of the St. Pancras mains cannot be so high that a permanently large difference of potential can be maintained between the conductors and the earth, and it would be interesting to investigate whether any combination of conditions that could exist in practice could enable a continuous 200 or 300-volt supply to produce a static or other spark which would ignite an explosive gas mixture.

The Brighton Corporation are to be congratulated on their street lighting, for several reasons. They have made a success from a practical, a financial, and an engineering point of view. The light is ample, the cost is but little more than gas, and five lamps are run in series on the mains. But most heartily are they to be congratulated for their proposal to terminate two of their contracts with the gas company, and for their recommendation of the adoption of arc lighting in the principal roads and streets. The effect of the light steel tube arches across the streets will be watched with interest, and we hope that the Corporation will have no difficulty in obtaining the necessary permissions. For narrow streets such a system seems excellent. Mr. Wright, in the report which we recently published, proposes to use, for certain wide streets, a standard "having a graceful curved arm or bracket from which the lamp would be suspended." The lamp posts "designed at Munich," probably "made in Germany," and used at Oxford, are tolerably graceful, but this without a graceful curved arm. These standards were in 1892, and, as far as we know, still are better than anything else of the kind. The curve generally adopted in these cases is a semicircle—a curve which, in the hands of a skilful designer, may be sufficiently disguised to pass for something graceful. An almost invariable custom is to hang the lamp from an eye to the extremity of a curved arm; bracket is not the word. An arc lamp is, as a rule, a rather elongated affair, and this mode of suspension generally adds some three to five feet to the total height of the standard, as, for example, at Ealing. Why not ask the designer for a real bracket, provided with a ring seat for the lamp? Let the globe hang below the ring, and the hood stand above it. The wind pressure due to a rigid lamp ought to give no trouble. Seeing how much engineers do to disfigure their country, some pains might be taken where there is an opportunity for a little ornament.

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We reprint this week a Paper on "The Production of Rotary Magnetic Fields by a Single Alternating Current," read before the American Institute of Electrical Engineers by Mr. Gutmann. The author claims to have devised a system of motor winding by means of which a self-starting synchronous motor, which will work on an ordinary one-phase alternate current circuit, can be obtained. The Paper has the double merit of being well illustrated and of freedom from the abstruse and irrelevant mathematics with which Papers on kindred topics are frequently accompanied. At the same time it must be noticed that the Paper confessedly deals only with an incompletely developed invention; and practical men will observe that it is unaccompanied by any results of actual tests under working conditions. When Mr. Gutmann's system of motor winding and connections has borne the brunt of practical work, starting and running motors on full loads without complicated starting gear, condensers or choking coils, it will be quite soon enough to venture the opinion that his principle contains "the germ for the ideal distribution of power." All that can be said at present is, that some such motor as that claimed to have been invented by Mr. Gutmann is badly wanted.

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It is not often that any scientific discovery invested with potential importance is made without someone arising who has "done it before——long ago." Sometimes the antetypical inventor has done it before with success; but occasionally he comes forward with the jeremiad that he did it before and found it a failure. To this latter class belongs a Mr. C. J. Reed, of America, who advances the double claim to have anticipated Dr. Borchers' work in the construction of a carbon-consuming battery, and to have proved that this same "carbon-consuming" battery really consumes nothing else but copper. Even the most conservative scientist must, we think, have hailed Dr. Borchers' curious cell as a step in the direction of a practicable carbon battery; and it is a great disappointment to have Mr. Reed's chemistry, which we publish this week, hurled against it, since if his conclusions are well founded, the solvent for carbon, either solid, liquid, or gaseous, which will liberate its energy of oxidation electrically, remains yet to be discovered; and engineers must continue to be content with their old wasteful furnaces and the pessimism of thermodynamics.

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It will be remembered that Dr. Borchers endeavoured to realise the principles laid down by Prof. Ostwald regarding the direct production of electrical energy from fuel by causing the combination of carbon monoxide and oxygen to take place in the presence of cuprous chloride acting as an intermediary and electrolyte. Mr. Reed denies that the production of current observed by Dr. Borchers was due to the oxidation of carbon monoxide, and asserts that it was obtained at the expense of the copper electrodes employed in the experiment. He remarks with some cogency that carbon should be capable of replacing copper as a material for the electrodes throughout the combination, and considers that its substitution would negative the conclusions drawn by the German electrician. The situation at present is not susceptible of useful argument, as the facts are not agreed upon. Direct assertion is met by equally direct denial. The matter is not a difficult one to decide by experiment, and until further evidence is adduced, opinion must lean towards the view best supported by actual recorded observation, which, it appears to us, is that held by Dr. Borchers. One small statement at the end of Mr. Reed's Paper requires comment. He seems to have been unable to obtain evidence of the direct combination of oxygen and hydrogen in an ordinary gas battery when the gases were prepared by other than electrolytic means. There are too many affirmative results to permit this single negative statement to be regarded as conclusive. The Mond gas battery, using hydrogen from water gas, is a case in point.

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Our invaluable and usually well-informed friend, *Whitaker's Almanack*, departs from its customary accuracy in the brief paragraph which it devotes, this year, to "Electrical Measures." To begin with, it gives an obsolete definition of the ohm. "The practical unit of resistance, called the Ohm," it says, "is the one on which all the others depend, and is defined as the resistance offered by a column of mercury 106 centimetres long, and one square millimetre in section, at the temperature of melting ice." As a matter of fact, the dimensions of the standard mercury column are not now defined in terms of the length and section, but in terms of the length and *mass* of the column. But let that pass. What, however, are we to make of the following definition of the volt?—"A Volt would define a current having an electromotive force capable of moving a mass of one gramme through a length of one centimetre in one second." This is but a delirious tangle of things C.G.S. We hope our perennial library companion will be electrically up to date when next it appears.

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New Year's Honours.—Amongst the recipients of New Year's honours is Mr. J. C. Lamb, C.M.G., Assistant Secretary to the Post Office, who is to be a C.B.

The Vienna Telephone Exchange.—The Vienna Telephone, which has about 9,000 connections, was taken over on New Year's Day by the Telephone Department of the Post and Telegraph Office.

Institution of Civil Engineers.—The 2nd inst. was the seventy-seventh anniversary of the establishment of the Institution of Civil Engineers, which was founded for the general advancement of mechanical science. It now numbers 1,846 members, 3,647 associate members, 359 associates, 17 honorary members, and 791 students, making a total of 6,660 of all classes.

The Welsbach Light v. the Glow Lamp.—In the Clichy sector, in Paris, only five electrical consumers have, says the *Gas World*, abandoned electricity in favour of the Welsbach light, while two have moved in the contrary direction.

Interurban Telephony in Switzerland.—The Swiss Budget for 1895 contains an item of £5,320 for a telephone trunk line connecting Geneva with Zürich, and an item of £2,120 for telephonically connecting Lucerne and Basle. In 1896 Geneva is to be telephonically connected with Basle.

Cable Interruptions :—

	Date of Interruption.
Latakia-Cyprus	Nov. 27, 1894.
Aden-Zanzibar	Dec. 21, 1894.
Cadiz-Teueriffe	Dec. 26, 1894.
Hongkong-Macao	Dec. 31, 1894.

During the interruption of the Cadiz-Teneriffe Cable telegrams for Senegal can only be forwarded by the Eastern Company's route, via St. Vincent. Messages for the Canary Islands can also be sent by the same route.

Electric Lighting in Munich.—The electric lighting of Munich, remarks a gas contemporary, bids fair to be the largest undertaking of the kind in Germany. "The mere lists of the streets lit up by the electric light is a very long one." Naturally; since the streets are in German nomenclature.

Electropathic Belts.—We regret to find that *The Times* has renewed the insertion of advertisements relating to so-called electropathic belts. The good work done by a contemporary in exposing the true character of these contrivances is thus in a great measure neutralised, and it says little for the public spirit of the proprietors of a great and powerful organ of the Press that they should be so easily tempted. Without the aid of the daily Press such nostrums would speedily die a natural death.

The Berlin-Memel Telephone Trunk Line.—The Berlin-Memel telephone trunk line came into operation on New Year's Day. The *Elektrotechnische Zeitschrift* points out that whilst the railway distance between the capital and Memel is only some 511 miles, the telephonic distance is 632 miles. It is pointed out that the successful working of this line shows that telephone lines connecting Berlin with the most distant towns in the empire can be erected and worked satisfactorily without any of the extraordinary means considered essential for the New-York-Chicago line. The Berlin-Memel line is of 4·5mm. bronze wire throughout.

Australian Cable Contracts.—A cable, dated Melbourne, January 3rd, states that an Intercolonial Conference will be held on February 12th to consider the situation created by the decision of the Victorian Government to withdraw from the guarantee given to the Eastern Extension Telegraph Company by all the Australasian Colonies, except Queensland, and in virtue of which the charges for cable messages were materially reduced. The Postmaster-General expresses the opinion that the Colony's withdrawal from participation in the cable subsidy will not render it necessary for the Company to raise the tariff for the transmission of messages to the old figure. Pressure is, however, being brought to bear by New Zealand and the other Colonies to induce the Victorian Government to reconsider their decision.

A Works Electric Locomotive.—*Electricity*, of New York, and formerly of Chicago, says that a firm of tinplate manufacturers in Maywood, Ill., are using in their factory an electric locomotive deriving its propelling power from a storage battery. The locomotive is 5ft. in length, 30in. in width, and 44in. in height. Its weight is about 5,000lb. The battery consists of 24 of the so-called "chloride" cells, and is charged on the premises from a generator which is also used for supplying power to motors running machines in various portions of the plant. The locomotive has displaced hand labour in pulling small cars loaded with tin plate from one part of the factory to another. The plant consists of a number of detached buildings, and the magnitude of the operations compelled the adoption of some sort of mechanical power in transferring the heavy material between the several departments.

Municipal Railways.—A step in the direction of municipal railways will, says the *Manchester Guardian*, be brought before Parliament for its consideration next session, when a proposal will be made to authorise the London County Council and the City Corporation to enter into contracts for the construction, management, and maintenance of the Epping Forest Railway authorised last session, to contribute funds towards the making of the railway, and to hold shares in the undertaking. The Bill only went through last year after considerable controversy with the County Council, who sought to impose upon the promoters onerous conditions with respect to the running of workmen's trains and the charging of cheap fares, and the Company, in the event of the present Bill being rejected, have deposited an alternative proposal for the abandonment of the line. The present authorised capital of the Company is £2,100,000 by shares and £700,000 by borrowing powers, and it is proposed to increase these amounts by £21,000 and £70,000 respectively.

A Wire-Wound Flywheel.—The following description of a heavy flywheel composed of wire appears in the *American Manufacturer* :—"Amongst the most recent and novel applications of wire, perhaps none has greater interest to the mechanical world than that presented by the new wire flywheel lately erected at the Mannesmann Tube Company's Works, Germany. Heavy flywheels driven at high velocities obviously present dangers of breaking asunder from the great centrifugal force developed. The wheel at the factory mentioned consists of a cast iron hub or boss, to which two steel plate discs or checks, about 20ft. in diameter, are bolted. The peripheral space between the discs is filled in with some 70 tons of No. 5 steel wire, completely wound round the hub, and the tensile resistance thus obtained is far superior to any casting. This huge flywheel is driven at a speed of 240 revolutions per minute, or a peripheral velocity of about 2·8 miles per minute (250ft. per second, approximately), which is nearly three times the average speed of any express train in the world. The length of wire upon such a constructed flywheel would be about 250 miles."

Patents Expiring This Year.—The following is a list of the leading electrical patents expiring during 1895 :—

Dated 1881.		No.	Name.	Subject of Patent.
Jan.	11	129	C. Faure	Secondary lead battery, pasted plate.
Feb.	23	768	T. A. Edison	Lamp filament joint, by plating.
Feb.	28	783	J. Perry and W. E. Ayrton.	Electric traction, buried conductor and block system.
Apr.	26	1,802	T. A. Edison	Screw lamp holder and lead fuse.
Apr.	28	1,835	C. F. Brush	The Brush regulator.
May	10	2,038	R. J. Gülcher	The Gülcher arc lamp.
July	7	2,989	J. Hopkiuson	Coupling two or more motors in series or parallel for varying the speed of vehicles.
July	21	3,189	H. S. Maxim	The Maxim glow lamp.
Aug.	18	3,599	C. Lever	The Lever arc lamp.
Sept.	10	3,926	J. S. Sellon	Secondary battery plates, roughened and indented.
Sept.	29	4,202	J. W. Swau	Lamp filament jointing by flashing.
Oct.	11	4,409	T. O. Callender	Vulcanised bitumen for cables.
Dec.	28	5,702	J. W. Swan	Lampholder for bottom-loop lamps.

Polyphase Current Distribution in a French Factory.—At a recent meeting of the Société des Electriciens M. P. Boucherot described an interesting Brown polyphase plant laid down at the works of the Weyher-Richemond Company at Pantin. The plant comprises three two-phase generators driven by a horizontal engine. Some of the machinery is driven direct by individual motors; but, with a view of making some use of the existing shafting, groups of machinery are driven from the shafting by belts, the shafting itself being driven by a 45-H.P. electric motor. The average power demanded at the Pantin works is about 260 H.P., and the efficiency between dynamo terminals and the work is of the order of 72 per cent. M. Boucherot laid emphasis upon the interesting fact of a company which manufactures both continuous and alternate current plant, giving preference to a two-phase system of distribution in its own factory, where the distance to be traversed is not more than 200 metres, and the voltage only 110. A two-phase distribution was chosen in preference to one of three phases on account of its greater simplicity, and the possibility it affords of running the motors off the lighting circuits without too much disturbance.

Junction-Box Explosion in the Euston-road.—In the early hours of Sunday morning an explosion took place between Endsleigh-gardens and Gower-street, on the south side of Euston-road, whereby about 40 yards of pavement were displaced and the cover of a large man-hole, with several flagstones, were blown into the air. Two pedestrians who were passing at the time were injured and had to be conveyed to University College Hospital, close by. Major Cardew has made an inspection on behalf of the Board of Trade. It is curious that on January 12th last a similar accident took place in Endsleigh-gardens, about 100 yards from the spot where this explosion occurred. It is not thought that the explosion has been caused by sewer gas. That it was due to an accumulation of coal gas, however, is considered very probable. Another theory is that some water must have penetrated through the lid of the culvert and dropped on to the exposed copper, thus causing a spark, which ignited some gas in the aperture. An inspector says that he reported an escape of gas in the immediate neighbourhood about a fortnight ago. Mr. J. Barnett Simmons, writing from 18, Endsleigh-gardens, says: "For the second time this year our household, in common with many others, has been disturbed by a violent explosion, caused, as I understand, by the contact of the gas with the electric light. This time a considerable portion of the pavement in Euston-road has been torn up. Is it not time that the Department of the State responsible for the lighting of the Metropolis should take steps to prevent any future recurrence of the alarming event in question?"—Major Cardew has written to Mr. Pycraft, vestry clerk of St. Pancras, announcing that the Board of Trade proposes to hold an Inquiry into the facts relating to the accident on Thursday next, the 10th inst.

Electric Communication with Lighthouses.—The Plymouth Chamber of Commerce had under consideration last week the subject of electric communication with lighthouses. Mr. R. Bayly proposed that a memorial be forwarded to the Board of Trade with a request that, following the recent stranding of the "Dunottar Castle" on the Eddystone reef, steps may be taken immediately to establish electric communication between lighthouses and the shore. He said it was providential that the stranding of the "Dunottar Castle" was not attended by great loss of life. Had not the sea been smooth and the tide rising there would have been an awful calamity. Twenty-five years ago the "Schiller" was wrecked at Scilly in almost precisely similar circumstances, the only difference being that the tide was then falling, and as it fell the sea became troubled. By that wreck 331 lives were lost, and at the coroner's inquest on the victims the jury declared that if the Bishop Lighthouse had been in telegraphic communication with the shore not one life need have been lost; but to this day there was no telegraphic communication with the Bishop Lighthouse, nor was there any cable to the Eddystone. It was true that the Trinity House authorities had given notice of their intention to establish electric communication between certain lighthouses and the shore, but at the present rate of progress the work, which might be done in two years, would not be done in 20. There was provision at the Eddystone for a signalling staff. A mercantile signalling station there would pay as a commercial investment. Mr. Bellamy thought it unwise to suggest that the electric cable should be used for signalling passing vessels, because the Trinity Brethren held the view that if lighthouse men undertook signalling duties their other work might be neglected. Mr. Bayly replied that vessels could signal a message to any lighthouse along the coasts of Denmark, France, Holland, and, indeed, of most civilised countries, and it was not to the credit of the Trinity Board that such facilities did not exist along the coast of England. The resolution was ultimately adopted unanimously.

Interdependence of Patents.—In an interesting article on the above subject in the *Law Times* of the 29th ult., "G. B. E." remarks:—Muirhead's action against the Commercial Cable Company was one of extreme interest, as it related to Muirhead's system of duplex telegraphy, whereby two messages can be despatched in contrary directions along the same wire. So far as the law point is concerned the case is comparatively simple. Muirhead took out an English patent in 1876 for duplex telegraphy, and in 1880 took out a United States patent also for duplex telegraphy. The 14 years of the English patent ran out in 1890; whilst the American patent would run for the full 17 years (namely, to 1897) unless cut short by reason of the expiry of the English patent. By the United States law the United States patent would expire with the British patent, supposing it covers the same invention. The simple point, therefore, came to this, Was the United States patent of 1880 the same as the British patent of 1876? The judge of first instance held that the two were different, and now the Appeal Court held (Lord Esher dissenting) that the two inventions were substantially the same. The result of the litigation is that there is a balance of judicial decision in favour of each litigant. Although the action is nominally for £3,500, the amount in dispute is about ten times that sum. If the United States patent is in force the Commercial Cable Company, who are licensees, will have to pay royalties until the end of the seventeen years. The case will accordingly be the subject of appeal to the House of Lords. A case which brings into discussion United States law is of interest; and although the United States law is regulated by their revised statutes, it is possible to see that the underlying principles are common to both countries. Those persons, however, who have to deal with patent procedure in Washington know that there is often a great apparent difference between British and United States specifications for the same invention. This is the case particularly with the claims; and, consequently, too much reliance cannot be placed on apparent differences between the United States and British specifications. The decision of the majority of the Court of Appeal will be found to be correct.

Light Railways.—In case the following letter, signed Thos. Barrett Lennard, jun., Horsford Manor, December 27th, which appeared in *The Times* of Monday, should prove too much for any of our readers interested in light railway construction, we print its antidote below it:—

TO THE EDITOR OF THE TIMES.

SIR: There has been a good deal of correspondence of late in *The Times* as to light railways, but most of it, I think, from engineers, and little or none from practical farmers. I have the misfortune to be one of the latter class, and I feel sure that the construction of light railways, like many other panaceas advocated ostensibly for our assistance by people who do not farm, will be of no use to us; but that, on the contrary, if light railways are constructed out of public funds, they will only add to our burdens in the shape of increased rates, or, if constructed by private enterprise, will pay no dividends, provided that the promoters rely upon us farmers for support. I say this for the following reasons:—First, farmers only carry produce to market at comparatively rare intervals; as a rule only corn, or sometimes hay and straw, and rarely roots. Secondly, farmers must keep for the work of the farm more horses than they require in the winter, and their carrying out produce during that season keeps these horses which are over and above those required during the rest of the year in occupation. Thirdly, farmers' crops are so scattered about a farm that no light railway could tap each part of each field where the crop is stacked or clamped, as the case may be, and therefore the crops would still require to be carted to the light railway, and then would arise the cost of transhipment. Fourthly, farmers' produce is not sold to be delivered at one central depot, but has to be conveyed to the warehouse of each individual buyer, and thus a fresh transhipment would be required on arrival at the terminus of the light railway. Fifthly, the usual custom, in these parts at least, is for the farmer to cart his produce to the buyers' warehouse, and then to pick up a return load of cake, muck, coal, or what may be most required at home, and this return load probably comes from a different part of the town to that at which he has deposited his load of produce. For engineers, lawyers, and Parliamentary agents, no doubt light railways would be most valuable; but on behalf of the ratepaying farmers, on whose shoulders the fees of these gentlemen and the other burdens incident to the construction and maintenance of the light railway would no doubt fall as no light burden, I say, "Help us from our friends."

The Great Eastern Railway Company has been approached by Cambridgeshire landowners and farmers, who offer to provide the land and money for the construction of a light railway provided the Company works it. After inspecting the district, which is a purely agricultural one, with a sparse population, the Directors have decided to make the railway themselves, and to work it, provided they get the necessary land at ordinary agricultural values, and that it shall be for the carriage of goods only.

THE SERIES SYSTEM OF ELECTRIC TRACTION FOR AGRICULTURAL LIGHT RAILWAYS.

BY NELSON W. PERRY.

I have been much interested in the letter of Sir Courtenay Boyle and the discussion to which it has given rise on the question of light railways as reported in your valued Paper of November 9th. I gather from this that it is probable that a relaxation of the Board of Trade restrictions, such as now seem to render such undertakings entirely impossible, may be granted in the event of a proper presentation of the case by the Associated Chambers of Commerce, &c., before whom Sir Courtenay Boyle's letter has come. There seems, then, a question whether or not if these roads could be constructed into the agricultural districts their traffic would warrant the outlay, and several of the speakers insisted that Government aid would be required for their establishment.

While in this country we have had no experience with electric railroads of 2½ft. or 3ft. gauge, such as seem to be in mind in England, our experience with the 4ft. 8½in. gauge (or thereabouts) has amply demonstrated their dividend-earning capacity, provided they have not been handicapped by a too large fixed investment for the traffic of the territory through which they operate. Much territory adjacent to our larger cities, which but a few years ago was purely agricultural land, has already been subdivided into building lots, and much of it occupied, so that the roads that have developed this property are now doing a profitable traffic in what was agricultural land. The distances, however, to which these roads can reach, without a too great investment of copper (remembering that the weight of copper must increase as the square of the distance) has been, comparatively speaking, so limited that we have no electric roads that could be, strictly speaking, classed as agricultural roads, or which depend in any considerable degree, upon farm patronage for their incomes.

In the first place, all of our roads to the outlying districts are but extensions of city systems usually supplied with power favourably located for city distribution. As the extensions must necessarily be of the same gauge as their urban portions, the cost of construction in the outlying districts can be but a fraction less per mile than that lying within the city limits. The location of the power station favourable to the city traffic places it in the most unfavourable position as regards the outlying lines, limiting the distance to which such roads can be economically operated to, I should say, seven miles as a fair figure, beyond which it becomes more economical to erect a second power station, and put on the pay roll a duplicate set of employés, with all that that implies, than to put sufficient copper into the circuits to reduce the drop in line at greater distances to a permissible figure.

It seems exceedingly doubtful if a purely agricultural country, however thickly settled it may be, could support a railroad involving the fixed outlay required by a standard track or that involved in sufficient copper to carry the current without disastrous drop to the distances required on the one hand, or the investment in a duplicate station on the other. The investment in permanent way must be decreased, and the suggestion of reducing the gauge to 2½ft. or 3ft., and using a lighter rail appeals to me as being certainly in the right direction. But it seems to me that another step is also imperative, viz., that the cost of distributing current must be also reduced in order that such roads should be self sustaining. In cities where areas rather than distances are concerned the multiple arc system has been all but universally employed for electric railways and incandescent lighting, the facilities which such requirements afford for tying together such a system by feeders of comparatively short length having rendered it economical. When, however, we come to the arc light which is distributed over still larger, and more sparsely settled areas, the constant current or series system has *had* to be resorted to. In fact, it would seem that the constant current method, if certain of its objectionable features could be removed, would be the ideal one for great distances, and especially so where not only distances but constantly varying and shifting loads are concerned as in electric traction.

By the multiple arc system, if we go twice the distance we must invest four times as much in copper. If three times the distance, nine times as much. The question arises, Will the traffic at double or treble the distance pay four or nine times as much as the shorter haul, as it would be required to do to pay its share on the outlay? This question will in every case be answered in the negative. As a matter of fact the traffic from the more distant portions will pay a less and less proportion of average cost per mile as those distances are greater and greater. A limit is therefore soon reached beyond which every additional mile becomes an increasingly great burden upon the road until it bankrupts it.

When we come to consider the distribution of current to electric railways by the constant potential method, we see how irrational and uneconomical it is. Our conductors are necessarily fixed in size. The pressure is also fixed, and the current, which is the thing that must be delivered, is variable. The conductor must, therefore, be proportioned so as to deliver the maximum current at the further end within an allowable drop. Such an investment of copper is never warranted by the business at the further end. It could only be warranted by a steady demand for that maximum current at the further end. In practice this maximum load may not occur at that point but once or twice a day, and then only last at a few minutes at a time. More often on a light road there would be no load at the further point, and the mean load would be but an insignificant fraction of the maximum, yet the copper must be put in in order to operate that load when it occurs, even though it be for a few minutes only. A much more rational method would be to make our current the constant factor of the energy, and the pressure the variable. By so doing the investment in copper would vary directly as the distance, instead of as the square of the distance, or about in the same ratio as the traffic might reasonably be expected to vary.

Another feature is that having once determined the size of conductor that will be most economical for one car a mile distant, that same size will remain the most economical for 20 miles, whether there be one car or a dozen, and whether those cars all be bunched at the further end, or be distributed along the route. Compare this with the constant potential method, where our conductors become least efficient when, for economy's sake, they are required to be most so—viz., when the load is at the further end.

It is exceedingly doubtful if any road, even a light road, depending upon the traffic furnished by a sparsely settled country, could be successfully operated to any considerable distance, where the copper required must be increased as the square of that distance, or the loss in transmission on the line must increase as the square of the energy supplied.

This brings us back again to the constant current method, in which both the copper and line loss increase only as the distance or as the load, or, in other words, in proportion to the traffic.

But the constant current method of distribution for moving translating devices, as tried both in this country and in England, has developed so many difficulties that it has had to be abandoned. Speaking of the difficulties as developed here, with which I am familiar, they were the following: The switches by which the current was diverted from one wire to another, so as to enable the cars to run in series, were mechanical, were necessarily placed on the trolley wires themselves, where they were exposed to the weather. They were required to fit tightly to prevent burning out, and frequently became so tight as not to operate. They were moved by the trolley as it passed by—one car throwing the switch in one direction and the succeeding car throwing it back again to its original position; hence, if one car failed to operate the switch properly, the next car would leave no switch to throw, and the line became open and all cars came to a standstill. For this same reason cars had to be put into and taken out of service in pairs, or the circuit would become open, and branching roads or inter-connecting systems could not be operated; for a car in passing from one system to another became a case of adding, a single car to one system and taking one car off of another which would leave both open. And, again, the result was the same if the trolley got off the wire: everything had to stop until it was replaced and the dynamo had time to build itself up again.

Experience, demonstrated, however, the extreme economy of operating cars in this way over the multiple arc method ; one of the greatest advantages was the ability of recovering the energy consumed in bringing the car up to speed, or in ascending a grade by electrically braking the car on bringing it to rest or in checking its speed on a descending grade. This is accomplished by simply revolving the brushes around the commutator, whereby the motor is converted into a dynamo in series with the one at the power house, and driven by the momentum of the car or by gravity. The advantage of utilising this energy instead of frittering it away in heat on the brake shoe, as is done in mechanical braking, is certainly very great, and was very fully demonstrated by Prof. Short in a series road some three miles in length at St. Louis. It was also demonstrated, if I mistake not, in England at Northfleet, and described by Mr. Edward Manville before the British Association in September, 1888.

But the irregularities introduced into the circuit by the cars were cumulative, and became so great that when more than three or four cars were put into service the system had to be abandoned as impracticable. It was but a repetition of Mr. Brush's experience with the arc lamp. He solved the difficulty with the lamps, however, by the introduction of the automatic cut-out or by-path so satisfactorily that any number of lamps may now be operated successfully in series, and arc light circuits operating 100 to 150 lamps each are already common in this country, and the tendency is rather to increase than to diminish the number.

The constant-current road failed for the same reason that the constant-current distribution to arc lamps failed at the same stage of its development.

I have ventured to suggest the introduction of the automatic cut-out into electric railway circuits operated on the constant-current system, and believe that with this and other improvements at the same time this method of distribution of current to railways has been rendered in every way as practical as has the distribution to arc lamps by the same method.

The Franklin Institute has examined into my invention and deemed it of sufficient merit to honour me with the award of the John Scott Legacy and Medal for 1894, and it occurs to me that it may not be uninteresting to your many readers at this time to refer to some of its supposed advantages, which I do the more willingly since the system is not patented in England, and I do not thereby lay myself open to the accusation of attempting to further my financial interests.

The points which would seem to recommend this series system for adoption on the light roads that you are now discussing may be briefly summed up as follows :—

1st. Best investment per unit of output in power station.

2nd. Ability to reach greater distances with a given outlay.

3rd. The investment in copper will be strictly proportional to the distance and the expected traffic, instead of increasing as the square of the same.

4th. The loss of energy in transmission will always be that dictated by the most economical investment in copper, whether at light load or full load, instead of as the square of the load under the most favourable conditions, and a still greater ratio under normal conditions of multiple arc arrangement.

5th. The recovery of a large portion of the energy absorbed in acceleration or working against gravity by electrical braking, impossible of accomplishment by present methods.

6th. The advantages of a perfectly automatic and positive block system.

It seems to me that these advantages, if they can be attained, as I think they can be now, are such as to practically solve the question which may result from your present discussion of how to construct a light agricultural railway so as to be self-supporting.

Pennsylvania Street Railways.—There are 99 street railway companies in Pennsylvania. The highest rate of dividend paid by any of these companies during the past year was 20 per cent.

LAMP-CONNECTION DIAGRAMS.

In order to bring home to our readers some of the statistical facts relating to lamp connections deducible from our electric supply station table published with the present issue, we give below a few diagrams graphically representing these statistical deductions.

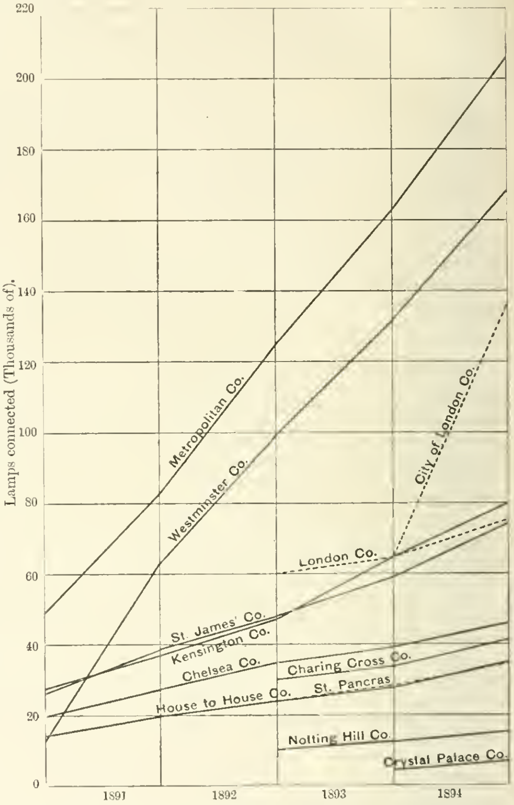

Diagram 1.—Lamp connections of the London Companies.

Diagram 1 shows the "lampages" of the various metropolitan electric supply concerns from the end of 1890 onwards.

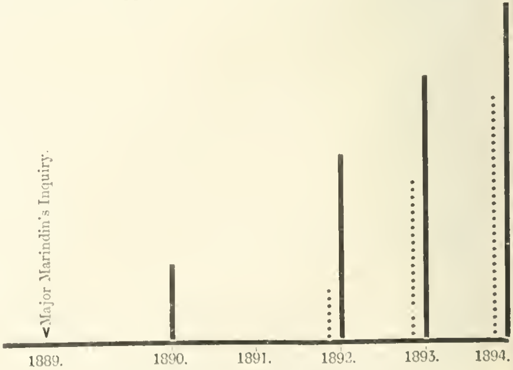

Diagram 2.—Lamp Connections of the United Kingdom.
London ———— . Provinces ………
Scale (approx.) 1 inch = 400,000.

The Metropolitan Electric Supply Company is, it will be observed, *facile princeps* so far as its lamp connections are concerned, its total of 206,000 being followed at a respectful distance by the 168,500 lamps of the Westminster Electric Supply Corporation, and then by the 136,000 of the City of London Electric Lighting Company. It is evident by the sustained steepness of these curves that London is as yet by no means electrically "saturated."

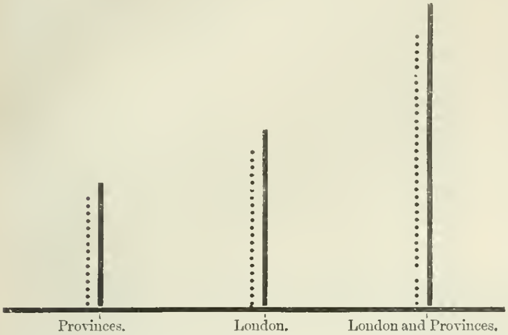

DIAGRAM 3.—Alternate- and Continuous-Current Lamp Connections.

Alternate-current .... Continuous ————.

Scale (approx.) 1 inch = 400,000.

In Diagram 2 the vertical columns show total lamp connections for the United Kingdom. The London total (180,000) for the end of 1890 is taken from Mr. Frank Bailey's Paper, read before the Society of Arts. The remaining totals are from our own tables. At the end of 1894 there was a grand total "lampage" in London and the Provinces of close upon 1,600,000, as against 1,125,000 for the end of 1893. The present totals for London and the provinces are respectively 925,000 and 670,000.

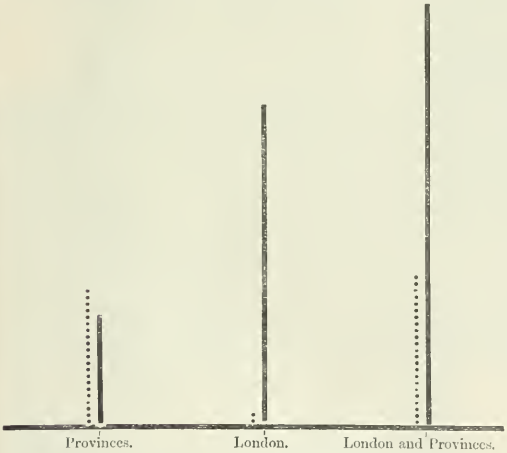

DIAGRAM 4.—Lamp Connections of Municipalities and Companies.

Municipalities .... Companies ————.

Scale (approx.) 1 inch = 400,000.

In Diagram 3 the vertical columns represent the relative "lampages" of alternate-current and continuous-current systems. It is interesting to note how closely these two rival methods of distribution run each other. The totals are set out in the table below :—

—	~	–
London	458,200	466,900
Provinces	321,000	348,800
Total	779,200	815,700

In Diagram 4 the vertical columns represent the relative "lampages" of municipalities and of companies, and clearly show that in spite of present day municipalising tendencies by far the greater part of the electric lighting of the United Kingdom is still in the hands of companies ; a result for which, however, we have only London to thank. The totals are set out in the table below :—

—	Municipalities.	Companies.
London	38,000	887,100
Provinces	368,200	301,600
Total	406,200	1,188,700

NEW GRAPNELS.

The illustrations below show two new forms of grapnel which have been brought out by Messrs. Johnson and Phillips. These grapnels are the invention of Mr. Claude Johnson.

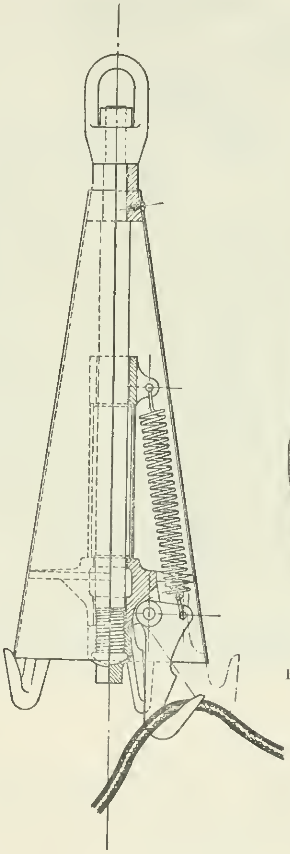

FIG. 1.—Claude Johnson Collapsible Prong Grapnel. Sectional Elevation.

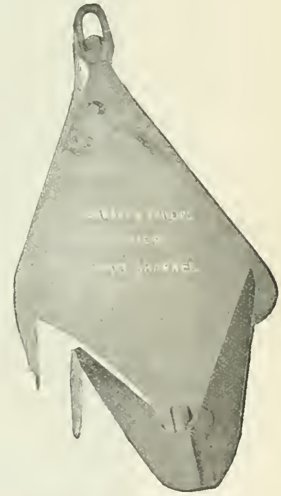

FIG. 2.—Claude Johnson Grapnel for Muddy Bottoms.

In Fig. 1 is shown a sectional elevation of a collapsible prong grapnel for the recovery of cables lying on rocky bottoms. Any one or all the prongs can retire within the shield either before or after the cable is hooked, the idea being to prevent rocks stopping the progress of the dragging or injuring the instrument. The principle of the automatic movement of the prongs of this grapnel is essentially different to that of a grapnel having retractile prongs. In the latter form the prongs open outwardly, and so practically increase the size of the instrument, and the expanded prongs are in their weakest position to resist strain from contact with rocks. In the present grapnel the reverse takes place.

Fig. 2 is an illustration of a grapnel designed for the recovery of cables in mud bottoms. This grapnel has two steel prongs, which are comparatively thin, but deep in section, so as to offer little resistance to their penetration into the mud. The prongs are connected to one end of a broad flat plate, which constitutes the shank, the plane of which is at right angles to the plane of the prongs. On dragging with this grapnel the shank slides with its flat face on the surface of the mud, while the downward directed prong penetrates to its full length into the mud, so as to seize the cable imbedded therein.

WESTINGHOUSE GENERATORS AT PHILADELPHIA.

An interesting series of articles describing the "Electric System of the Philadelphia Traction Company," by Mr. H. S. Hering, recently appeared in the *Electrical World* of New York, and we give the following abstract, in which the large 1,500-H.P. generator is described. We are indebted to our esteemed contemporary for the three illustrations which accompany the abstract.

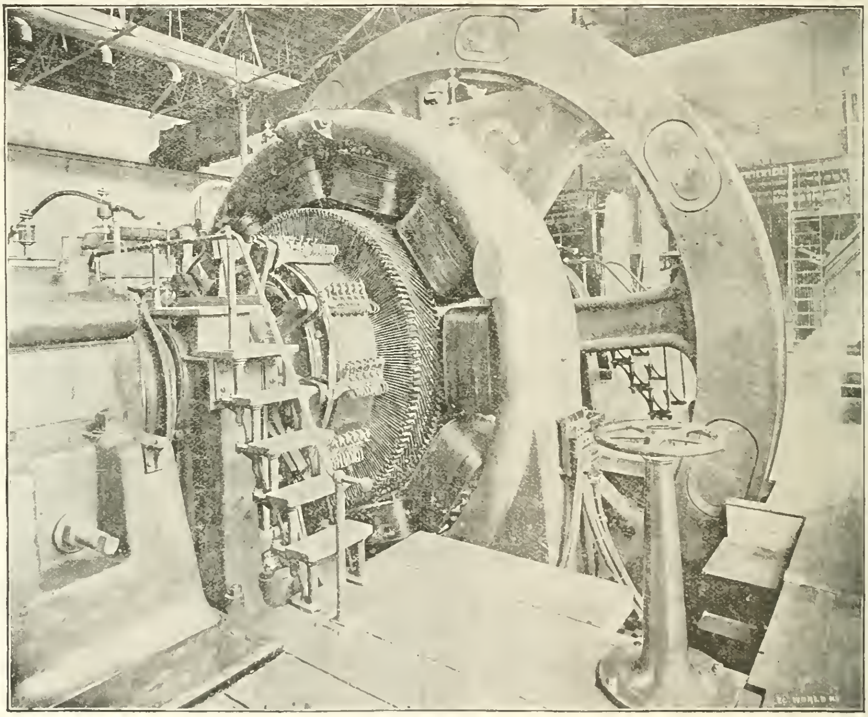

Fig. 1.—1,500-H.P. Westinghouse Generator.

The 1,500-H.P. direct-coupled generators which are being installed are a comparatively new feature in railway work, and a detailed account of them will doubtless be interesting. Fig. 1 is a photograph of one of the generators at the Mt. Vernon power station. An idea of the size of these machines can be obtained from Fig. 2, which shows one of the workmen of the Westinghouse Company standing inside of the field of one of these machines in the Westinghouse shops.

From these views the general arrangement can readily be seen. The machines are similar in design to those seen at the World's Fair. They have 10 poles and a circular yoke, 12½ft. outside diameter. A valuable feature is that the field is divided vertically into two parts which can be slid apart on the base plate, giving access to the armature and field coils, so that repairs can readily be made without disturbing the engine.

The field is designed according to the usual Westinghouse practice, with cast-iron yoke, and wrought iron laminated pole pieces. These pole pieces are built of sheet iron punchings, held together with riveted end-plates, and the whole cast into the massive cast-iron yoke, thus securing effective protection against eddy currents in the cores, together with perfect magnetic contact between core and yoke. The machine is compound wound; but a new feature in the winding is that the series coils of the various pole pieces, instead of being connected in parallel, as is customary, are all connected in series, the entire current passing around each, which secures more perfect magnetic balance. These series coils have an enormous cross-section, and are made of strips of Lake Superior drawn copper, forged into spirals, taped and then compressed. The shunt coils are wound on substantial sheet-iron bobbins, and are connected in series with each other, as is usual.

The armature also shows some new departures. It has a slotted core built up as a ring, in sections of laminated sheets between two brass end-plates, and securely held together by mica insulated bolts. The laminated ring is pressed upon the cast-iron hub and securely keyed on. Fig. 3 shows a core of an armature of one of these 1,500-H.P. generators, finished and ready for the coils to be placed into the slots. Before being wound, this armature is pressed on the engine shaft by means of a hydraulic press. The armature coils are individual, and are wound on lathes into a special shape, all together to constitute a continuous parallel drum winding. They are well insulated with mica, and have to stand an insulation test of 5,000 volts alternating current, after being placed in the slots. The leading advantage in this method of construction, is that any given coil can readily be removed from the core without disturbing more than a few adjacent coils. No binding wires are used, either on the core or on the projecting ends of the coils. The armatures of the machines of the Philadelphia Traction Company were wound and connected after being mounted in place on the engine shaft, the entire work for a 1,500 H.P. generator consuming a remarkably short space of time; this method has the advantage of doing away with the risk involved in the transportation of a completely wound armature of these dimensions. The diameter of the 1,500-H.P. armature is $7\frac{1}{2}$ft., and its width is $22\frac{1}{2}$in.; the 750-H.P. armature, as used at the Sutherland-avenue station, is 6ft. in diameter and 25in. wide.

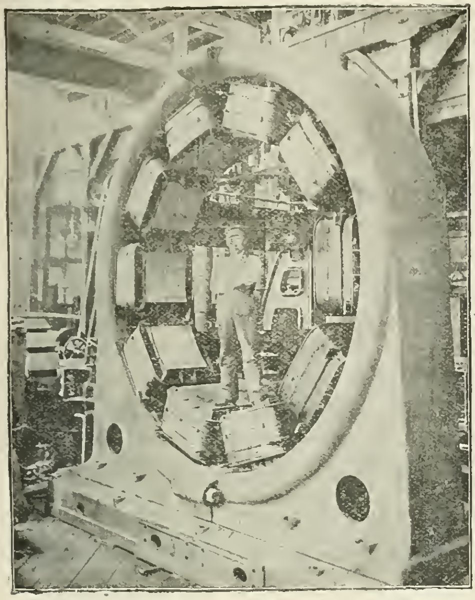

Fig. 2.

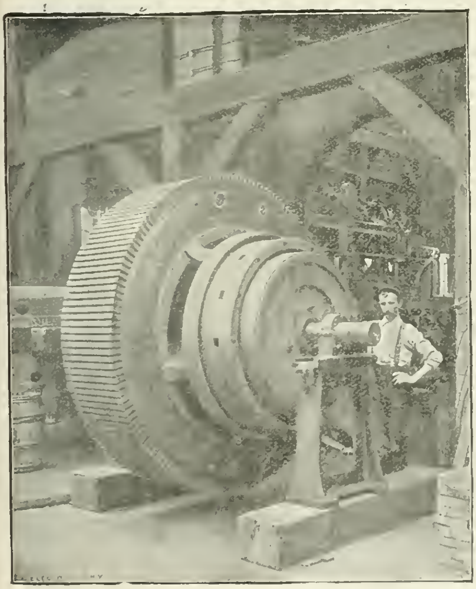

Fig. 3.

The commutators are entirely built up of drop-forged copper segments, insulated with pure mica. The segments are supported on a ring, making a part of the cast-iron armature hub, and are clamped together by taper rings in the usual way, the only, but important, difference being that the outside is made in sections, so as to allow any special strip, or part of the commutator, to be removed, in case of repair, without taking the whole apart. These commutators are subjected to a test of 5,000 volts alternating current before leaving the shops. The diameter of the one for the 1,500-H.P. machine is 5ft., and for the 750-H.P. machine is 4ft.

The current is collected by carbon brushes, five of which are located in each of the ten brush-holder arms. The brushes are individually clamped in a light brass housing, and this is connected to the support by a flexible copper shunt, thereby doing away with all sliding or vibrating contacts inside of the brush holder box. The ten arms are thoroughly insulated and fastened to the iron rocker spider, which can be revolved by means of hand wheels and worm gearing. The rocker spider is held by a stand which is bolted to the engine foundation, and allows the spider to rotate upon a bearing. The arrangement can be plainly seen in the photograph (Fig. 1). Formerly the brush holders were supported by arms bolted to the yokes, the bosses of which can be seen in the photograph. This rendered the brushes difficult of access, while the new plan, allowing of a well-insulated stairway to be built over the stand, enables the attendant to readily get at the brushes and also to go from one side of the machine to the other without going around the engines or through the basement. The shifting wheel is of the usual engine pattern, being a 19in. hand wheel on a 3ft. pedestal placed on the floor, one on each side of the machine.

The weight of the 1,500-H.P. generator, complete, excluding the shaft, is 130,000lb. (58 tons).

The 1,500-H.P. generator, running at a speed of 80 revolutions per minute, gives 2,250 amperes at 500 volts, while the 750-H.P. generator gives 1,125 amperes, running at the same speed and voltage. Machines of both sizes are running daily up to the maximum capacity without signs of heating, or any undue sparking at the brushes, and the engineers of the Philadelphia Traction Company say that they have given entire satisfaction so far.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, January 4th.

Institution of Electrical Engineers.

8 p.m. Students' Meeting at 28, Victoria-street, S.W. Election of a Representative Committee. Discussion on the Electric Traction Papers recently read before the Institution.

TUESDAY, January 8th.

Royal Institution.

3 p.m. Afternoon Juvenile Lecture. "The Work of an Electric Current," by Prof. J. A. Fleming, F.R.S.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. Monthly Ballot. The following Papers will be read:—(1) "The St. Gothard Mountain Railway and the Stanzer-Horn Cable Company," by Sigvard J. Berg. (2) "The Monistrol-Montserrat Rack-Railway," by Alfred Collett. (3) "The Usui Mountain Railway, Japan," by C. A. W. Pownall.

WEDNESDAY, January 9th.

Society of Arts.

7 p.m. Juvenile Lecture. "Waves and Ripples," by Prof. C. Vernon Boys.

THURSDAY, January 10th.

Institution of Electrical Engineers.

8 p.m. Ordinary Meeting at 25, Great George-street. Inaugural address of the President, Mr. R. E. Crompton

The Electrician.

(The Oldest Electrical Journal, 1861—1878.

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All letters intended for insertion in "The Electrician," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as evidence of good faith. No notice whatever will be taken of anonymous communications.*

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NOTICE.

With the current number of "The Electrician" are issued (Gratis to Subscribers) two Supplements: one a large Tabulated Statement, giving interesting particulars and details of Electric Supply Stations throughout London and the Provinces; the other a SHEET MAP, showing at a glance towns in England in which the Electric Light is supplied, either by a Local Authority or Private Company, and the System adopted (Continuous or Alternate-Current). Complaints of non-receipt should be at once sent to the Publisher.

Extra Copies of these Sheets can be obtained (post free), price 1s. 6d. in roller, or mounted for hanging, price 3s. 6d. varnished, 3s. unvarnished.

1894.

There can be no shadow of doubt that if manufacturers and business men were polled after the present most approved fashion of ascertaining public opinion, the vote in favour of the twelvemonth which has just passed over to the majority would be a phenomenally small one. Nevertheless, the revenue returns record that the country, taken as a whole, has materially prospered. In much the same way, we cannot help thinking that the totals deducible from the central station table published in the present issue give the "lie circumstantial" to much of the subdued pessimism met with in electrical circles. At the end of 1893 the total lamp connection of the United Kingdom amounted in round figures to 1,125,000; to-day the figure is nearly 1,600,000. A 42 per cent. increase cannot be considered compatible with utter ruin. Doubtless the vast amount of work implied by an addition of nearly half a million lights was divided among too many firms; but for that, alas, the blame must rest upon the "general order of things." Possibly, also, the growth of "isolated plants" has been somewhat checked by this great extension of public supply, and the gain may not, therefore, be a clear net gain. The contrary opinion is, however, held by many; certainly, there have been numerous big isolated plants laid down for railway-stations, goods yards, hotels, and country houses. Ship lighting also has shown no signs of having reached the stationary state. So much for the past. As to the future, a round dozen of central stations are in progress, and another round dozen are projected. But, as our map brings out very clearly, much more remains to be done. There are less than 120 electric supply systems at work or in hand in the United Kingdom. There are no less than 190 operative Provisional Orders in existence. Over 100 municipalities possess electric lighting powers; some 50 only have so far used them. Far too much fuss has been made about the incandescent gas burner. It is a rival, certainly, and not to be despised. On the other hand, there is no good ground for the panic which its advent appears to have given rise to abroad. Its clumsy shape, garish light, heat-emitting properties, and comparative fragility militate immensely against its adoption anywhere, except in places where appearance, health, comfort, and convenience are one and all secondary to cost. The only thing in connection with this much-puffed burner which electricians might do well to imitate is the energy with which it has been pushed. With the advent of a decent day-load—an advent not necessarily hopelessly remote—the average price of the Board of Trade unit may be expected to reach a figure rendering gas competition considerably less severe than it now is. Even as it is, public electric supply has made and is making healthy and encouraging progress.

Turning from the satisfactory picture presented by the electric lighting industry to the display made by electric traction, a very different state of things is immediately seen to exist. Since our last annual review was penned not one single new tramway or railway has been opened, only one of first-class importance has been got under weigh, and only one of first-class importance has been projected. The Douglas-Grondle-Glen line has, indeed, been extended to Laxey, the Waterloo and City Railway has been commenced, and the adoption of electricity by the Mersey Railway Company is contemplated, though the scheme is in an entirely embryonic, not to say problematic, stage. On the other hand, the Coventry tramways are still "In Progress," as they were this time last year, and the only new tramways in a progressive state are the Brighton-Rottingdean line and that decided upon by the Dublin Southern Tramways Company. Meanwhile London still waits patiently for its half-dozen tunnel railways. Seeing that the field open to electric traction is not only far freer from competitors than that which was open in this country to electric lighting, but is one of greater popular utility, our American friends may well be at a loss to comprehend why we in England remain so long, so obstinately and so complacently at a standstill. Certainly the cause of this comparative stagnation cannot have anything whatever to do with electrical or mechanical imperfections. The complete suitability and great economy of electricity when applied to urban railways have been demonstrated beyond dispute in Liverpool and in London, and if the meagre mileage of the United Kingdom counts for little as a proof of the suitability and economy of electric tramways, the thousands of miles of electrically-equipped track in the United States may be pointed to. The reasons for this apparently dogged disinclination to admit and make use of the advantages offered by electricity in the matter of rapid transit are threefold; social, political and financial. Climatic and racial reasons make even town-bred Englishmen prefer walking to riding, five days out of every seven and fifty weeks out of every year. Again, whilst "riding in a car" is, it would seem, the height of enjoyment across the Atlantic, it is with us deemed by many a somewhat painful process, to be borne indeed with cheerful resignation, but not to be deliberately sought after any more than any other of the trials of life. Fashionable, as well as industrial suburbs, are, it appears, developed in America by a happy combination of "real-estate men" and street-railway promoters. In England fashion fades away at the rumble of the tramcar wheels. With us, therefore, tramways are neither so frequently used nor so universally patronised as is the case in America. And side by side with this curtailment of sources of revenue comes the demand for Board of Trade standard equipment; and, over and above all, looms the day of municipal purchase, paralysing improvements of all sorts. The only practical solution of the present *impasse* seems either to be an alteration in the terms of the purchase clause of the Tramways Act, or the passing of an Act allowing and encouraging municipalities to lay down and work tramways. At present private enterprise is stifled and municipal enterprise hampered. Let us get over on to one side of the hedge or on to the other! From the point of view of the manufacturer of electric traction material there can, of course, be no doubt whatever that the more municipalisation there is, the better for him. From a more general standpoint it would seem as if it were almost preferable to do without tramways than to still further extend the area of operation of the parochial employé, who, as a *Times* letter-writter recently figured out from a London County Council return, can, when he is a municipal bricklayer, only manage to lay 23 bricks per day—of eight hours, of course. Let us hope this pertinacious arithmetician's arithmetic is in the wrong, and not the so-called layer of bricks. A last and most potent cause for the slow advance of electric traction in these islands is to be found—as Mr. Ferranti recently pointed out at the Institution of Electrical Engineers—in the fact that there is nothing analogous in this country to the General Electric Company of America. A well-established manufacturing concern, with ample supply of capital and of master patents, would not in all probability prove an unqualified blessing; but, to use a transatlantic colloquialism, it certainly would "make things hum."

The position in this country of the most promising miscellaneous application of electricity—namely, its application to mining purposes—is in many ways, and for much the same reasons, very similar to the just discussed position of electric traction. Lack of capital and the passive resistance of men and managers retard its more general introduction, and prevent it receiving the fair play it is entitled to. The Americans, however, promise to come to our rescue with a new mine, electrically-equipped from engine-house to face, and then—we shall see what we shall see, and the sooner the better. In France that strange contrivance, the Heilmann electric locomotive, has satisfied its happy possessors, the Compagnie des Chemins de Fer de l'Ouest, and two more "locos" endowed with all the improvements suggested by experience are on order, and are expected to come into regular service this spring. We can well imagine a sober stay-at-home central-station Willans engine putting to its 1,500-H.P. congener careering about on the new Heilmann locomotive the famous question, "Que diable fais-tu, mon cher, dans cette galère?" Another noteworthy event of 1894 has been the harnessing of Niagara; as the daily papers delight to term it. May the harness not prove too costly! But whether successful or not from an engineering and financial standpoint, it is an achievement not likely to be forgotten, nor to remain entirely barren of fruit of some kind. The courage with which Prof. George Forbes attacked and stuck to the task has been not the least remarkable feature of the undertaking.

In the telegraph world the past year will be memorable for the completion of those two most remarkable mountain lines, the Transandine and the Srinagar-Gilgit. Some progress has also been made with the interesting and important work of placing our lightships and rock lighthouses in telephonic or telegraphic communication with the shore. The induction method, however, still remains without an actual exemplar. The agreement between the Post Office and the National Telephone Company with reference to the purchase and working of the telephone trunk wires of the United Kingdom is still unsigned. Parliament shows every disposition to go back upon its previous decision, and who is there to say it nay? On the Continent interurban telephony is making rapid strides; a line connecting Berlin with Vienna came into public use on December 1st after the customary Imperial certificate of virtue had been granted, and on New Year's Day the Berlin-Memel line followed suit. In England, or rather in London, there has been an unobtrusive, though much appreciated, improvement in the telephone service, due mainly to the adoption of the twin-wire system.

In the cable world considerable interest has been excited by the two new Atlantic cables, with their abnormally heavy copper conductors, and their resultant abnormal capacity for high-speed transmission. In April the Eastern Extension Company laid a cable between Singapore, Labuan and Hong Kong —a length of 1,971 knots. In July the Colonial Conference at Ottawa passed a resolution in favour of the Pacific cable; tenders have since been invited and sent in, and the next step is awaited with some little curiosity. Seldom has the power of mere sentiment been more strikingly exemplified than in the matter of this Pacific cable. In July, also, the Silver Jubilee of Telegraphy to the Far East was appropriately celebrated at the Imperial Institute. It is satisfactory to think that the success which has attended British enterprise in this direction still awakens a feeling of pride, notwithstanding the present-day tendency to belaud State management and to deprecate vast private undertakings.

Ever since the legal birth of electric lighting—that is to say, ever since the Act of 1882—electrical engineers have come into contact with the Board of Trade at every turn. These collisions have until lately resulted more often than not in the evolution of heat, and a desire on the part of the atoms composing the electrical industry for a somewhat longer mean free path. Latterly, however, it has come to be generally recognised that if the Board of Trade sins it does so by Act of Parliament, and that the difficult task of filling in blank Bills left to it by a lazy Legislature is not one it takes to *con amore*, but with a high sense of duty, and with a desire to hold the balance evenly between the interests and safety of the public and the interests and profits of promoters; indeed, electrical engineers during the last twelve months had frequent occasion to exclaim, "Thank Heaven, we have a Board of Trade!" The conference called by that Department in February to consider its proposed electric traction regulations began the conversion of the electrical heathen, and the light railway and transformer pit conferences of last month completed it. Amongst the good deeds flowing from Board of Trade labours, the issue in August of an Order in Council legalising the Ohm, Volt, and Ampere must not be forgotten.

On the occasion of the death of a gifted writer recently the hierophants of literature settled it to their own supreme satisfaction that he was a classic; forgetting, it would seem, that no one can be said to be a classic until his writings have survived him at least a century. With this in view we will not be so presumptuous as to attempt to appraise to-day the value, potential or actual, of the scientific work of 1894. We will content ourselves with bald chronological references so far as it relates to Electricity. Early in the year Prof. du Bois beat the record in the matter of magnetic induction density; 38,000 lines in air and 60,000 in iron were his maxima. A little later Prof. Philip Lenard's detailed account of his curious and beautiful experiments with cathode rays excited much attention and no little controversy, the last word of which has been up to now Prof. J. J. Thomson's interesting and convincing Paper, which he read before the British Association, and in which he showed that the velocity of cathode rays agreed very nearly with the velocity which a negatively electrified atom of hydrogen would acquire under the influence of the potential fall which occurs at the cathode; thus casting grave doubt upon the hypothesis that these puzzling cathode ray phenomena are due to ethereal disturbances. It was at the British Association also that Mr. F. G. Bailey described his remarkable experimental corroboration of the truth of Prof. Ewing's molecular theory of magnetism. In June the new-born Verband der Elektrotechniker Deutschlands met at Leipzig, and were treated amongst other things to a highly suggestive Paper by Prof. Ostwald on "Modern Views of Electro-Chemistry"; one of the first fruits of which has been the scientifically interesting battery of Dr. Borchers.

The death-roll of 1894, containing as it does the names of Helmholtz and of Hertz, is indeed a heavy one. The significance of the scientific labours of these two men is too well recognised by electricians, and has too recently been sympathetically appreciated in these columns to need further elaboration. But in this age of self-seeking and self-sufficient scientists it may not, perhaps, be amiss to lay emphasis on the perfect modesty and generosity of two such men as Hertz and Helmholtz. "Little localised powers and little narrow streaks of specialised knowledge are things men are very apt to be conceited about. . . . Scientific knowledge, even in the most modest persons, has mingled with it a something which partakes of insolence. Absolute, peremptory facts are bullies, and those who keep company with them are apt to get a bullying habit of mind. . . ." We may console ourselves for the general truth of this observation in the remembrance that it did not apply to Hertz and Helmholtz more than to Henry or Faraday.

SUMMARY OF ELECTRICAL EVENTS FOR 1894.

January.

Death of Hertz (1st).

Metropolitan Traction Company of New York offer a $50,000 prize for a system of electric traction which shall be an improvement on the trolley.

Brighton Town Council decide to purchase the Brighton and Hove Electric Lighting Company's business for £5,000, and to make extensions of the municipal system, estimated to cost £30,000 (4th).

Worthing Town Council vote a sum of money to enable M. Hermite to carry out his electrolytic system of disinfection on a large scale.

Accumulator works classed by the Home Secretary amongst those in which dangerous or injurious processes are carried on (5th).

Prof. Minchin, by means of his sensitive cells, measures the photo-electric force of the stars.

Death of Capt. Robert C. Halpin (20th).

Death of Mr. G. B. Prescott, electrician to the Western Union Company.

Prof. Henry Rowland brings an action for $30,000 against the Cataract Construction Company in payment of services rendered; awarded $9,000.

Dividends declared: Anglo-American Telegraph Company, 2½ per cent.; St. James and Pall Mall Electric Light Company, 4½ per cent.; City and South London Railway Company, ⅝ per cent.

February.

Public trials of the Heilmann Electric Locomotive (9th and 10th).

Paper read before the Society of Arts by Mr. E. O. Walker on "Telegraphic Communication between England and India: its Present Condition and Future Development" (8th).

Maj.-Gen. Webber reads a Paper entitled "Some Notes on the Electric Lighting of the City of London" before the Institution of Electrical Engineers (8th).

Conference at the Board of Trade on the subject of the proposed Electric Traction Regulations (21st and 23rd).

Trial of the Hermite Sewage Process at Worthing.

Paper read before the Institution of Electrical Engineers by Mr. Gisbert Kapp on "Methods of Testing the Magnetic Qualities of Iron" (22nd).

An Induction Density of 38,000 in Air and of 60,000 in Iron attained by Herr du Bois.

Dividends declared: Kensington and Knightsbridge Electric Lighting Company, 5 per cent.; Newcastle and District Electric Lighting Company, 5½ per cent.; India Rubber, Gutta-Percha and Telegraph Works Company, 12½ per cent.; Newcastle-upon-Tyne Electric Supply Company, 4 per cent.; Telegraph

Construction and Maintenance Company, 20 per cent.; Chelsea Electricity Supply Company, 5 per cent.; Westminster Electric Supply Corporation, 4 per cent.; Charing Cross and Strand Electric Supply Company, 4½ per cent.; Liverpool Electric Supply Company, 5 per cent.; Birmingham Electric Supply Company, 4 per cent.

MARCH.

Action brought by Messrs. Muirhead against the Commercial Cable Company in connection with the payment of royalty for use of their American "duplex" patent No. 234,490 of 1880.

Meeting of an Australasian Postal Conference at Wellington, various resolutions supporting a trans-Pacific Cable passed.

Issue of the Board of Trade Electric Tramway Regulations (6th).

Successful Telephone Experiments carried out between Berlin and Trieste (600 miles).

Paper "On Parallel Working with Special Reference to Long Lines" read before the Institution of Electrical Engineers by Mr. Mordey (8th).

Telephonic communication effected with the Kentish Knock and North Goodwin lightships.

Opening of the Transandine line of the Pacific and European Telegraph Company (19th).

Publication of some important researches on "Cathode Rays," by P. Lenard.

Important Paper on "A New Alternate-current System" read before the National Electric Light Association at Washington by Mr. C. F. Scott, of the Westinghouse Company.

Municipal electric lighting stations opened at Oldham and Londonderry.

The Waterloo and City Railway Company invites public subscriptions.

Visit of a Committee of Trinity House to inspect the La Hève Electric Lighthouse.

The American Institute of Electrical Engineers adopt the names of Gauss, Weber, Oersted and Gilbert for the units of magnetic flux-density, flux, reluctance, and magnetomotive force (21st).

Dividends declared: W. T. Henley's Telegraph Works Company, 5 per cent.; Commercial Cable Company, 7 per cent.; Hastings and St. Leonards-on-Sea Electric Light Company, 5 per cent.; Pontypool Electric Light and Power Company, 2⅝ per cent.; Direct Spanish Telegraph Company, 4 per cent.; Eastbourne Electric Light Company, 5 per cent.; Morecambe Electric Light and Power Company, 2 per cent.

APRIL.

Publication of the Second Report of the Royal Commission on Electrical Communication with Lighthouses and Lightvessels.

Death of M. Paul Jablochkoff (6th).

Opening of the Lancaster Municipal Electric Lighting Station (14th).

In an action for damages and injunction brought against the City of London Electric Lighting Company, Mr. Justice Kekewich in giving judgment for damages ruled that electricity supply companies are not exempt by reason of their statutory powers from actions at Common Law for nuisance (19th).

Paper on the "Cost of Electrical Energy" read before the Institution of Electrical Engineers by Mr. R. E. B. Crompton (26th).

In the vibration action, Wise *v.* Metropolitan Electric Supply Company, Mr. Justice Stirling gave judgment in favour of the plaintiff; but suspended the operation of the injunction for three months (27th).

Judgment given by Mr. Justice Kennedy in favour of the plaintiff in the action, Muirhead *v.* Commercial Cable Company. Defendant Company sought to prove that the plaintiff, to whom they were paying royalty under an American duplex patent, No. 234,490 of 1880, had anticipated himself in his English patent No. 2,564 of 1876, thereby causing his American patent to expire in 1891 simultaneously with the similar English one (28th).

Important Paper on "Destructive Effect of Electrical Currents on Subterranean Metal Pipes," read before the American Institute of Electrical Engineers by Mr. I. H. Farnham.

Presidential address to the Institution of Mechanical Engineers delivered by Prof. A. B. W. Kennedy.

Dividends declared: Eastern Extension Telegraph Company, 7 per cent.; Indo-European Telegraph Company, 10 per cent.; Metropolitan Electric Supply Company, 2 per cent.

MAY.

Sanction given by the Emperor to the Berlin Overhead Electric Railway.

Death of Dr. K. E. Zetsche, the well-known Continental telegraph engineer.

"James Forrest" lecture on "The Relation of Mathematics to Engineering," delivered by Dr. John Hopkinson before the Institution of Civil Engineers (3rd).

The American Institute of Electrical Engineers at their annual meeting at Philadelphia adopt the names "inductance" and "reactance" respectively, for coefficient of self-induction, and inductive resistance.

Cambridge Engineering Laboratory opened by Lord Kelvin (15th).

Jubilee of the American Telegraph (24th).

Dividends declared: Consolidated Telephone Construction and Maintenance Company, 2 per cent.; London-Platino Brazilian Telegraph Company, 2½ per cent.; Western Brazilian Telegraph Company, 2½ per cent.

JUNE.

Friday Evening Discourse by Dr. Oliver Lodge on "The Work of Hertz" (1st).

Great Northern Telegraph Company celebrates the Twenty-fifth Anniversary of its existence (1st).

The Promoters of the Electric Railway from the City to Epping Forest withdraw their Bill owing to the onerous conditions as to workmen's trains sought to be imposed by the London County Council (5th).

Opening of the Portsmouth Municipal Electric Light Station (6th).

Mr. Emile Garcke elected Chairman of the Electrical and Allied Trades Section of the London Chamber of Commerce (7th).

Work commenced on the Waterloo and City Railway.

Public examination of the Directors of Woodhouse and Rawson United (Limited) commenced.

Death of M. Edmond Carré, of electric carbon fame.

Meeting at Leipzig of the Verband der Elektrotechniker Deutschlands; important Paper by Prof. Ostwald on "Modern Views of Electro-Chemistry."

A series of trade conferences on technical education matters held by the London Technical Education Board.

The Metropolitan Traction Company accept offer of the General Electric Company to lay down in New York three miles of line on the Budapest conduit system.

Paper on "The Rotation of the Electric Arc," read before the Royal Society by Mr. A. P. Trotter (21st).

Lighting of the entire sea front at Hastings by alternate-current arcs (30th).

Dividends declared: Electric and General Investment Company, 25 per cent.; Telegraph Manufacturing Company, 7½ per cent.

JULY.

Mr. Ludwig Mond endows the Royal Institution with a physical-chemistry research Laboratory to be called the "Davy-Faraday" Laboratory.

Mr. S. A. Varley is granted a Government Pension of £50 per annum.

The laying of the Commercial Cable Company's third Atlantic cable completed by the "Faraday" (2nd).

The London County Council and the promoters of the City and Epping Forest Railway arrive at a compromise with regard to the running of workmen's trains and the Bill is recomitted (9th).

The Inter-Colonial Congress at Ottawa adopts a resolution asking the Canadian Government to move in the matter of furthering the laying of a Pacific cable.

Action brought by the Anglo-American Telegraph Company against the Compagnie Française du Télégraphe de Paris à New York for rupture of a common-purse agreement decided in favour of the former concern (10th).

Celebration of the Silver Jubilee of Submarine Telegraphy to the Far East (20th).

Successful trials of Prof. Elisha Gray's Telautograph between London and Dover (22nd).

Opening of the Municipal Electric Lighting Station at Hanley (26th).

Completion of the laying of the new Anglo-American cable (27th).

The House of Lords decides that the price of a tramway line purchased by a municipality under the 43rd clause of the Tramways Act is to be the cost of erecting and establishing a similar line in a similar condition (30th).

Douglas-Laxey Electric Tramway opened (28th).

Dividends declared: Eastern Telegraph Company, 6½ per cent.; Direct United States Telegraph Company, 2⅝; National Telephone Company, 5 per cent.; Electrical Power Storage Company, 5 per cent.; Edison and Swan United Electric Light Company 6 per cent.; Globe Telegraph and Trust Company 4½ per cent.

AUGUST.

The Siemens-Halske factory at Chicago burnt down (1st).

Meeting of the British Association at Oxford: Important Papers read by Prof. J. J. Thomson, on "The Velocity of Cathode Rays," and by Mr. F. G. Bailey on "A Remarkable Experimental Corroboration of the Truth of Prof. Ewing's Molecular Theory of Magnetism" (8th).

The business of the London Electric Supply Corporation placed in the hands of a Receiver at the instance of Lord Wantage.

Close of the public examination of the Directors of Woodhouse and Rawson United (Limited) (8th).

The Compagnie des Chemins de Fer de l'Ouest, satisfied with the performance of the Heilmann experimental electric locomotive, orders two additional ones.

Draft of the proposed agreement between the Postmaster-General and the National Telephone Company laid on the table of the House of Commons; its signature postponed until the next Session.

Suspension of the publication of *La Lumière Électrique*.

Order in Council published legalising the ohm, volt, and ampere (23rd).

Dividend declared: Cuba Submarine Telegraph Company, 8 per cent.

SEPTEMBER.

Death of von Helmholtz (8th).

Publication of new French electrical journals, *L'Éclairage Électrique* and *L'Énergie Électrique*.

Berlin Municipality agree to the construction of the proposed overhead electric railway.

Dividend declared: Brush Electrical Engineering Company, 5 per cent.

OCTOBER.

Opening of the Hampstead Vestry Electric Lighting Station (1st).

Opening of the Ealing Municipal Electric Lighting Station (3rd).

Concession for an underground electric railway in Vienna granted.

Hermite electrical sanitation process adopted at Ipswich (10th).

Opening of the Worcester water-power Municipal Electric Lighting Station (11th).

Preliminary injunction obtained in the United States against the manufacturers of the chloride accumulator.

Amalgamation of the Société Française des Télégraphes Sous-marins and the Compagnie Française du Télégraphe de Paris and New York.

Opening of the Bolton Municipal Electric Lighting Station (31st).

Dividends declared: Brazilian Submarine Telegraph Company, 6 per cent.; Venezuela Telephone and Electrical Appliances Company, 4 per cent.

NOVEMBER.

Opening of the Southport Municipal Electric Lighting Station (9th).

Expiry of the Swan "parchmentised cotton filament" patent (27th).

New platinum standard of light proposed by the Reichsanstalt.

Hammersmith Vestry accord permission to the London United Tramways Company to run an overhead-wire electric tramway from Shepherd's Bush to Acton.

Indian Government award Mr. Melhuish of the Telegraph Department a special bonus on account of his telegraphic inventions.

Spanish Government appoint a Royal Commission to inquire into the condition of the telegraph service.

Rumford Medal awarded to Prof. Dewar for his low temperature researches; a Royal Medal awarded to Prof. J. J. Thomson for his contributions to electrical theory.

Accident to the City of London Electric Lighting Company's mains in Cannon-street (19th).

London County Council decides that all future electric lighting loans shall be for 50 or for 20 years, according to the nature of the expenditure (20th).

DECEMBER.

Berlin-Vienna Telephone Line opened (1st).

Board of Trade Conference on Light Railways (6th).

Bedford Municipal Electric Lighting Station opened (6th).

Dewsbury Municipal Electric Lighting Station opened (10th).

Board of Trade Conference on Transformer Pits; decided not to veto general principal (13th and 20th).

Court of Appeal decide that the English Muirhead "duplex" patent of 1876 did anticipate that taken out in America in 1880 (18th).

Court of Appeal decide that an injunction shall issue against the City of London Electric Lighting Company in the action brought against them by Mr. Shelfer (18th).

Berliner Telephone patent declared void by the United States Circuit Court.

Electric Tramway Concession granted for Cairo.

Amalgamation of all the storage-battery interests in the United States.

Leicester Municipal Electric Lighting Station commences supply (19th).

M. Violle contributes a Paper to the Académie des Sciences, in which he states that his experiments tend to show that the temperature of the arc itself is greater than that of the crater.

THE ELECTRIC RAILWAYS AND TRAMWAYS OF THE UNITED KINGDOM.

Place.	Length.	System.	Worked by.
In Operation—	Miles.		
Bessbrook—Newry ..	3¼	Third Rail (Dr. E. Hopkinson)	Bessbrook and Newry Tramway Company.
Birmingham	3	Accumulator Cars	Birmingham Central Tramways Company.
Blackpool	2	Holroyd - Smith's Conduit	Blackpool Corporation
Brighton	1	Third Rail (Volk)	Mr. Magnus Volk.
Carstairs	1¼	Anderson - Munro	Mr. J. Monteith, of Carstairs (Private).
City and South London Railway (King William - street—Stockwell)	3¼	Third Rail (Dr. E. Hopkinson)	City and South London Railway Company
Douglas—Laxey (I. of Man)	7	Under-Running "Bar" (Dr. E. Hopkinson)	Douglas Laxey Electric Tramway Co.
Guernsey	2¾	Overhead (Siemens)	Guernsey Railway Company
Leeds (Roundhay Park Line)	3¾	Thomson-Houston Overhead Trolley	Thomson - Houston International Electric Company.
Liverpool Overhead Railway	6¼	Third Rail	Liverpool Overhead Railway Company.
Portrush (Giant's Causeway)	8	Third Rail (Siemens)	Giant's Causeway Electric Tramway Co.
Ryde	¾	Third Rail (Siemens)	Ryde Pier Company.
Southend Pier	1¼	Third Rail (Crompton)	Southend Corporation
Walsall, Wednesbury, Bloxwich, and Darlaston	8	Overhead Side Trolley	South Staffordshire Tramways Company.
In Progress :—			
Brighton — Rottingdean	3	Accumulators ...	Brighton and Rottingdean Seashore Railway Company.
Coventry	5¾	Overhead Trolley .	Coventry Electric Tramways (Limited)
Dublin	...	...	Dublin Southern Tramways Company.
Waterloo—City	1½	...	South-Western Railway Company.
Projected :—		...	
Birkenhead	...	...	Mersey Railway Co.
Cork	1¾	...	...
Deganway (Wales)	...		...
Douglas (I. of Man)	2½	Overhead Trolley .	Douglas Southern Electric Tramways (Limited).
London—			
Central London Railway (City and Shepherd's Bush)	6½	...	Central London Railway Company.
City & South London Railway Extensions—			
Clapham	1	Third Rail (Dr. E. Hopkinson)	City & South London Railway Company.
Islington	2¾		
Finsbury Park and City	3¼	...	...
Finsbury — Walthamstow	3½	...	...
Hampstead, St. Pancras, and Charing-cross	5¼	...	...
Shepherd's Bush—Acton	...	Overhead Trolley .	London United Tramways Company.
Waterloo — Baker-street	3	..	...
Snowdon	...	...	Snowdon Mountain Tramroad and Hotel Company.

ELECTRIC LIGHTING NOTICES.

(SESSION 1895.)

The following is a list of applications for Provisional Orders deposited with the Board of Trade by the 21st ult. under the provisions of the Electric Lighting Acts of 1882 and 1888. On p. 171 of our issue of December 7th we published a list of applications advertised in the *London Gazette* during the months of October and November. The two lists are very much alike, though the second is always shorter than the first, owing possibly to the necessity of sending in a £50 fee with the miscellaneous and multitudinous documents that have to be deposited with the Board of Trade by December 21st. The deposit of the £50 fee may be taken as an outward and visible sign that the promoters are in earnest. Hence the list we publish below may be considered reliably indicative of the amount of additional electric lighting work that will receive Parliamentary sanction during the next twelve months. There are in all 29 applications, 24 of which relate to the Provinces and 5 to London. Of these 29 applications, 14 are by local authorities and 15 by companies.

THE METROPOLIS.

Districts.	Names of Applicants.
Battersea	County of London and Brush Provincial Electric Lighting Company.
Newington	County of London and Brush Provincial Electric Lighting Company.
Notting Hill (a portion of the Parish of St. Mary Abbotts, Kensington)	Notting Hill Electric Lighting Company.
St. Olave's (District of the Board of Works)	County of London and Brush Provincial Electric Lighting Company.
Strand (District of the Board of Works)	Charing Cross and Strand Electricity Supply Corporation.

THE PROVINCES.

Towns.	Applicants.
Alderley Edge	Urban District Council.
Bath	City of Bath Electric Lighting and Engineering Company.
Bootle	Corporation.
Brechin	Scottish House-to-House Electricity Company.
Carlisle	Corporation.
Leigh	Local Board.
Liverpool (Toxteth Park)	Liverpool Electric Supply Company.
Llandudno	Urban District Council.
Luton	Corporation.
Margate	Municipal Electric Light and Power Corporation.
Montrose	Scottish House-to-House Electricity Company.
Motherwell	Commissioners of the Burgh.
New Windsor	Corporation
Pontypool	Pontypool Electric Light and Power Company.
Prescot (District)	British Insulated Wire Company.
Radcliffe	Urban District Council.
Salisbury	Salisbury Electric Light Supply Company.
Southampton	Southampton Electric Light and Power Company.
Stirling	Commissioners of the Burgh.
Swindon (New Town)	Local Board.
Walthamstow	Local Board.
Winchester	Corporation.
Windermere (District)	Windermere and District Electricity Supply Company.
Worthing	Corporation.

NEW PUBLIC COMPANIES OF 1894.

The following are the more important limited liability companies connected with the electrical engineering and allied industries registered during the past year, with their capital :—

	Capital.
Allan (William) and Co.	£50,000
Altrincham Electric Supply	50,000
Aluminium and General Foundry Syndicate	10,300
Aluminium Soldering Company	10,000
Angular-Hole Machine Company	35,000
Ariel Arc Lamp Syndicate	20,200
Armanni Automatic Stamping Company	212,000
Bailey and Garnett	10,000
Baird, Thompson and Co.	60,000
Barnett (Rowland) and Co.	20,000
Baron (F. E.) and Co.	6,000
Barraclough (William)	12,608
Belcher's Patent Smoke Preventer Company	1,000
Birmingham Stamping and Tool Company	6,000
Boote (T. and R.)	50,000
Bowes-Scott and Western	10,000
Brayton Petroleum Motor Company	80,000
Brightside Foundry Company	25,000
British Aluminium Company	100,000
British and Foreign Electric and Engineering Company	2 000
Bronze Steel Syndicate	6,000
Californian Electric Power and Mining Development Syndicate	30,000
Canadian Mica Company	90,000
Capsule Battery Company	30,000
Carbon Syndicate	100,000
Central Chili Copper Company	255,000
Chadburn and Son	30,000
Commercial Electricity Supply Company	2,000
Coventry Electrical Engineering Company	5,000
Cowper-Coles Galvanising Syndicate	2,000
Cruts Incandescent Lamp Agency	5,000
Dalziel's News	150,000
Dawson Gas Engines Syndicate	70,000
Denison Auto-Telegraph Machine Syndicate	1,000
Easton, Anderson and Goolden	200,000
Economic Electric Specialty Company	50,000
Edmondson Electricity Meter Syndicate	2,000
Electric Exploitation Company	25,000
Electric Motive Power Company	20,000
Electric Novelty Syndicate	4,500
Electric Time-Distributing and Clock Company	5,000
Electric Traction Company	300,000
Electricity Users' Association	2,000
Electro-Chemical Company	200,000
Electrophone	20,000
Elieson Electrical Switch	5.000
English and Colonial Electric Light Company	50,000
Exploitation	1,250
Foreign Chemical and Electrolytic Syndicate	3,000
Fowler, Lancaster and Co.	50,000
Fraser and Fraser	30,000
Froggatt's Electric Lighting Company	3,000
Froggatt's Inventions Syndicate	1,000
Fulgur Electric Lighting Company	7
Gas and Oil Engine and Dynamo Supply Company	5,000
General Exploitations	20,000
Great Western Electric Light and Power Company	1,000
Hall Electrical Company	4,000
Hall (Robert) and Sons, Bury	75,000
Hampstead General Electric Fittings Company	1,000
"Harp" Arc Lamp Syndicate	5,000
Hemming and Co.	25,000
Herbert (Alfred)	25,000
Hooper's Telegraph and India-Rubber Works	50,000
Hopkinson, (J.) and Co.	40,000
Immisch Electric Launch Company	12,000
International Electric Storage	200,000
Joyner (Charles) and Co.	35,000
Kerbey Bowen	20,000
Kerr, Stuart and Co.	60,000
"La Boite Magique"	3,000
Lancashire Rubber Company	70,000
Lancaster (William) and Co.	25,000
Las Carbesses Manganese Mines	250,000
Liquor Register Syndicate	18,000
Liverpool Rubber Company	123,117½
Llandudno Electric Supply Company	15,000
London Mathematical Society	—
London Refuse Steam Generator and Electrical Power Corporation	600,000
Lynton and Lynmouth Electric Light Company	8,000
Marine Steam Turbine Company	25,000
McDowell, Steven and Co.	200,000
Metropolitan Tramways and Omnibus Company	1,00,0000
Mildé Telephone and Electric Supply Company	20,000
Mills (John) and Sons	25,000
Mitchell, Corbitt and Sons	50,000
Nalder and Harrison Construction Syndicate	15,000
National Electric Engineering Company	5,000
Newport Electrical Engineering Company	2,000
Non-Corroding Silver Metal Syndicate	20,000
Northern Engineers' Supply Company	3,000
Oriental Telephone and Electric Light Company	200,000
Parker (Thomas)	75,000
Pass (C.) and Son	100,000
Patent Enamel Company	60,000
Patents Pioneer Syndicate	10,000
Pilling (John) and Sons	50,000
Putney Electric Supply Company	1,000
Randall's Phonantograph Company	25,000
Revolution Wooden Pulley Company	20,000
Richardson (Thomas) and Sons	250,000
Robinson and Auden	35,000
Royce (F. H.) and Co.	30,500
Salisbury Electric Light and Supply Company	20,000
Saycee Electrical Syndicate	10,000
Scott (Ronald A.)	10,000
Shanks (Alexander) and Sons	50,000
Smith (William) and Brothers	100,000
Snowdon Mountain Tramroad and Hotels Company	70,000
Spanish Telephone Company	16,000
Standard Wire Company	50,000
Station Indicator Company	50,000

	Capital.
Steel and Garland	£40,000
Syndicat de Traction par le Gaz	20,000
Taylor's Smokeless Boiler Syndicate	30,000
Telpher Cable and Cliff Railway Syndicate	6,000
Tramway Motor Company	200,000
Vegetable Silica Patents Insulating Syndicate	5,000
Vulcan Gas Engine Company	1,000
Wigston Electrical and Engineering Company	25,000
Willans and Robinson	300,000
"Williams" Valveless Engine Company	25,000
Wimshurst, Hollick and Co.	40,000
Windermere and District Electricity Supply Company	40,000
Wray Electrical Engineering Company	10,000
Wrigley's Patents	60,000
Yorkshire Steam-Valve Company	40,000

PUBLIC COMPANIES WOUND UP, DISSOLVED, &c., IN 1894.

The following are amongst the limited liability companies which have been wound up during the past year, the asterisk denoting that the Company was wound up by order of the Court :—

*Agence Dalziel.
Arcas Plating Company.
*Barnard, Bishop and Barnards.
Blakey, Emmott and Co.
*Bolton (R.) and Co.
*Collier Audible Telephone Syndicate.
*Common Petroleum Engine Company.
Crossley Telephone Company.
Dalziel's Cable News Agency.
District Messenger Company of Paris.
Domestic Telephone Company.
Easton and Anderson (reconstructed as Easton, Anderson and Goolden).
Electric Arms and Ammunition Syndicate.
Elmore's French Patent Copper Depositing Company (reconstructed).
English Electric Manufacturing Company.
Field's "M.P." Development Association.
Fowler's Engineering Company.
General Electric Power and Traction Company.
Gülcher (New) Electric Light and Power Company.
Herculite and Electrical Manufacturing Company.
Home Telephone Company (business taken over by the National Telephone Company).
International Electric Subway Company.
Latimer Clark, Muirhead and Co.
Lithanode and General Electric Company.
New Telephone Company.
*Newington, Priddle and Co.
Orient Electric Light Company.
Panulcillo Copper Company (business acquired by the Central Chili Copper Company).
Platinum Plating Company.
Practical Electro-Plating and Enamelling Company.
Roper's Electrical Engineering Company.
Swan United Electric Light Company (undertaking acquired by the Edison and Swan United Electric Light Company).
Swan's Electric Light Company.
Wells, Gallimore and Taylor.

The following companies have been dissolved, or have ceased to exist, in most cases nothing having been done beyond registration, and no business having been commenced :—

American River Electric Power Supply Company.
Automatic Electric Supply Company.
Automatic Electrical Corporation.
British Electric Propulsion and Traction Company.
Electric Semaphore Signal Syndicate.
Electric Stores.
Electrical Inventions Company.
Electrical Works Construction and Maintenance Company.
Electro-Galvanic Machine Company.
Eston Arc Lamp Syndicate.
Fibrite Syndicate.
Froggatt's Invention Syndicate.
Hampstead Electric Light and Power Company.
Holloway Electricity Supply Company.
Hoster, Albert.
Ipswich Electricity Supply Company.
New Electro-Amalgamator Company.
Pontypridd Electric Lighting Company.
Portland Electric Light Company.
St. Luke's, Chelsea, Electric Lighting Company.
Thompson's Electrical Fitting and Screw-Cutting Company.
Woking Electric Supply Company.
Wolverhampton Electric Light and Power Company.

ELECTRICITY DIRECT FROM FUEL.*

BY C. J. REED.

The recent experiments of Dr. W. Borchers on the direct production of electricity from fuel gases, described in the *Electrical World* Digest of December 8th (*see* also *The Electrician*, November 30, 1894, p. 139), are not as hopeful as one might think from the erroneous conclusions which Dr. Borchers has drawn from his experiments. While the doctor is undoubtedly working in the right direction, he has, in the experiments described, accomplished absolutely nothing. If the doctor will carefully analyse the materials he employs and the products he obtains, he will make another startling discovery. He will discover :

1. That the increase in weight of his copper tubes is due to the formation of a coating of insoluble cuprous chloride, Cu_2Cl_2, produced by corrosion of the copper tubes.

2. That the oxygen absorbed by the cuprous chloride solution does not combine at all with the carbon monoxide or other fuel gases, but is used solely in oxidising the cuprous to cupric chloride according to the following equation.

$$O+\underset{\substack{\text{Cuprous}\\\text{Chloride}}}{Cu_2Cl_2}+2HCl=\underset{\substack{\text{Cupric}\\\text{Chloride}}}{2CuCl_2}+H_2O.$$

The ultimate and only product of the reaction is cupric chloride produced at the expense of the copper tubes.

3. That the energy evolved as electric current is due to this corrosion of the copper tubes and to nothing else.

4. That the same results would have been obtained by his apparatus if he had not used any gases at all.

If the reactions supposed by the doctor to have taken place did actually occur, they would occur in the same manner with both electrodes of carbon, and there would be a continuous evolution of carbon dioxide. Even if the reaction did actually take place, the arrangement would be of no practical value, as the cuprous chloride, Cu_2Cl_2, rapidly changes in the presence of air *by the absorption of oxygen* to cupric chloride, $CuCl_2$, which would have to be continually reduced by metallic copper or an equivalent reducing agent. In that case an ordinary zinc primary battery is more economical than a copper battery.

The writer tried about a year ago the same experiments described by Dr. Borchers, using carbon tubes for both electrodes instead of copper. Over 100 different solutions, including cuprous chloride, were tried as electrolytes. I was unable to find that any two gases would combine spontaneously under these conditions unless they were capable of combining spontaneously at low temperatures when brought in contact with each other in the gaseous state. Electrolytic gases formed at the electrodes by an electric current will recombine. But I was unable to get positive evidence of combination of even oxygen and hydrogen obtained from other sources and free from ozone and other impurities.

ON THE PRODUCTION OF ROTARY MAGNETIC FIELDS BY A SINGLE ALTERNATING CURRENT.†

BY LUDWIG GUTMANN.

Since the first announcements of Prof. Ferraris and Mr. Tesla that rotation can be accomplished by employing two or more alternating currents of displaced phase, the question has been raised by many an engineer as to the possibility of producing a rotary magnetic field by the use of a single circuit, carrying the ordinary alternating current, instead of requiring three or more wires or several independent circuits. So far it has been necessary to construct a special generator armature, the windings of which were rotated in a field of constant polarity, to produce two or more currents lagging in phase behind each other. To use the currents generated for establishing a progressive or rotary field it was necessary to carry as many wires to the place of consumption as currents were employed differing in phase. Six years have passed, and quite rapid progress has been made in various directions. I wish now to bring to your notice a method of generating a rotary magnetic field by a single alternating current or its field without condensers or choking coils. This is accomplished by a device brought out by me some three years ago. Its fundamental principle is hardly as yet appreciated ; however, the World's Fair exhibits, as well as literature of late, show that the device has attracted attention, and that several engineers have approached the principle involved.

I wish to refer to my motor, and especially to its armature described in 1891.‡ Fig. 1 and 2 show the device. The former is principally used in the American patents, while the latter is given in the English patent of the same year. The novelty of the armature construction lies in a winding containing closed sub-circuits; and another point is that the closed circuits do not coincide in number with the poles of the field magnet. Before going into the action of this device I will mention two simple experiments which are essential in order to understand the operation of this rotary magnetic field system.

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* From the *Electrical World* of New York.

† Paper read before the American Institute of Electrical Engineers, December 19th.

‡ *Electrical Engineer* (New York), Vol. XII., Aug. 26, 1891, p. 230,

If we have a closed coil moving in an alternating magnetic field, or better, between the poles of *a field magnet*, as illustrated in Figs. 3 and 3A, energised by alternating currents; then the coil A will be repelled from the pole, owing to the secondary field which it establishes, so long as it cuts, or is threaded by the lines of force of the field. The consequence is that it will rotate, and place itself between the north and south pole, Fig. 4, where it reaches a *stable magnetic equilibrium*, as I like to term it, because in this position it acts like a pendulum properly suspended (Fig. 5). Any motion imparted causes the pendulum to make a few oscillations and come to rest, and similarly any attempt made to move the coil into an energised field will cause it to be repelled, and after a few oscillations it will remain at rest between the poles. It is repelled in either direction, because, as soon as it approaches a strong magnetic flux, currents are induced in its windings and create an opposing field. The same coil can be in unstable magnetic equilibrium (Fig. 6) if it stands just in front of a pole, in which position it would act like a pendulum which is balanced with the weight above the point of support (Fig. 7). Both are in unstable equilibrium; the least motion to the left or right imparted to either will cause them to accelerate in the direction of the impulse, and to assume a position of stability (Figs. 4 and 5). In this position (Fig. 4) the coil is therefore currentless. *This stable position is the natural position of synchronous motors in operation.*

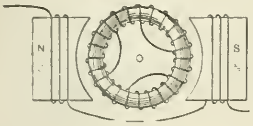

FIG. 1.

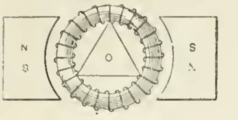

FIG. 2.

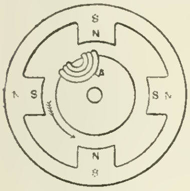

FIG. 3.

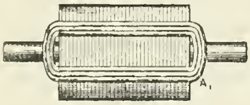

FIG. 3A.

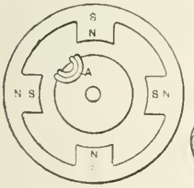

FIG. 4.

FIG. 5.

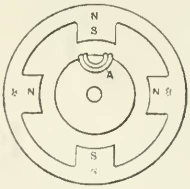

FIG. 6.

FIG. 7.

If such a synchronous motor is held behind the phase when rotating under load, a heavier current is induced in the spools which accelerate the armature and keep it in step. If, however, the motor runs in harmony and suddenly a great deal of the load is taken off then the armature has a tendency to go more quickly, but in this case opposing currents are generated in the windings which retard the speed of the armature and keep it back, to remain in step or in stability.

Let us look into the device before us, and consider first its quality as a motor. Returning to Figs. 1 and 2, preferably the latter, which is simpler and easier to explain, we find that if we send into the field magnet coil an alternating current the armature will turn through a certain angle and stop. This motion depends upon the position of the three closed coils with respect to the two poles. This same device can itself be self-starting if we make the poles far enough apart and the energising current sufficiently strong, so that at the initial speed the armature is repelled at a certain rate. This initial speed changes with the number of poles, closed circuits, and alternations. Let us take the first case, and examine it. If we try to rotate the *armature* (as I shall call it hereafter) in a field of alternating polarity, we induce currents in the closed circuits, which establish poles; but these poles are alternating in nature, and owing to the motion imparted, and owing, further, to the permanent connections in the winding, the poles move or travel with the latter. This accounts for the fact that if the field poles are close together the armature consumes power during its rotation through the alternating field; it acts as a dynamo and does not start from a state of rest. If we impart by mechanical means an impulse to the armature, currents are generated whose sum has a variable and principally negative value. The armature makes a few revolutions and places itself in a stable magnetic equilibrium, viz., in such a position, symmetrical if possible, as not to generate any currents, and hence not to induce any reactionary* poles in the core. If, however, we impart to this armature a certain initial speed, which I shall call *the critical speed*, then it will continue to rotate with a tendency to reach a certain fixed higher speed. This initial impulse may be given by mechanical or electrical means. I shall not state the results as yet, but prefer to explore the action first, so that the same may be before us in various diagrams, and enable us to make any deduction desirable. First, let us assume that the armature rotates synchronously; it is evident that, in order to have an armature with three close-circuited coils, interconnected as shown, rotate in one direction, we must have currents induced whose sum has a positive value—viz., two of the coils must do work, in the same sense, while the third coil is either without a current or has a smaller current in opposite direction, so that the value still remains positive. For true synchronism a close-circuited coil reaches within a half-period the opposite pole, and, consequently, our diagram for one revolution would look as follows: (*See* Fig. 8.)

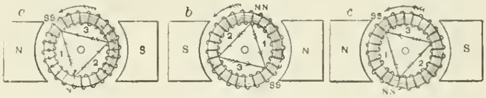

FIG. 8.

The three diagrams, *a*, *b*, *c*, show the flow of currents and resultant poles. The close-circuited coil 2, Diagram *a*, is at this moment generating opposing currents to the others; coil 1 is passing just in front of a pole. All three induced currents combined are developing poles as indicated, and rotating the armature in counter clockwise direction. The rotation being synchronous, diagram *b* shows the position of the armature when the polarity in the field has reversed; diagram c gives the position of the coils after the polarity has changed again. It will be noticed that the original position, as shown at *a*, has been reached again, and that the cycle will repeat itself. Without explaining these diagrams at this point, I wish to bring before you several other conditions, all of which will assist in reaching definite conclusions. Looking at the armature we see that it has a symmetrical winding, and as long as these closed circuits do not coincide with the number of poles of the field magnet (contrary to all synchronous motors built heretofore), other working positions are possible. The operation will take place as long as the sum of the armature currents have a positive value, since as far as the rotation is concerned it is indifferent which of the coils are doing the work. Let us assume that the armature does not run at a synchronous rate, but at another fixed speed which may have a certain commensurable relation to the periods of the exciting field current, which speed I shall call the *harmonic speed*. Instead of showing the diagram with windings, as in the first set, I have simplified them. In the following sets of diagrams, Fig. 9, I assume that the armature, on account of the load or other reasons, cannot reach synchronism, and that at each field reversal the position of the armature with respect to the field is the same, only the coils have

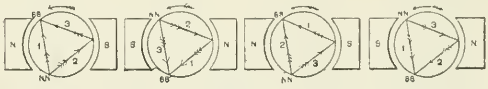

FIG. 9.

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* It is well to call the armature poles due to the armature currents reactionary poles. The other armature poles are induced directly by the field poles and contribute nothing to the torque.

changed places as indicated. You will notice that in this set of diagrams the armature, for each half-period, makes one-third of a revolution only—namely, coils 1, 3, and 2 exchange positions with the change of polarity. Let us step at once to another speed (Fig. 10), which you will, no doubt, admit as possible—viz., let us assume that coils 1, 2, and 3 cannot arrive at synchronous speed, and that coil 2 reaches the position which 1 ought to occupy; it will be seen that, owing to the symmetrical position, it is quite indifferent which of these coils arrives at a given position required for harmonic operation. This will be clear to you by referring to the third set of diagrams (Fig. 10).

We are now enabled to compare three sets of diagrams (Figs. 8, 9 and 10). The first set shows for this new type of synchronous motor that at synchronous speed the pole positions in the armature are practically stationary relatively to the coils and core, and rotate with it. The second set shows that during a complete revolution of the armature the field has reversed three times—that is, an odd number of times; hence, when the armature returns to its original position, after a complete revolution, it finds the field magnetisation of reversed polarity. The magnetic field of the armature rotates in the opposite sense, one and a-half times per revolution. In the third set, the armature makes but one sixth of a revolution per half-period, and the magnetic field of the armature in a complete revolution rotates three times in the opposite direction. This statement may be startling, and my argument, so far, may not be entirely convincing, as on close inspection it will be found that the armature poles have to do considerable jumping. I will now explain the performance of the rotary magnetic field of this armature in a four-pole field, where the changes occur far more gradually, leaving no doubt whatever as to the assertion made. Fig. 11 shows diagrams illustrating synchronous speed. By the aid of these four diagrams we can more easily follow the pole positions in the armature core, and find them stationary in it. Inspecting now Fig. 12, in which the armature speed is reduced, we are able to obtain a clear picture of the main subject under consideration.

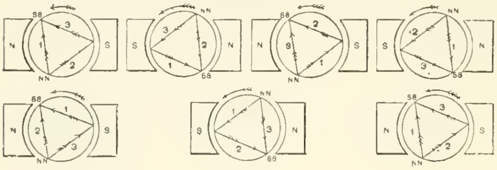
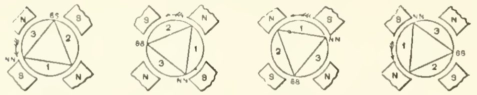


Fig. 10.

In this set of five diagrams we see five positions, which coil 1, for instance, occupies before it has made one-third of a revolution.

Fig. 11.



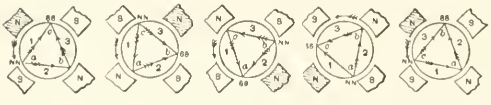


Fig. 12.

Nevertheless, if we now look at the changing pole positions, we can readily detect that they are progressively shifting, and we also see that they have made one whole revolution and that in opposite direction to the mechanical rotation, or, in other words, the magnetic field would travel three times around the armature core during one revolution. In all armature diagrams described, and to be described, the resultant of the magnetomotive forces of the armature currents is given only. To complete the picture showing every one of the component magnetomotive forces acting, it becomes desirable to plot a diagram of force (Fig. 13). These components act like three variable concurrent forces including an angle of 120deg. with each other. These forces we may represent as equal, for the sake of convenience, as it does not influence the idea which we wish to illustrate. However, those two forces which are acting in the same direction are indicated by heavier lines.

Plotting the direction of the forces in order, as, for instance, in the last named set of diagrams (Fig. 12), where the coils act in the order 1, 2, against 3; 3, 1, against 2, and 2, 3, against 1, we obtain Fig. 13 for one cycle. The three figures marked *a*, *b*, and *c* indicate the direction in which the three forces are acting in the three positions of one cycle or revolution.

By drawing the resultant diagram of force from the predominating forces of each position we obtain the accompanying figure (Fig. 14). These forces form a triangle, and the rotation resulting may be seen from the direction of arrows on the circumference of the surrounding circle. However, the reactive forces should be considered and represented separately to obtain the true picture, and we have to add them to find the total force applied and the manner in which all the forces are acting. We therefore repeat the resultant diagram (Fig. 14), and add the opposing forces at their proper places. This diagram (Fig. 15) shows that the reactive forces, shown by dotted arrows, also have a common centre, and that as regards time of maximum effect they succeed each other in the direction of rotation of the armature, while they are acting in the opposite direction of the main force. If we now plot a diagram of these reactive forces alone, we obtain the smaller triangle shown (Fig. 15) inside the larger. It will be noticed that rotation is in the opposite direction; or, in other words, that in reality we have, with this disposition, to deal with two rotary magnetic fields in opposite direction; the useful work done will depend on the difference of the angular velocity of these two rotating fields and their relative intensity.

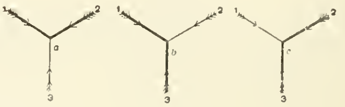


Fig. 13.

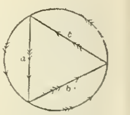


Fig. 14.

Looking now at the device as a generator (Fig. 12), we can account for the rotary magnetic field because we generate polyphased currents in the coils 1, 2, and 3. They operate together in the following order:—1, 2; 3, 1; 2, 3; 1, 2, &c. If rotated as shown, the coils will distribute three-phased currents over the armature, and this will be understood when examining into the flow of currents of the close-circuiting conductors, which are here provided with arrows. At this particular harmonic speed it will be further noticed that the simple alternating field of force has the identical qualities as a polyphase energising field, as the poles in front of the close-circuited coil seem to be travelling (for the armature) in clockwise direction. This is indicated by the shading of the pole of same sign in front of the coil most powerfully acted upon in the five positions, representing one revolution for the field. The currents displaced in phase cause the armature to rotate harmoniously with the alternations, and prevent the armature from being easily thrown out of step.

Returning once more to the earlier diagrams (Figs. 9 and 10), we see that below synchronism there are two other speeds which are entitled to be called synchronous, because a certain fixed relation exists between the periods of field excitation and armature rotation.

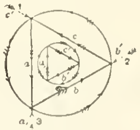


Fig. 15.

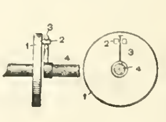


Fig. 15a.

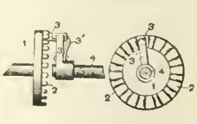


Fig. 15b.

It will be evident that the greater the number of closed circuits, the greater is the number of harmonic or synchronous speeds in which the armature can operate. If the armature contains 10 closed circuits, and rotates in a two-pole field, it will be able to generate five currents, lagging 72 degrees behind one another in phase, and would have at least five speeds which are synchronous; and the armature, owing to its peculiar construction, can operate at a slower speed than the synchronous speed as interpreted heretofore.

Looking at the device from a general standpoint, it will be clear that this particular armature construction embodies all the weak points of a synchronous, and all the strong points of the polyphase motor. The weak points are:

1. That the machine will not start from state of rest in the form shown, because in Figs. 1, 2, and 12, the coils act on one another differentially, and have a variable and negative value; they are in magnetic stability when at rest, hence no rotation can result.

2. The device has a small starting torque when rotated, owing to the differential action of the coils, which cause, with a small

number of closed circuits, strongly oscillating or jumping poles until a harmonic speed is reached.

3. The device, when in rotation, is not reversible by simply changing circuit connections.

The strong points are :—

First, that the motor develops polyphased currents in its own windings.

Second, that therefore it is more difficult to pull it out of step, as it has the capacity to stand what I would term magnetic slippage.

Let us assume that a certain coil, which should reach a given point to run harmonically, remains behind owing to a slower motion of the armature ; in this event the coil ahead has to perform the function at the expense of a slightly heavier current. The loss of revolutions due to this action may be comparable to the slipping of a belt over a pulley. However, there is also a limit to the slipping. The armature should have some harmonic speed with respect to the alternations. Should it fall below the lowest harmonic speed, then it will come to a standstill just like any other overworked synchronous machine.

Synchronism in a motor means nothing more nor less than a magnetic flexible clutch, which may be represented mechanically as follows :—

The old-fashioned non-starting synchronous machine, having equal armature coils and field poles, can be compared with the arrangement shown in Fig. 15*a*, giving side view and elevation. The disc 1 is provided with two projections ; 2 imparts rotation to shaft 4 by means of the flexible arm, or spring 3, which enables the shaft 4 to be slightly behind or ahead of disc 1. However, if the work put on shaft 4 is in excess of the strength of spring 3, then it will break, and shaft 4 will speedily come to a standstill.

In contrast to this older form of synchronous motors stands the new one, which forms the subject of this Paper, and the machines operated by bi- or polyphased currents. The mechanism for showing magnetic coupling for these latter types may be represented by Fig. 15*b*. In this case, 1 represents a crown wheel, the teeth marked 2 ; into these teeth meshes a catch 3 in a flexible manner, which catch is connected rigidly to shaft 4. Within the range of normal work, catch 3 would remain fixed between the two given teeth ; but if the shaft 4 is overloaded, the flexibility of catch 3 will cause it to yield, and pull out of its position, drop in between some other two teeth, and continue to operate, but at a slower speed. The greater the excess of work, the greater will be the slippage, and the more teeth will be jumped by the catch 3 in every revolution of disc 1. For the synchronous motor herein described, the overloading to the extent that it cannot reach the lowest harmonic speed would be equivalent to the breaking of spring 3.

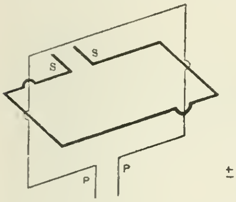


FIG. 16.

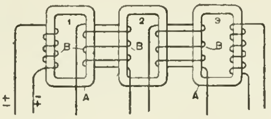


FIG. 17.

It will be remembered that Prof. Ferraris always, and Tesla sometimes, obtained a rotary magnetic field and rotation by influencing one coil carrying a primary current by another at right angles thereto carrying secondary currents. Here we have two phases from a single source (Fig. 16). To obtain a multiple of phases we may take two or three iron cores A, and surround them with coils B, like the links of a chain (Fig. 17), so that the secondary coil of transformer 1 is the primary of transformer 2, and so on ; or we may design a special core for a transformer and create a rotary magnetic field by applying to one coil a primary current from the line, and to another coil a secondary current from a transformer, whereupon, by the rotary field obtained, polyphased currents may be taken through other coils on the transformer. These methods have, however, one drawback, and that is that the phase will change more or less in lag with difference in load, while for many purposes it is most essential that for efficient working the phase should remain at the same constant angle. This desideratum has been accomplished by the device under consideration, and any suitable number of currents lagging in phase may be obtained from a single alternating current.

To obtain a rotary magnetic field in or by a stationary body, at least two electric or electromagnetic forces of definite phase relations, acting at an angle to one another, and changing at periods harmoniously, are essential requirements.

If, however, we allow the body, or part of the same, to be movable, we may substitute mechanical rotation primarily as an adjuster of the periodicity and phase of one of the two forces ; the fundamental relation between the two forces must in this case also be the same as in the other ; namely, they must work in harmony, and the periodicity and phase determines the periodicity and phase of the other of one force. If the second force is a current it must be one of the same period or some harmonic of that period ; if it is rotation it has also to be synchronous or harmonic. We can now clearly understand why, when rotating the armature (Figs. 1 and 2) in an ordinary alternating current field, we have no system of polyphased currents and no rotary field, simply because the armature rotation does not stand in any relationship whatever to the alternations ; but as soon as the speed does so there are generated polyphased currents lagging in phase at a field angle and a rotary magnetic field.

There is a difference, whether the armature is influenced by a single alternating current, or by several, causing themselves a rotating energising field. Nevertheless, in either condition the armature is in magnetic stability, and this state is the reason that it remains stationary in the first case, and that it rotates in the second. The reason that the motor starts in the second case is evidently because the inducing magnetic field is itself rotating in the stationary field magnet core. As said before, it is considered necessary for the proper operation of the armature for giving maximum torque that, if placed in an alternating current field of force, the armature rotation should have a definite relation to the alternations. Up to the publication of this device some three years ago, synchronous motors had as many armature coils as field coils, and hence, to obtain the value of the synchronous speed, all that was necessary was to divide the alternations of the armature current n by the number of field poles p of the magnet employed. But if the number of armature coils is not the same as the field poles, then the speed may vary from this synchronous speed and a modification is thought to be necessary. We would have to find the smallest common factor between field poles p and armature coils p^1, with which we have to divide the number of alternations to obtain the value of the lowest synchronous speed, while the condition of slippage may allow for the lowest harmonic the value $\frac{n}{p\,p^1}$.

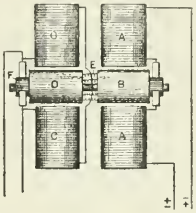


FIG. 18.

It will now be clear that motors can be designed having any desired variation of speed and have defined synchronous speeds or approach the indifferent relation. I wish it understood that I do not intend to treat the subject in all its details, and I am especially reluctant on the ground of having carried on but few experiments.

The few diagrams presented do not disclose many conditions of those possible. They show only one or two facts of conditions which frequently are of a complex nature. Evidently, the rotary magnetic fields in the device under consideration may have altogether different speeds from those shown in the diagrams ; also, that the magnetic field may rotate with and ahead of the armature, and lastly, the speed of rotation of the rotary field of the armature may be synchronous, and opposite in direction to its rotation.

The device has been given in form of a diagram, and as it has been described as not self-starting, I wish now to state that it becomes self-starting as a series, a shunt or an induction motor in a field of single-phase or polyphased alternating currents. Fig. 18 represents one of the earliest forms, which have since been simplified to a considerable extent. The part A B represents here a simple series motor, whose armature, B, may be any Gramme or ring type, open or closed coil winding ; the part C D may be similarly constructed. Both armature windings B and D, are connected electrically by four wires, E, at points of equal distance, which number of conductors, E, may be reduced or increased, depending on the number of phase currents desired. Now send an alternating current into the series motor, part A B,* then the armature will start from state of rest and will send current impulses into the D part winding, which becomes the more regular the more the armature has approached synchronous speed, where bi-phase currents will be established therein ; these react on the field magnet core C, and for the purpose of maintaining the armature in this synchronous speed, the commutator F is applied to rectify the polyphase currents, which continuous current may be used to energise the magnet C.

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* Preferably so that no reaction takes place from part D.

The fundamental principle disclosed opens to us a very wide field for work. Not only are we enabled to construct motors almost as cheap and simple as continuous-current motors, but there is in this principle involved the germ for the ideal distribution of power, inasmuch as we are enabled to collect the polyphased currents generated, or commutate them immediately at will.

Finally, I wish to call your attention to the fact that the last figure is in reality a motor-generator, and it is therefore evident that the electrical energy supplied need not all to be transformed into mechanical power, but that a portion may be utilised in one of the modified forms named above.

A DETERMINATION OF THE SPECIFIC HEAT OF WATER IN TERMS OF THE INTERNATIONAL ELECTRIC UNITS.*

BY ARTHUR SCHUSTER, F.R.S., AND WILLIAM GANNON.

This research was originally undertaken by Prof. Schuster and Mr. H. Hadley, before the authors were aware that Mr. E. H. Griffiths was engaged on a similar investigation. The principle of the method used is extremely simple. The electrical work done in a conductor being measured by $\int EC\,dt$, where E is the difference of potential at the ends of the conductor, C the current, and t the time. We keep the electromotive force constant, and measure $\int C\,dt$ directly by a silver voltameter. We do not, therefore, require to know the resistance of the wire, and we thus avoid the difficulty of having to estimate the excess of temperature of the wire over that of the water in which it is placed. We also gain the advantage of not having to measure time, and therefore to be able to complete the experiments more quickly than we could have safely done if the length of time the current passed had to be measured with great accuracy.

We divide our experiments into three series, but only attach any value to the third, as during the first two sets the thermometer was falling in the last period. We have hoped at first to be able to apply a small correction to eliminate the error which is due to the fact that a falling thermometer will read too high, and we made a large number of experiments to determine the correction. We arrived, however, at the result that the indications of a falling thermometer are so irregular that no correction is possible. Consequently in our third series the thermometer was rising during the whole course of each experiment.

Our final value is

J = 4·1804 Joules on the mercury scale of hard French glass,
4·1905 on the nitrogen scale,
4·1917 on the hydrogen scale,
at a temperatnre of 19·1°.

This result depends on the assumption that the electro-chemical equivalent of silver is 0·001118, and that our standard Clark cell had an electromotive force of

$$1{\cdot}4340\,(1 - a\,\overline{t^\circ - 15})\text{ volts,}$$

where $$a = 0{\cdot}000814 + 0{\cdot}000007\,(t^\circ - 15),$$

as given by Kahle (*Zeits. f. Instrumentenkunde*, Vol. XIII., p. 310, 1893). Glazobrook and Skinner's coefficient refers to a mean temperature of 7·5°, and is identical with the above at that temperature.

The comparison of the results of different observers will be facilitated by Table 1., in which we compare the work done in ergs with the foot-pound at Greenwich and the kilogrammetre at Paris. This table has been calculated on the assumption that g at Paris is equal to 980·96, and at Greenwich equal to 981·24.

In comparing our results with that of other observers, we have in the first place to consider the value which Mr. Griffiths has obtained in his very excellent series of measurements. His final result (*Roy. Soc. Proc.*, Vol. LV., p. 26 ; *Phil. Trans.*, CLXXXIV., A (1893) is

$$J = 4{\cdot}1982\,(1 - 0{\cdot}00266\,\overline{\theta - 15}) \times 10^7.$$

This refers to the nitrogen thermometer. At a temperature of 19·1°, the value would be reduced to 4·1936, which corresponds to our 4·1905 at the same temperature. Griffiths' value is to be increased slightly, owing to the fact that he really measures the difference between the specific heat of water and of air. This would increase the value of J by ·0011 about, so that the value of J at 19·1° would be raised to $4{\cdot}1947 \times 10^7$, which is exactly one part in a thousand larger than ours. The difference is small, but must be due to some systematic error, as both Griffiths' value and our own agree so well with each other, that ordinary observational errors and accidental disturbances could not have produced so large a difference in our results. The least satisfactory part of a calometric measurement must always be the application of the cooling correction, and we have considered it of great importance to reduce that correction as much as possible. Apart from the cooling correction, it is difficult to see how a difference of one-tenth per cent. in our result can be produced unless by the accumulation of a number of small errors.

Table I.

Ergs × 10^{-7}.	Foot-pounds at Greenwich.	Kilogrammetres at Paris.
4·160	772·83	424·07
4·165	773·76	424·58
4·170	774·68	425·09
4·175	775·61	425·60
4·180	776·54	426·11
4·185	777·47	426·62
4·190	778·40	427·13
4·195	779·33	427·64
4·200	780·25	428·15
4·205	781·19	428·66
4·210	782·12	429·17

The weak point of Mr. Griffiths's determination is the small quantity of water he uses, his result depending on the difference in his rate of rise after the addition of about 120 grams into his calorimeter. The highest water equivalent with which he worked was about 360 grams, of which 85 are due to the calorimeter itself. The chief objection to the use of such small quantities of water lies in the great cooling correction.

The difference between our value of the equivalent and that of Mr. Griffiths are, however, of smaller importance than the difference which exists between them and the equivalent as determined directly by Joule, Rowland, and Miculescu. Joule's latest value, which is the only one which needs consideration, is 772·65 foot-pounds, at 61·7F. The number refers to the degree as measured by Joule's mercury thermometer. Rowland adds to this a correction to the air thermometer of about three, and another small correction for a change in the heat capacity of the apparatus, which brings the value up to about 776. The correction to the air thermometer has been obtained by means of a comparison made by Joule himself with one of Rowland's thermometers. Joule's original thermometers have been temporarily placed by Mr. B. A. Joule in the hands of Prof. Schuster, in order that an accurate comparison may be instituted between it and modern thermometers. A full description of the comparisons made will be given on another occasion. The result arrived at shows that the correction is less than that assumed by Rowland, and would bring his value up only to 775 at the temperature indicated. Griffiths compares his result with that deduced by Rowland from Joule's observations. Rowland combined the different values obtained by Joule in his various investigations, attaching weights according to his judgment as their relative merits. He finds in this way that the difference between him and Joule amounts to one part in 350, but if equal weights are attached to all Joule's results the difference is reduced to one part in 4,281. Little value can be attached, however, to a combination of Joule's results, which give equal weights to that obtained in 1847 and that deduced from his latest and most careful work. There is, moreover, in Rowland's table a misprint or error in the reduction of Joule's 1847 result from foot-pounds to kilogrammetres, which lowers the value as given by Griffiths from 779·2 to about 778. It does not seem to us advisable to go beyond Joule's 1878 results, and the value assigned by him in this latest research should be taken as giving his final judgment on the matter. Reducing to the nitrogen thermometer of the Bureau International, Joule's result is 775 foot-pounds at Greenwich, at a temperature of 16·5 C. At the same temperature Griffiths' number is 779·8.

Great weight must be attached to Rowland's determination. which at the temperature to which Joule's number applies is 777·6, and at 19·1°, 776·1, corresponding to our 778·5. Rowland's value is therefore halfway between our and Joule's result. But it must be taken into consideration that if the comparison between Rowland's and Joule's thermometers as made by the latter is to be trusted, Rowland's value referred to the "Paris" nitrogen thermometer would be slightly reduced. At any rate it seems probable that if his value is in error, it is rather in the direction of being too high. We have therefore a difference of three parts in a thousand to account for between our result and that of Rowland, and of nearly four parts in a thousand between Griffiths and Rowland at a temperature of 19·1°. These results are summarised in the following table :—

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* Abstract of a Paper read before the Royal Society.

Table III.—*Equivalent in foot-pounds at Greenwich at 19·1°, referred to the "Paris" Nitrogen Thermometer.*

Joule.	Rowland.	Griffiths.	Schuster and Gannon.
774	776·1	779·1	778·5

As far as we can draw any conclusions from the comparison, it seems to point to a difference in the value obtained by the electrical and direct methods. Whether this difference is due to some remaining error in the electrical units, or to some undiscovered flaw in the method adopted by Mr. Griffiths and ourselves, remains to be decided by further investigation.

CORRESPONDENCE.

"LABOUR-SAVING" APPARATUS AS AN INSTRUMENT OF EDUCATION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : From the leader in your issue of December 21st I extract the following :—"We can quite understand the reluctance of conservative teachers to introduce ammeters and voltmeters into their laboratories ; but the argument that a student should be forbidden to time an experiment with a stop-watch until he has made one seems logical, and as neither Mr. Griffiths nor Prof. Carey Foster had an opportunity of replying to this suggestion, and presuming that they allow students to use ready-made resistance boxes, or, at all events, ready-made resistance coils for use with a slide-wire bridge, we should be interested to learn where they would draw the line."

As my name occurs in conjunction with that of Prof. Carey Foster, I have delayed a reply in the hope that it would be forthcoming from his more able pen.

Prof. S. P. Thompson asked, in the discussion referred to, if we expected a student to start *ab initio*, and actually construct his own weights ; I would remark that I, for one, have at no time expressed an opinion that students should be able to *make* the instruments they use. The argument as to the stop-watch is founded on the same misapprehension. I do, however, contend that a student should at no time employ an instrument until he has thoroughly mastered the principle on which its action is based. If a stop-watch is used (as, for example, at athletic sports) simply to accurately measure an interval of time, no knowledge is required beyond that necessary to read its indications. If, however, it is used as an educational apparatus, I do expect the observer to understand the general principles on which the uniformity of its action depends, and the manner in which it illustrates the laws of harmonic vibration, although I should not require a detailed knowledge of the method of gearing, or actual manufacture. I should ask the same with regard to the balance ; further, the observer should be instructed how to ascertain the errors, if any, of the balance and how to correct them. This is a very different matter from a knowledge of its mode of construction. I will illustrate my meaning by another example. Slide rules and calculating machines are most admirable things in their way, but surely Prof. Ayrton would forbid their use by the members of a class learning arithmetic, although, to quote his own phrase, "it would enable them to obtain a sufficiently accurate result without the introduction of troublesome corrections." As soon as the student can understand and apply the principles of logarithms I, for one, have no objection to his making use of a calculator, although I certainly do not expect him to be able to construct one. I do not know if this is "conservative," but it certainly appears to me to be common-sense.

The whole controversy has very possibly arisen from a misunderstanding as to certain fundamental terms. For example, Prof. Ayrton and Mr. Haycraft state, at the commencement of their Paper, that it was an apparatus "which could be placed in the hands of *junior* students," (the italics are mine). Now, I confess that had it not been for this phrase my criticisms during the discussion of the Paper would have been considerably modified. It ought, perhaps, to have occurred to me that Prof. Ayrton and I regard the students from very different elevations, and the student who appears to him to be very low down may appear to me to be very high up. For example, the junior student at the Central Technical College is evidently familiar with the principles and construction of a "good commercial ammeter-voltmeter" (by the way, are those names educational ?) and further, is acquainted with the probable error of those instruments after standardisation by the Board of Trade. Again, in his reply at the end of the discussion, Prof. Ayrton remarked that his object was to make the mechanical equivalent of heat a "real thing" to the student, and that it only became so when he had performed an experiment and got an approximate value himself. Now, the actual result obtained by the student in the example given in Prof. Ayrton's Paper was as follows : "The mechanical equivalent of heat in ergs per gramme-degree at 15° C. equals $4·211 \times 10^7$." I ask, is the above result a "real thing" to a junior student ? Let the junior student slip down a rope a little too quickly ; let him hammer a piece of lead until it becomes so hot that it ignites some phosphorus placed on it ; then let him raise the temperature of water by means of a frictional machine, and I think he will acquire a greater "grip" of the real meaning of the phrase "mechanical equivalent" than he can even by the result as stated above. If, which is of course possible, the phrase "ergs per gramme-degree at 15° C. equals $4·211 \times 10^7$" is a "real thing" to the junior students at the Central Technical College, the senior student must indeed be at a high elevation !

I am afraid that in the discussion previously referred to I did not make my position sufficiently clear, for Prof. Ayrton evidently misunderstood me. He remarked, "Mr. Haycraft was a student, and he had improved the apparatus ; but having done so he brought it before the Physical Society ; he had not burned it." Now, I admired the apparatus extremely, the manner in which the probable errors of each of the measurements was estimated and balanced was admirable, and, if it is to be considered as the result of an advanced student's work, it is everything that such a piece of apparatus should be. The Paper, however, had given me the impression that it was prepared by a professor for the "use of junior students," and I repeat that, viewed in that light, I regard it as unwise. We none of us require further illustrations of Prof. Ayrton's great ability as a designer and constructor of beautiful apparatus, and therefore I considered it unnecessary to emphasise my appreciation of the instrument itself.

In conclusion, I would follow the line of argument adopted by Profs. S. P. Thompson and Ayrton, and give an extreme illustration. If this kind of thing is to continue, the physical laboratory of the future will present somewhat the appearance of a modern railway-terminus, and where we can now obtain vestas, chocolates, eau de cologne, &c., by means of a penny, the junior student of the future will, by the expenditure of a like sum, receive, within 20 seconds, printed slips "certified correct to ¼ per cent. by the Board of Trade" giving him the values of the mechanical equivalent, the electro-chemical equivalent of silver, or the latent heat of the evaporation of water, &c., and thus "many troublesome corrections," and much "expenditure of time" (if such are the objects of his education) will be avoided.

The truth of the matter is that the use of *any* apparatus is safe when the teacher is competent. I do not for a moment protest against the use of labour-saving apparatus at the Central Technical College under the direction of such teachers as Prof. Ayrton and his colleagues ; there is no need to raise questions as to the form of apparatus there used—to do so would be an impertinence. However, there is always the danger and the probability that such apparatus would pass into the hands of less energetic and capable instructors, for the work of the teacher is much diminished by its use. In such cases, the more perfect the apparatus the greater the evil.—Yours, &c.,

Park Side, Cambridge. E. H. Griffiths.

THE SPERRY ELECTRIC BRAKE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In acknowledging the kindly and full treatment which my electric brake received at your hands several weeks since, I would say that the remark near the close of the article in reference to the disturbance of the passengers has been very fully noted, and observations during the past year would *not* lead us to believe that there is anything to be feared on this score from the use of the electric brake.

Upon almost every line employing the brake the emergency stop has been used in case of accident and necessity. Its effect upon the passengers being alluded to in a newspaper comment recording one of these accidents, I take the liberty of sending it to you in the hope that it may throw some light on this point.

I hand you together with this a copy of another clipping taken from the same Philadelphia paper. The accidents recorded in these two clippings were almost identical. Both boys were chasing dogs across the track, and the headway and speed of the cars on both lines are the same, one being supplied with an electric brake and the other not. The electric brake car was much the heavier and longer car body, and, therefore, should have been more difficult to stop quickly. No comment upon the results is necessary.

We have 125 cars equipped with the electric brake in Philadelphia at present writing.—Yours, &c.,

Cleveland, O., December 19, 1894. ELMER A. SPERRY.

[Extract from *Philadelphia Ledger*, September 18, 1894.]

A BOY'S NARROW ESCAPE FROM DEATH.

A nine-year old son of Frederick Bosworth, of Rittenhouse-street, Germantown, fell in front of a trolley car running at a high rate of speed at Lafayette-street, and Germantown-avenue, yesterday; but the motorman, Joseph Gabel, applied the electric brake and stopped just before the front wheel touched the prostrate lad, who was lifted from under the car unhurt, but badly frightened. By the sudden stopping the passengers were hurled from their seats in the car; but they did not complain when they learned the cause; on the contrary, they were loud in their praises of the coolness and quickness of the motorman.

ANOTHER BOY KILLED BY THE TROLLEY.

Motorman George Brooks, 2,942, Edgely-street, of car No. 1,254 of the Ridge-avenue line of the Philadelphia Traction Company, stated that as he approached Twentieth and Hamilton-streets, on his uptown trip about 2:30 p.m., a dog rushed across the track. Following the dog ran a little boy with a stick in his hand. The motorman's eyes had scarcely left the dog when the child appeared, and before it was possible to apply the brake the people were rushing from the sidewalk, and he knew that an accident had occurred. The boy lay in the roadway, gasping feebly, and he was carried to the sidewalk. With him was the dog which had dashed across the track in front of him. Until the body was removed to the Morgue the dog remained by the child, and it looked as though they had been companions.

TRADE IN 1894.

Notwithstanding the undoubted depression which has characterised the past year, more especially in London, it is gratifying to learn that many of the chief electrical engineering and supply firms have secured large contracts, although the majority of the reports refer to the low prices which have ruled. The gradual weeding out of firms (both manufacturing and supply) whose affairs have for years past been in the hands of Receivers and Managers, will, doubtless, tend to improve matters in this respect, and the allowance for "bad and doubtful debts' may also, we hope, in the near future be reduced. The following reports are to hand:—

THE BRUSH ELECTRICAL ENGINEERING COMPANY report that their works, both in England and Vienna, have been fully occupied with all classes of electric lighting work, both for isolated and central station instalments. A large increase has been made during the year to the working staff indoor and outdoor. Of the central stations previously equipped by the Company extensions have been made at Huddersfield, Sheffield, Bournemouth and Hastings, and the contracts for Hanley, Worcester, Lancaster, Leicester, and Coatbridge, have been completed. Bolton has been supplied with electrical plant, as has also the Great Northern Railway Company's large station at Holloway (London). The plant for the electric lighting at Earl's Court Exhibition was supplied by the Brush Company. The supply station contracts in hand include Dover, Wandsworth and St. Luke's (London), and further extensions at Bournemouth, Leicester, Worcester, Hanley, &c. A contract has been received during the year for a complete station equipment for Malta, and the Company have in hand the construction of the lighting plant for the London Exhibitions (Limited). A large number of private orders have been completed during the year, including the lighting of Arundel Castle for the Duke of Norfolk; and the Company have in hand plant for the Leith Docks Commissioners and for the lighting of the Public Library and Town Hall for the West Ham Corporation, for which gas engines will be used. The Company's Vienna works have been busy in the construction of plant for a number of Continental supply stations, and also for the generating plant for the lighting of the Dutch State Railway's station at Flushing; while in the Colonies the Company's branches at Sydney, Melbourne, and Adelaide have each carried out important electric light and power plant contracts, including those for the Broken Hill Proprietary Company, the Rockhampton Gas and Coke Company, the Hobart Exhibition, and sugar mills in Queensland. Colonial orders also include the supply of plant for the De Beers Mines Company in South Africa. The Brush-Vienna arc lamp, which has only been on the market during this year, is reported to have made satisfactory progress, and large orders are on hand for both home and foreign supply. The Company have during the year lighted the entire sea front at Hastings with the Brush alternate current arc lamps. In the lamp, fittings, instrument, and apparatus departments satisfactory orders have been received, and the Company have now taken the sale of their incandescence lamps into their own hands.

Messrs. BENNETT AND DRUCE, although a comparatively new firm, report a satisfactory amount of business, especially in the north of England. Here again, however, prices have ruled low in consequence of keen competition. The firm have installed nearly 5,000 lamps, a large amount of mill lighting work having been carried out.

THE CORLETT ELECTRICAL ENGINEERING COMPANY has been busy during 1894 in the supply of power plant and apparatus, and also in the electric light department. Considerable business has been done in the sale of Messrs. Crompton and Co.'s electrical specialities, the Corlett Company acting as agents in the North of England. Trade for 1895 is considered from orders on hand to have begun well.

A firm which is well known throughout the country, and in the Manchester district in particular, both for the excellence and variety of their manufactures, is Messrs. DORMAN AND SMITH, whose report on the year's work is exhilarating. The healthy expansion of the electrical industry is everywhere noticeable, but the increase is probably more marked in the export than in the home trade. This is more especially the case with regard to power transmission plant, which on the Continent and in the Colonies is making rapid progress. In order to cope with the increased demand for all classes of apparatus made by the firm, it has been necessary to extend the factory, the extension consisting of an additional three-storey building. From inquiries for future delivery Messrs. Dorman and Smith consider that another busy year may be confidently anticipated.

MESSRS. DOULTON AND CO., who usually have a satisfactory report to make, inform us that, in addition to their usual extensive business in insulators, battery jars, and other pottery goods specially designed for electrical purposes, they have carried out several important contracts for the supply of their patent stoneware conduit for underground electric light mains. Edinburgh and Sunderland have each given large orders, upwards of 15 miles of this conduit having been laid at Edinburgh alone, while Chelmsford, Preston, Brighouse, Liverpool, Manchester, and several of the London supply companies have sent in orders and repeat orders, making up a total of upwards of 140,000 yards in all. A brisk business has been done in insulators required for underground bare copper mains, and the special facilities which Messrs. Doulton possess for expeditiously turning out large quantities of these articles has proved of great service. Orders for insulators have also been received for one of the large electric traction schemes now being carried out in this country. In another district branch of this firm's business progress has been satisfactory, viz., the erection of plant for the purification and softening of water. Amongst the firm's customers for this plant may be mentioned the electricity works of the St. Pancras Vestry.

THE ELECTRICAL COMPANY report a brisk business in "Luna" arc lamps and "E.C." incandescents. A new differential alternating current arc lamp with constant focus is now being added to the large variety of arc lamps made by the Company. In lampholders business has increased threefold, while the well-known "Dolivo" instruments supplied by the firm have continued to give satisfaction and have secured a ready and still increasing sale. Amongst the materials supplied should be mentioned "Stabilit," which, although only recently placed upon the market, has during the year, it is stated, met with considerable success, especially in high-tension work. During 1894 a new department has been added in connection with the transmission of power and light by means of the three-phase system, in the construction of which machinery the firm's main factory in Berlin has been kept fully going. The Berlin house has for some time past made a speciality of this plant with, it is said, highly satisfactory results. Inquiries are being received from mining centres for these machines, for which a number of good orders are already in hand.

The works of Messrs. Johnson and Phillips at Charlton have been busy during the year. The manufacture of alternators, dynamos, transformers, and central station apparatus and accessories has been more than double that of any previous year, and includes the construction of the polyphase electric transmission plant for the Sheba gold mines in South Africa. Amongst the lighting plant contracts obtained by the firm was that for the electric light installation at the Waterloo goods station, Liverpool, where plant was supplied for 36 arcs and over 700 incandescents. Other contracts include the plant for the Bedford Corporation and for steam alternators and arc lamps at Tunbridge Wells. The increase of work in the cable department has necessitated a new shop being added to that part of the works dealing with the manufacture of vulcanised cables. Large export orders for cables have been received, principally for Spain and South Africa, and one of the large home orders executed by the department was that for the Worcester Corporation, which comprised the laying of high-tension feeders on the Brooks insulated oil system. In the arc lamp department very large orders for Brockie-Pells have been executed. Orders have been received for the General Post Offices in London, Glasgow, and Hull, for the principal railway companies, the corporations of Wolverhampton, Ealing, Londonderry, Plymouth, Nottingham, Birmingham, and Tunbridge Wells; and the extensive premises of Mr. William Whiteley, at Westbourne-grove, London, have been fitted with a number of these arcs. The sale of "D. P." accumulators has kept the battery department of the works more than usually busy, and orders for carbons show a healthy increase. The orders for the Perry meter, the manufacture of which has been taken up by this firm, show a satisfactory growth, and the latest permanent magnet type are now being supplied. The outlook for the future is described as "very gratifying."

The use of forced draught has, during the past year, found favour with managers of electric supply stations, and Messrs. Meldrum Bros. have supplied furnaces on this system for Bolton, Pontypool, Glasgow, Loughborough, Bootle, Blackburn, Belfast, and Dublin, and have orders in hand for Newport, Stafford, and Islington. At Rochdale, the boilers at the Refuse Disposal Works are fitted with "Meldrum" furnaces, part of the power being employed in the production of electric current. It is claimed that the furnaces are very economical, as "Meldrum" bars deteriorate but slowly, whilst small fuel can be burnt efficiently.

Large ship-lighting plant contracts have been secured during 1894 by Messrs. Ernest Scott and Mountain, of Newcastle, as well as a number of power plants for pumping, coal-getting, &c. A power plant has been supplied to the Lothian Coal Company at Dalkeith, to deliver 400 gallons per minute against a head of 700ft., and for the Cowpen Coal Company, Blyth, an electric plant supplied has resulted in a saving which is estimated at £1,000 per annum as against the old system of wire-rope pumping. Similar plants have been supplied to the Willington Colliery, Durham, and for use in several of the South African gold mines. A new type of electric coal-cutting machine has been supplied to the Glenclelland Colliery, near Wishaw, capable of being worked by two men, and cutting on a long wall face from 95 to 100 yards 3ft. deep in 4½ hours. The success of this machine is stated to have resulted in the firm securing four further orders for the supply of complete electric coal-getting plants. Considerable extensions have been made in the works on account of increased trade, and the outlook for 1895 is stated to be excellent.

Amongst northern firms, Messrs. D. Selby Bigge and Co. report a busy year in connection with the application of electricity to power purposes. A large power plant has been supplied to the Bedson Wire Company, of Middlesborough, whose new and extensive works are driven throughout by electricity. The plant includes a 600-H.P. Pieper multipolar machine, coupled to a triple expansion condensing engine by Messrs. Westgarth, English and Co. There are over 50 electric motors, ranging from 5 H.P. to 40 H.P., in this installation. Messrs. Dorman, Long and Co. have also been catered for by the firm, and, owing to the success of the work, have considerable extensions in hand for 1895. Electric driving plant for the soda works of Messrs. Bell Brothers at Port Clarence and plant for rock-drilling at the Lumpsey Mines have been supplied. At the Workington Hematite Iron and Steel Company 40-ton ladles are being tipped by means of an electric motor, and the Anderston Foundry Company and several works in the Manchester district have been supplied with plant. At Hartlepool the shipyards of Messrs. T. Richardson and Sons and Messrs. Furness, Withy and Co. have been supplied with electric driving plant, and the past year may, therefore, be described as a good one, the total result being that the business of the firm has more than trebled.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices :—*

The 1894 Edition of "The Electrician" Electrical Trades' Directory and Handbook contains 1,000 closely-printed pages, and several new and useful features have been added. The price of this edition of the Directory and Handbook is now 4s. post free; abroad 5s. **The 1895 edition is in active preparation**, and subscription and advertisement orders should be sent in **immediately**.

Laboratory Notes and Forms.—With the above title, we have in the press a set of Elementary (now ready) and Advanced Exercises (ready shortly) for use in Electrical Engineering classes. These have been prepared in Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is just out, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"The Work of Hertz."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. net., is now ready.

"Electrical Engineering Formulæ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"Electromagnetic Theory" (Vol. I., second issue), by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application. Vol. II. is in preparation.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"Drum Armatures and Commutators."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

Tenders Accepted.—The tender of Messrs. Coates, Fountain-street, Belfast, has been accepted for the electric lighting of the Industrial Exhibition, to be held in March next.

Tenders Received.—The Edmonton Local Board have received the following tenders for the supply and erection of telephonic communication and electric call fittings, and for maintenance of same :—Consolidated Telephone Construction and Maintenance Company, London, £307, maintenance £9; Blenheim and Co., Egham, £277. 5s., maintenance £16. 10s.; Private Wire and Telephone Installation Company, London, £268, maintenance £20; J. Faulkner, £245, maintenance £35; Julius Sax and Co., London, £244. 10s.; E. E. Vaughton and Co., Birmingham, £193, maintenance £28; National Telephone Company, London, £175, maintenance £24; J. E. Cullum, £139, maintenance £13; F. E. Stuart, Twickenham, £122. 2s., ordinary maintenance £17, special £22. The Board's engineer has the tenders under consideration.

Liquidations.—At meetings of the shareholders of the Arcas Plating Company (Limited) on November 21st and December 19th it was resolved to wind up the Company voluntarily.

——— A meeting of the shareholders of the Rotary Engine Syndicate (Limited) resolved on the 22nd inst. to wind up the Company voluntarily.

Vacant Appointment.—The Sunderland Town Council invite applications for the appointment of an assistant electrical engineer at a salary of £120 per annum. Some particulars are given in our advertisement columns, and applications must be sent in not later than 5 p.m. on Wednesday, the 23rd inst., to Mr. F. M. Bowey, Town Clerk, Town Hall, Sunderland.

Partnership.—Mr. Henry Edmunds has taken into partnership Mr. Godfrey Blundell Samuelson, son of Sir Bernhard Samuelson, Bart., M.P., the style of the firm remaining W. T. Glover and Co., as hitherto.

Dissolution of Partnership.—The partnership between Samuel Breuell and Douglas James Callow, carrying on business as electrical engineers at Pier-place, Chiswick, Middlesex, under the style of Callow, Breuell and Co. has been dissolved by mutual consent as from August 28, 1894.

New Firm.—Mr. A. H. M. Francis, late of the Edison and Swan Company, has joined Mr. Spilsbury, and, under the style of Francis and Spilsbury, they have commenced business as electrical engineers and electrical agents, at Mansion House-chambers, 20, Bucklersbury, E.C.

New Offices.—The Direct Spanish Telegraph Company have opened offices at Liverpool and Manchester for the receipt and delivery of telegrams exchanged with station viâ the Falmouth-Bilbao direct cable.

Personal.—We are asked to notify that Mr. Emile Garcke's future address will be 1 and 2, Great Winchester-street, London, E.C. Telegraphic address, "Garcke London."

Deed of Arrangement.—Messrs. W. and A. Hodgett, electrical engineers, of Hay Green, near Stourbridge, have filed a deed of arrangement with their creditors. The liabilities are given as £144. 7s. 5d., and the assets, after deducting secured claims, £72. 13s. 2d.

A New German Incandescent Lamp Company.—A joint-stock company has just been formed at Nuremburg, to be known as the Phœnix South German Incandescent Lamp Company. The Company, which has a capital of £10,000, has been formed to acquire and work the incandescent lamp patents of Herr Zobel.

The Hermite System of Electric Sanitation.—We have received a copy of a reprint of an article written by Mr. E. J. Paterson, M.I.E.E., from the *Surveyor and Municipal and County Engineer*. In the pamphlet Mr. Paterson fully describes the apparatus and methods of using.

"Geared" Aeromotors.—The Aeromotor Company send us their latest sheet of illustrations and prices of a variety of various sizes of aeromotors manufactured by the firm, which can, it is claimed, be put to a number of uses in connection with electric lighting work, including the pumping and storage of water, driving air compressors, &c.

Calendars.—Messrs. King and Co., of Leith, issue a handsome hanging calendar with illustrations of special types of electrical machinery manufactured by the firm.——Bell's Asbestos Company issue an ornamental hanging sheet calendar, which is very neatly got up, and has a number of views of the firm's machinery rooms.——The Eastern Telegraph Company send us, for about the tenth year in succession, a very serviceable paper-knife calendar, which, in addition, shows the routes of the cables owned by the Eastern, Eastern Extension, and associated companies.——The Indo-European Telegraph Company issue a hanging pad calendar with tear-off monthly sheets, upon which is printed a list of the Company's stations, tariff rates, &c.——Messrs. W. H. Willcox and Co. send us a useful hanging sheet calendar and date remembrancer, which will be found a useful office reminder.——Messrs. George Street and Co., the well-known advertising agents, of 30, Cornhill, forward a handsomely-framed calendar for 1895, adorned with coloured designs of the Imperial arms and those of our principal colonies.

Calvert's Mechanics' Almanack.—The 1895 edition of this valuable workshop companion, which is published at the low price of 4d., is to hand. It contains all the old well-known features which have made the almanack popular for nearly a quarter of a century.

Amusements.—A feature in many of the leading establishments in London and the chief cities is the attention which has been given to the electrical displays. Very few places of note are without a lighting installation of some kind, and in many places the installations are of considerable magnitude. At the Waverley Market Carnival, Edinburgh, Mr. Moss has provided amusements at which 10,000 people can be present, and Messrs. King and Co., of Leith, have expended great taste and ingenuity in the electric lighting arrangements. Hanging from the girders and roof supports are hundreds of incandescent lamps in various colours and tints, imparting a variegated and brilliant appearance to the scene. 18 arc lamps of 1,500 c.p. are distributed near the roof and over the stage, and in addition the same firm have provided one of their electric ventilating fans, which has proved a great boon to the visitors in the upper tiers of seats. Three 30-H.P. engines are required for the work, the whole of which was put in operation within six days from the receipt of the order.

Bolton.—A Sub-Committee of the Town Council has been appointed to consider the advisability of providing a lift for the Town Hall premises, and also to take into consideration and report upon the lighting of the various offices by electricity.

Burnley.—During a discussion at a recent meeting of the Town Council on a motion to increase the salary of Mr. S. Thursfield, the electrical engineer, from £150 to £200 (a motion which was subsequently approved), it was stated by Mr. Tempest, a Socialist member of the Council, that the electric light had not been a paying concern. In reply to this statement Mr. Alderman Lancaster said he had obtained returns from 30 boroughs, and found that the average cost per unit for the electric light was 4·18d., while the cost at Burnley was only 2·68d.

Cardiff.—The electric light has now been switched on in the main streets of the town, and gas in the ordinary street lamps s dispensed with over the electric lighting area.

Chelmsford.—In response to a petition from the consumers of electric current in Chelmsford, the local electric lighting company have decided to give a continuous supply, excepting for one hour at midday from 12 to 1 o'clock.

Chester.—In reference to the statement made by the Mayor, n the course of the recent Local Government Board inquiry as to the bad quality of the gas supplied by the local gas company, a correspondence has taken place in which the good quality of Chester gas is stoutly upheld by the Chairman of the company, who points out that so far as public lamps are concerned, in case of electric lighting being adopted in any of the streets, the gas company reserve to themselves the power to review the terms of the present arrangement with the Town Council, which is described as "exceptionally liberal." The Mayor, in reply, states that, although the gas may be as the Chairman of the gas company states, above the standard of 15 candles, this standard is the minimum, and was fixed 36 years ago. The Mayor looks "hopefully forward to the time when the electric light undertaking will prove a source of considerable profit in relief of the rates."

Church Lighting.—A resolution in favour of adopting the electric light for the restored parish church of Dewsbury has been unanimously adopted by the Building Committee.——St. Peter's Church, Eaton-square, London, has recently undergone additions and alterations, added to which a new wrought-metal chancel screen, of which the pulpit forms a portion, has been put in, from designs of Sir Arthur Blomfield and Sons. The electric light has also been introduced.

City and South London Railway.—A bill has been lodged in Parliament asking for an extension of time until July, 1901, for the purpose of completing the authorised extension of the City and South London Railway Company's electric railway from Stockwell to Clapham Common. This railway is only 79 chains in length, and this is the second extension of time asked for. Further borrowing powers for £40,000 are also asked for in the bill.

Edinburgh.—It is probable that the Edinburgh street tramways will shortly become the property of the Town Council, that body having decided to notify the Tramway Company that the Council are prepared to purchase the undertaking in August next.

Electrical Machinery for British Guiana.—All machinery, apparatus and wire for electric lighting purposes imported into British Guiana is being admitted free of duty until March 31st.

The Electric Light for River Steamers in India.—It is stated that all the steamers belonging to the Rivers Steam Navigation Company and the India General Company are to be fitted up for the electric light, to enable them to trail down the rivers at night. Owing to the presence of shoals and sandbanks, the night navigation of the Indian rivers has been prohibited. By the adoption of the electric light, not only will this night work be permitted, but the passage up and down the rivers will be considerably shortened.

Exhibition.—On reference to the New Companies in the current issue, particulars will be found of "Light and Heat Exhibition, 1895," which is formed to open, and carry on in London during this year an exhibition of manufactures, inventions, and objects of interest connected with the actual means of lighting and heating in all its branches. For this purpose Woodhouse Park, Shepherd's Bush, London, W., is acquired, and the control of the business is vested in an executive committee, consisting of, among others, Mr. R. Brudenell Carter, chairman, Sir H. Trueman Wood, vice-chairman, and including Capt. Abney, Sir H. Doulton, Mr. W. H. Preece, Sir David Salomons, and Mr. Alexander Siemens. The Hon. Secretary and Director is Mr. John Furley. The profits of the undertaking are to be devoted to charity.

Finsbury Park and City Electric Railway.—The Great Northern and City Railway Company, which was incorporated in 1892 to construct an electric railway from Finsbury Park to the City, are asking Parliament for an extension of time from June, 1895, to June, 1897, within which to purchase the necessary land, and a further extension to June, 1900, for completing the line for traffic. It is asked, also, that the rates and charges fixed for Great Northern Railway goods and passenger traffic shall apply to this line when completed.

Hospital Fete.—The inmates of University College Hospital, Gower-street, London, were on Wednesday last provided with a Christmas entertainment, the wards being prettily decorated by the students and nurses. A huge Christmas tree was provided for the juvenile sufferers, laden with toys of every description. The tree was lighted by electricity, the lamps being kindly lent by the Edison-Swan Company, and the wiring expenses being defrayed by Dr. Fleming. It is needless to say that thorough enjoyment was the result. Funds are badly wanted.

Killarney.—In connection with the lighting of this town a condition of affairs has arisen which could probably only exist in Ireland. Each of two contending sections of the Town Commissioners have given out contracts for lighting, one to the local gas company, the other to the local electric light company, each party contending that their contract was the legal one. Both companies have now sent in their bills, and the Town Commissioners have decided not to pay either until the legal position of the contracts given is ascertained. The electric light company have accepted the challenge, and have served the Clerk to the Commissioners with writs demanding payment of their account. The gas company appear to be lying low, awaiting the results of the proceedings.

Lectures.—The lectures being delivered at the Royal Institution by Dr. Fleming, entitled "The Work of an Electric Current," have attracted crowded audiences. The concluding lecture will be given to-morrow (Saturday), January 5th, at 3 o'clock.

Leeds.—A discussion arose at the last meeting of the County Council on the subject ofthe Tramways Committee and their haulage report. The committee was appointed in the early part of 1894 to visit Paris, for the purpose of obtaining information upon the subject of tramway traction, and some members of the Council thought the time had come when this report should be presented. Alderman Firth, however, stated that the reason of delay was that one system of haulage, regarding which the Committee were obtaining all possible information, had developed more in the past six months than in the previous six years, and that therefore it would be unwise to unduly press for the report, which will be presented as soon as inquiries which are now being made are completed. It is stated that the engineer's report on the different systems of haulage is to be presented to the Tramways Committee on the 14th inst.——The Chamber of Commerce have adopted a resolution calling upon the Government to adopt the Rating of Machinery Bill, with the view of its passing during next session.——In reference to the negotiations which are in progress between the Yorkshire House-to-House Company and the City Council, the only question at issue now remaining for settlement is the minimum quantity of current the Council will undertake to consume for lighting the Town Hall and Municipal Buildings. Negotiations have once been interrupted, and the Corporate Property Committee have considered the question of laying down new plant, the old having become obsolete. It has, however, been decided to renew the negotiations with the House-to-House Company before making a final decision.

Liverpool.—At a meeting of the City Council, on Wednesday, a discussion was to have taken place on recommendations of the Special Lighting Committee appointed to consider the question of the purchase from the Liverpool Electric Supply Company (Limited) of the whole of their undertaking and business as a going concern during the current year; but a mass of other important business was due for discussion before this subject was reached, and it was therefore decided to adjourn the matter for a week. In the meantime a statement is to be prepared as to the legal status and position of the Corporation in regard to its negotiations with the Electric Supply Company. Included in the recommendations made by the Committee is one that the scheme for the purchase of the undertaking referred to shall include the extension of the electric light to all the public buildings and markets in the city, the current to be supplied through stations to be established by the Corporation.

Manchester.—On Wednesday Mr. Alderman Gibson, at the meeting of the City Council, called attention to the suggestion of the Electric Light Sub-committee that increased borrowing powers should be obtained for electric supply purposes. It was anticipated that a further sum of £100,000 would be required to enable the Council to carry out the extensions which would be required in the near future. Originally a plant was put down for 20,000 16-c.p. lamps. Provision had since been made for a further 8,000 16-c.p. lamps, and at the present moment the Committee has customers for 27,000 16-c.p. lamps, and current is being supplied to new clients as fast as possible. The committee's suggestion was approved, and authority given for the necessary steps to be taken for borrowing £100,000.

Mill Lighting.—Springfield Sawmills, the extensive works of Messrs. J. Baird and Co., of Grahamston, are being fitted throughout for the electric light by Mr. Lawrie.—The saw mills recently erected by Messrs. Price, Walker and Co. (Limited), at Gloucester are lighted throughout by electricity.——The Seebpore and Howrah mills at Calcutta are to be lighted by electricity, and the number of lamps in each case will be about 1,300.

Norwich.—The Town Council have passed a resolution "that the Council join with other municipalities in opposing so much of the draft agreement between the Postmaster-General and the Telephone Company as relates to the vesting in the Company of the wayleave powers of the Postmaster General under the Telegraphs Acts." It was stated that at the present time the Postmaster-General could, under these acts, erect wires where he pleased, and it was in order that this power might not be transferred to the Telephone Company that the resolution was adopted. It has been decided to memorialise the Postmaster-General to extend the trunk telephone line providing communication with London to Norwich.

The Past Year's Patent Record.—1894 has proved a busy year at the patent office, the record having been beaten. 25,572 patents were actually filed, against 25,102 in 1893, the previous record year. Electrical "inventions," particularly those dealing with lighting by electricity, are especially noticeable, and another class of inventions in which great activity prevailed was for patents in connection with cycling.

Portsmouth.—The highest tender received by the Town Hall Committee of the Corporation for the plant recently advertised for sale was £310, this offer being made by the Croydon Corporation. The plant is being disposed of as the Town Hall is to be supplied from the Corporation mains. It is understood that the plant may be offered to the Asylum Committee for the purpose of lighting that institution. With regard to what was fairly described as an undue assessment on the electric lighting works (£3,500), it is gratifying to learn that this impost, which would have been a serious burden upon the undertaking, has been reduced from the above large sum to £335. Notwithstanding the arrangements made for satisfying, as it was thought, all probable requirements, it is likely that a considerable extension of the lighting area will shortly have to be made, as residents in several parts of the borough not now supplied with the light are agitating for it.

Postal, &c., Regulations.—The "Post Office Guide" for January contains a number of revised arrangements, especially with reference to the Post Office express delivery service, the international express service, and the foreign parcels post. The limit of weight for parcels exchanged with several countries on the Continent of Europe, including France and Germany, has been raised to 11lb. Re-direction charges on English postcards, newspapers, book packets, and sample packets are abolished. New regulations are made for the disposal of undelivered English postcards, newspapers, and book packets under 2oz. in weight. Arrangements have been made for late-fee posting at railway stations. Cape Colony has been admitted into the Postal Union.

Private House Lighting.—Amongst the orders recently received by Mr. C. A. Hemingway, of Richmond, are instructions for the electric lighting of the Terrace House, Richmond, for Mr. Max Waechter, for which 200 16-c.p. lights will be used. The work will be carried out under the supervision of Mr. Morgan Williams. Mr. C. E. Rube, of Norfolk Lodge, and Mr. John Edgar, of the Terrace Lodge, Richmond, have placed similar orders with Mr. Hemingway for 106 and 46 lights respectively.

Salford.—It is stated that the scheme for supplying electric current for this district is not sufficiently advanced to justify the expectation that it will be ready for use this winter.

Sunderland.—An exhibition of marine, electrical, and engineering plant and accessories is now being held at Sunderland, which will remain open to the 12th inst. The exhibition was opened in November by the Mayor of Sunderland, and has, we understand, proved very successful. A number of firms well known in the electrical and engineering trades are lending the exhibition their support.

The Taxation of Machinery.—The Machinery Users' Association, acting on behalf of Messrs. Armstrong, Mitchell, and Co., have been successful in contesting an assessment claim by which an increase in the valuation of the Company's machinery to nearly £37,500 was attempted. The result of the action taken by the Association has been the saving of an annual sum of about £3,000, which the Company would have had to pay as a tax upon their machinery had the action resulted unfavourably.

Telephonic Extension.—The National Telephone Company have received a sufficient number of subscribers in the Banff, Macduff, and Keith districts in the north to warrant them in proceeding to erect exchanges, and it is anticipated that a little later Buckie, Dufftown, Huntly, Turriff, and other small places will be connected up.

Telephoning between Colombo and Trincomalee.—In November last a successful attempt was, it is stated, made in telephoning between Colombo and Trincomalee. Mr. Simpson, telegraph superintendent, and Mr. Torr Todman (whose telephones are being tried) were at the Colombo, and Major Savage at the Trincomalee end, the distance being 220 miles. The sounds at one end were not heard quite so distinctly as at the other, and this is attributed to the batteries not being of equal strength. Further experiments are to be made, and interest is taken in the result.

Theft. A clerk named Goodwin was charged at the West London Police Court on Wednesday with stealing a large sum of money from his employers, Messrs. John Bryden and Sons, electricians, Gloucester-road, South Kensington, S.W. The prisoner had been in the service of the firm eight years, and attributed his misdeeds to bad company and betting. He was sentenced to two months' imprisonment with hard labour.

Trade Union Dispute.—The *Daily Chronicle*, which may fairly be described as the representative daily organ of the working classes in this country, takes to task very severely a number of men employed by Olympia (Limited) in wiring the building for the electric light, in order to give efficient lighting effect to the grand display now being presented to the public, and which is absolutely essential to the success of ths show. It would appear that a question arose as to the employment of non-unionists. From the explanation given by Mr. H. M. Fisher, secretary of the Company, it would seem that a wilful attempt was made to damage the Company's installation, for which, it is stated, about 40 miles of wiring is used. There seems to be no doubt that an outrage was committed, as the prosecution of the men has resulted in fines being inflicted. The Company seem to have treated the men with marked liberality, as, in addition to the wages, exceeding the unionist rate, a bonus was given, and when overtime was worked "substantial meals, beer, and cigars were provided." It is satisfactory to learn that, notwithstanding the attempt to interfere with the completion of the work in time for the opening day, the Company have experienced no difficulty, and it is especially satisfactory to find the *Daily Chronicle*, which is a power amongst the men, insisting on fair treatment to the employers. The journal indignantly calls for a satisfactory explanation of the incident from the officials of "The Electrical Trades' Union." So far only a very poor attempt has been made to furnish such an explanation.

Treharris.—A reply from the Quaker's Yard Gas Company in respect of an application for reduction in the charge for public lights not being considered satisfactory, Mr. Lewis, member of the Merthyr Board of Health, proposes to introduce a scheme for the electric lighting of the district.

Tunbridge Wells.—The report presented by the Electric Lighting Committee has been adopted by the Town Council. It refers to the progress made in the laying of the lighting mains and in the erection of the central station. Much satisfaction is expressed at the probability of an early supply of electric current.

Underground London.—The *Daily Chronicle* of Friday last contains an account of an interesting interview with Mr. Greathead, engineer to the City and South London Railway.

Wandsworth.—The General Purposes Committee of the District Board of Works are considering an application of the County of London Company to lay mains from Putney to The Plain, and thence to Streatham. The Company have purchased a site for a generating station at The Plain.

Worcester.—Thirty-six applications were received by the City Council for the appointment of electrical engineer, and after consideration three names have been left for final selection—Mr. E. T. Ruthven Murray, of Aberdeen, Mr. S. J. Mahood, resident electrician for the Worcester works, and Mr. Leonard Wigan, clerk of the works at Powick. With regard to the selection of a candidate, on the matter coming up for discussion on Tuesday, it was referred back to the Electricity Committee, it being the opinion of the councillors that the duties of the office were to be undertaken by the city surveyor. The result of this action was that Mr. G. H. Williamson, Chairman of the Committee, tendered his resignation, accompanied by that of the other eight members. The Council, however, declined to accept the resignations.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

December 17, 1894.

24,999. E. S. d'Odiardi and E. S. d'Odiardi. London. Electric apparatus for conveying and passing currents of electricity, induced, continuous, or currents of high frequency, through footboards and oar handles and the bodies of rowers in lifeboats or other boats.

24,500. E. S. d'Odiardi and E. S. d'Odiardi. London. Electrodes for conveying different currents of electricity through ladders, trapeziums, wheels, running tracks, dumb bells, and any other gymnastic apparatus, and through the bodies of those who use them.

24,534. R. H. Wolff. London. Velocipedes provided with electrical communicating apparatus.*

24,541. C. Kellner. London. Method of and apparatus for effecting electrolysis.

December 18, 1894.

24,551. P. Collinson. Bradford. Improvements in electricity meters.

24,564. W. E. Heys. Manchester. Improvements in and connected with electro-locomotives. (J. J. Heilmann, France.)*

24,583. G. H. Whittingham. London. Improvements in electric heaters for cars.*

24,613. W. P. Hall. London. An improved electric signalling system.

24,630. H. S. Blackmore. London. Process of and apparatus for dissociating soluble salts by electrolysis.

24,638. R. Pelargus. London. An improvement in or connected with binding screws for electric conductors.

24,639. J. T. Harris. London. Improvements in method and apparatus for purifying liquids magnetically, to which may be added electrolysis and aeration.*

December 19, 1894.

24,701. Tangyes (Limited), and A. B. Mees. London. Improvements in electrically-driven hoists or lifts.

24,707. R. Pape. Liverpool. Improved process and material for the manufacture of buttons, articles of jewellery, stands for beer glasses, piano keys, insulators for electrical apparatus, and other articles.

24,714. L. Epstein. London. Improvements in secondary voltaic batteries.

24,732. F. J. Ricarde-Seaver and L. Pernot. London. Improvements in and connected with the reproduction of objects by the aid of the electric current.

24,738. E. M. Lacey. London. Electrical ventilator for ducts, pipes, street boxes, transformer chambers, and other confined spaces used for or in connection with electrical mains and other electrical apparatus.

December 20, 1894.

24.745. F. J. Curley. London. Detachable ornamental fibrous plastic covers for electric light ceiling fittings.

24,747. L. H. Cline. Wallsend-on-Tyne. Improvements relating to electric spring connectors.

24,770. G. H. Cottam. Hanley. Improvements in and relating to manholes and manhole covers for underground conduits and culverts, transformer chambers, &c.

24,796. A. Findenigg and J. Schwartz. London. Improved electric igniting apparatus.

December 21, 1894.

24,864. F. A. G. Cassell. London. Improvements in the construction of primary electric batteries in order to make them portable when charged, with improved methods for carrying same, being especially adapted for use on the person, cycles, carriages, and the like kind.

24.873. W. P. Thompson. Liverpool. Improvements in telephones. (The Actien-Gesellschaft für Fernsprechpatente, Germany.)

24,876. H. Aron. Liverpool. An improved apparatus for electrically winding up a driving spring.

24,899. L. Schuler. London. An improved dynamometer.*

24,906. A. B. Blackburn and W. Buchanan. London. Improvements in alternating electric current transformers.

24,907. A. B. Blackburn and G. W. Fairall. London. Improvements in electric arc lamps.

24,908. A. B. Blackburn. London. Improvements in apparatus for indicating and recording electric currents.

24,924. J. Taylor. Warrington. Improvements in telephone switchboard plugs.

24,926. A. B. Blackburn and W. Buchanan. London. Improvements in dynamo-electric machines.

December 22, 1894.

24,934. H. J. Wagg. Brighton. An improved quick-break or make-time switch.

24,951. H. B. Bourne and W. F. Bourne. London. Improvements in safety fuses or cut-outs for electric circuits.

25,014. W. Herbert and J. Herbert. London. Improvements in electrical batteries specially applicable for use in connection with portable lamps.

25,019. F. M. Newton and T. Hawkins. London. A new or improved automatic switch for electro-motors.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1893.

18,403. Mann. Inter-communication by telephone.

23,855. Thomas and Hillmann. Galvanising metal tubes and bars.

24,254. Nalder and Others. Electric switch.

24,414. Thompson (Rast). Electric railways.

1894.

494. THOMPSON (Coflin). Working metals electrically.
1,087. THWAITE and CAWLEY. Electric haulage.
1,788. BAYLY (Wicklund). Electric glow lamps.
1,810. HOLT. Electrical measuring instruments.
3,166. HOWARD (Simon and others). Electric traction.
3,426. HUNTER and JACK. Electric lamps.
13,579. FROST. Coin-controlled electrical apparatus.
18,057. ZAUSMER. Carbon regulator for arc lamps.
20,886. MACDONALD. Telegraphic relays.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1894, pages 274-300, *&c. &c.*]

CHISEL SAW COMPANY (LIMITED).—This Company has been registered with a capital of £50,000, in £5 shares, to carry on the business of machine and engineering tool makers, mechanical engineers, boiler makers, metallurgists, and manufacturing chemists.

GILBERT GILKES AND CO. (LIMITED).—This Company was registered on December 31st, with a capital of £20,000 divided into 650 £6 per cent. Cumulative Preference and 1,350 Ordinary shares of £10 each, to acquire the business of a civil and mechanical engineer carried on by Gilbert Gilkes, at Kendal, and to carry on the business of iron and steel manufacturers, mechanical engineers, electrical engineers, tool makers, metal workers, boiler makers, &c.

LIGHT AND HEAT EXHIBITION, 1895 (Incorporated).—This Company was registered on December 29th as a company limited by guarantee, having a membership of not more than 100, and each is liable for the sum of £1 in the event of winding-up. The objects are: To open and carry on in London during the year 1895 an exhibition of manufactures, inventions, and objects of interest connected with actual means of lighting and heating in all its branches, and including, amongst other things, a museum illustrative of the historical development of such means from early times to the present, the pecuniary profits of which will be devoted to the Sunday Hospital Fund, and to enter into and carry into effect an agreement dated October 4th, and made between The Kensington Woodhouse Park Syndicate (Limited) and John Furley, J. P., for the tenancy of the premises known as Woodhouse Park, Shepherd's Bush, London, W. The control of the business will be vested in an executive committee, consisting of R. Brudenell Carter, F.R.C.S. (Chairman); Sir H. Trueman Wood, M.A. (Vice-Chairman); Capt. Abney, C.B., F.R.S.; Capt. Barlow; Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D.; Sir Raylton Dixon; Sir Henry Doulton; Col. Edis, F.S.A.; Dr. E. Frankland, F.R.S.; Col. Farquhar Glennie; Sir Alfred Jephson, Captain R.N.; Lieut.-Col. J. Jocelyn, R.A.; Prof. V. B. Lewis, F.I.C.; Sir William T. Lewis; J. Norman Lockyer, C.B., F.R.S.; Major P. A. Macmahon, R.A., F.R.S.; Col. G. M. Onslow; W. H. Preece, C.B., F.R.S.; Dr. W. J. Russell, F.R.S.; Sir David Salomons, Bart.; Col. Shaw-Hellier; Alexander Siemens; W. A. Valon; and Honorary Secretary and Director, John Furley, J.P.

RAILWAY WAGGON AND ENGINEERING COMPANY (LIMITED).—This Company was registered on December 31st, with a capital of £10,000 in £1 shares, to carry on the business of railway carriage and waggon builders and repairers, engineers, general metal workers, &c.

SHEPHERD, HILL AND CO. (LIMITED).—This Company was registered on December 31st, with a capital of £7,000 in £5 shares, to carry on the business of manufacturers of advanced types of metal working machine tools, hydraulic machinery, and general engineering.

SILVEROID COMPANY (LIMITED).—This Company was registered on December 29th, with a capital of £400, in £1 shares, to carry into effect an agreement for the working of a secret process for the electrical deposition of silver upon brass, copper and other metals usually electro-plated, dated November 29th, made between Charles H. Woolf and Arthur E. Hayman, and Sidney F. St. J. Steadman, Bertram B. van Praagh, Arthur Sims, Harold G. Campion, and Harold S. Simmons.

UNIVERSAL ELECTRICAL FITTINGS COMPANY (LIMITED).—This Company was registered on December 29th, with a capital of £6,000 in £1 shares, to carry on the business of metallurgists, metal founders, metal workers, electrical instrument makers, electrical contractors, and manufacturers of and dealers in and affixers of dynamos, lamps, meters, transformers, conductors, switches, lampholders, brackets, electroliers, and all or any kind of electric apparatus, &c. The subscribers are (with one share each) G. Franklin, H. S. Ayres, C. Field, A. le Lofes, F. Hobdon, W. H. Chantrey, and J. G. Godwin.

GUILDFORD ELECTRICITY SUPPLY COMPANY (LIMITED) formerly the Holloway Electricity Supply Company, Limited).—Special resolutions passed and confirmed for the division of the existing 200 shares of £10 each in 400 shares of £5 each, for the increase of the nominal capital to £20,000 by the creation of 3,500 new £5 shares, and 500 new shares of £1 each, and for the change of name as stated above, have just been filed. New Articles of Association have also been registered, and these contain (*inter alia*) provisions for the purchase by the Company, if the Directors think desirable, of the business of a central electric lighting station and of electrical engineers and contractors carried on by Messrs. Sharp and Kent at Tollington-road, Islington, London, N., and elsewhere. The annual return, made up to November 26th, was filed on December 11th following. Only the seven shares subscribed for by the signatories have been taken up, and nothing has been called.

J. C. HOWELL (LIMITED).—The annual return of this Company, made up to November 8th, has been filed. Out of a nominal capital of £25,000, in £5 shares, 2,907 have been taken up, of which 2,000 have been issued as fully paid. The full amount has been called on the remaining 907 shares, resulting in the total receipt of £4,510.

ISLE OF WIGHT ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return of this Company, made up to November 19th, and recently filed, shows that only 7 shares have been subscribed for out of a nominal capital of £1,000, divided into 940 Ordinary and 60 Founders' shares of £1 each, and no calls have as yet been made.

ITALIAN ELECTRICAL LIGHT AND POWER COMPANY (LIMITED).—The annual return of this Company, made up to November 28th, has been filed. Out of a nominal capital of £60,000 in £4 shares, 307 shares have been taken up, and of these 300 were issued as fully paid to Girolamo Taddei.

CITY NOTES.

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ended December 30th were £859, as against £837 in the corresponding period of 1893, being an increase of £22. The total receipts for the half-year amount to £23,306, as against £21,886, an increase of £1,420.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts for the month of December are £3,400, as compared with £3,834, in the corresponding month of last year.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—Estimated traffic receipts for the month of December, 1894, £1,671, against £1,895 in the corresponding period of last year.

ELMORE'S AMERICAN AND CANADIAN COPPER DEPOSITING COMPANY (LIMITED).—At the annual meeting of this Company, on Monday, Mr. J. J. Atkinson, who presided, said the Directors would have been very glad had they been in a position to announce the sale of the property during the past year, but there had been no offer for it at anything like a satisfactory figure, and there was no likelihood of a sale until they were in a position to show beyond all question the commercial value of the patents. Until the European companies could show a substantial profit for the working of the patents the American and Canadian company was not in a position to insist upon a proper purchase price for their rights.

ELMORE'S FOREIGN AND COLONIAL PATENT COPPER DEPOSITING COMPANY (LIMITED).—A meeting of this Company was held on Monday last, when Mr. F. L. Rawson moved the adoption of the report and accounts. The general expenses of the Company were almost one-third less than hitherto. The Board had decided to write off the value of the Deferred shares in Elmore's American and Canadian Patent Copper Depositing Company, on the ground that there was no hope of such shares ever realising anything like their face value. This, however, did not represent any actual pecuniary loss, as the Company would continue to hold the shares for whatever they might ultimately realise. After providing for this reduction in the Company's assets, there remained a surplus of £166,417. 5s. 5d. The Board believed that their difficulties, which were chiefly of a financial character, had now been overcome. The French Company had escaped liquidation, and the German Company had attained to a perfectly satisfactory position from a manufacturing point of view. Negotiations were on foot for the sale of the Belgian, Indian, Italian, Russian, and Spanish patents. It was proposed to issue £5,000 of First Mortgage Debentures. The Directors had met the most pressing financial claims against the Company during the year. Mr. J. Shurmer (secretary) was elected a Director, in the place of Mr. W. Elmore, who retired.

HOBART ELECTRIC TRAMWAY COMPANY (LIMITED).—The interest on coupon No. 6 of the First and Second Mortgage Debentures of this Company is payable on and after the 1st inst. at the Commercial Bank of Scotland, 62, Lombard-street, London, E.C.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended the 30th inst. amounted to £837. The amount for the corresponding week last year was £619.

NEW TELEPHONE COMPANY (LIMITED).—An extraordinary meeting of this Company was held at the offices, Telephone-bldgs., London-wall, E.C., yesterday. Mr. S. H. Sands, who presided, proposed the confirmation, as a special resolution, of the resolution which was passed at the extraordinary general meeting of the Company held on the 19th ult., "that the Company be wound up voluntarily."—Mr. Gaine seconded the resolution, which was adopted unanimously.—On the motion of the Chairman, seconded by Mr. Goddard, a resolution was afterwards passed appointing Mr. Albert Anns liquidator of the Company.

SALT LAKE AND OGDEN GAS AND ELECTRIC LIGHTING COMPANY.—The coupon due on this Company's stock on January 1st is payable in this country at the National Provincial Bank of England, Bishopsgate-street, E.C.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended December 28, 1894, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,829.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Dec. 24		Price Wednesday, Jan. 2.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 2.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,850	Stock	9 0	Anglo-American	38	39	38	39	6 2 7	Jan., Apr., July, Oct.	..	..
£2,993,560	Stock	13 0	Do. Preferred	71¼	72¼	71¼	72¼	5 10 4	,, ,,	72¼	71¼
£2,993,560	Stock	6/0	Do. Deferred	6¼	6¾	6¼	6¾	..	..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer) xd	102	105	100	103	3 17 8	January and July	..	..
130,000	£10	3/0	Brazilian Submarine xd	10¾	11¼	10½	10¾	6 0 11	Mar., June, Oct., Dec.	10¾	10½
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906) xd	111	115	109	113	4 8 6	June and December	..	..
10,000,000	$100	$2½	Commercial Cable Capital Stock xd	140	150	140	150	4 13 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12½	13½	12½	13½	5 18 6	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	19	20	19	26	5 0 0	,, ,,	..	..
12,931	6	1/8	Direct Spanish (fully paid)	4¼	4¾	4¼	4¾	4 4 3	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¼	9¾	9¼	9¾	5 2 7	,, ,,	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	4 3 4	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8¼	8¾	8¼	8¾	6 2 10	Jan., Apr., July, Oct.	..	..
400,000	10	2/6	Eastern	15¾	16¼	16	16½	4 0 0	,, ,,	16⅛	16
70,000	10	6%	Do. 6 per Cent. Preference	16¾	17¼	16¾	17¼	3 9 7	,, ,,	.	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	119	122	120	123	3 5 1	May and November	122	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	110	106	110	4 12 10	February & August	..	..
250,000	10	2/6	Eastern Extension	16	16½	16⅛	16⅝	4 5 6	Jan., Apr., July, Oct.	16¾	16 3/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	119	123	119	123	3 5 1	February & August	..	..
£62,700	100	6%	* Do. 6 p. c. (Austln. Gov. Sub.) Debs. 1900 xd	103	107	101	105	4 15 3	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900 xd	103	107	101	105	4 15 3	,, ,,	104¾	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	105	108	105	108	3 15 6	February & August	106	
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	109%	112%	109%	112%	3 11 11	May and November	110	109¾
180,227	10	1/3	Globe Telegraph and Trust	8¾	9	8¾	9	4 17 3	Jan., Apr., July, Oct.	9	8¾
180,042	10	6%	Do. 6 per Cent. Preference	15¾	16¼	16	16¼	3 13 10	,, ,,	16 3/16	16⅛
150,000	10	5 0	Great Northern xd	21¾	22¼	21½	22	3 18 10	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	..	..
17,000	25	12 6	Indo-European	47	49	47	49	6 8 2	May and November	..	..
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	102	106	102	106	5 15 5	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942 xd	103	108	103	106	3 15 6	.	..	..
11,839	8	4/0	Reuter's	2	4	2	4	..	April and October	..	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	110	115	110	115	6 4 4	,, ,,	..	..
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	101	104	4 17 10	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	1½	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	100	105	96	101	7 18 5	June and December	..	..
88,321	10	6d.	West India and Panama	1	1½	1	1½	..	.	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	5 6 8	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.) xd	109	112	107	110	4 10 11	June and December	..	.
64,242	15	3/0	Western and Brazilian	11	11½	11¼	11¾	4 9 4	May and November	11½	11
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6½	6¾	..	..	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	4¾	5¼	4¾	5¼	..	..	5¼	5
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 17 4	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 17 4	,, ,,	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	112	118	112	118	5 17 8	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 17 8	March & September	..	..
			TELEPHONES.								
44,000	6	10/0	Chili Telephone (fully paid)	2	3	2	3	..	..	2½	..
224,850	10/0	2⅜d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	..
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	7/16	9/16	½	⅝	..	Yearly	—	..
484,597	5	3/4	National	5⅛	5⅜	5⅛	5⅜	4 15 3	June and December	5⅜	5 1/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 15 0	,, ,,	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	,, ,,	15½	..
119,234	5	3/4	Do. 5% Non-Cumulative 3rd Pref.	5¾	6	5¾	6	4 5 1	.	6¾	[illegible]
1,000,000	Stock	4½%	* Do. Debenture Stock, 4½% (red.)	110	113	..		4 1 3	January and July	..	..
58,000	5	1/0	United River Plate	1	2	1	2		,, ,,	..	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	88	94	86	91	5 9 11	,, ,,	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	14	15	14	15	..	—	.	..
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15	15½	15	15½	3 18 8		15⅜	15¼
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	132	135	130	133	3 15 2	June and December	131	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	4½	5½	4½	5½	3 12 9	—	..	..
£57,100	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	..
8,322	£5	..	House-to-House Electric	..		..		—	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		—	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	.		.		—	January and July	..	—
45,000	£5	2/6	Liverpool Electric Supply (fully paid)	7 1/16	7 7/16	7 3/16	7 7/16	—	..	..	—
111,000	5	..	London Electric Supply	⅛	⅜	⅛	⅜	..	..	..	.
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	9¾	10¼	10	10½	2 7 7	..	10 1/16	10
£150,000	Stock	4½%	* Do. 4½% Debs. (Bonds of £10, £20, and £40)	116	118	115	118	3 17 9	June and December	117	..
6,452	£10	..	Notting Hill Electric	7¼	7¾	7¼	7¾	—	..	..	..
19,980	£5	2/0	St. James and Pall Mall	7¾	8¼	7¾	8¼	.	..	..	..
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8½	9	3 17 9	..	..	..
59,900	5	2/0	Westminster Electric Supply (fully paid)	7¼	7¾	7¼	7¾	2 13 1	..	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2¼	2¾	2¼	2¾	5 8 8	..	2⅝	2 9/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2⅜	2⅝	4 11 5		2 9/16	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	111	114	111	114	4 0 4	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	3	3½	3	3½	..	January and July	..	..
12,139	5	..	Edison and Swan United	—		—		..	..	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	..	—	..
120,000	2	..	Electric Construction	¼	½	¼	½	..	—	..	..
12,845	2	2 9½	Do. 7 per Cent. Cumulative Pref.	1½	2	1½	2	..	—	.	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1½	1¾	1½	1¾	..	—	1 9/16	.
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	.	.	..	.
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	25½	26½	25½	26½	4 11 4	February & August	26 3/16	26
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 7 7	March & September	..	—
15,995	£10	6/4	International Okonite Ordinary	..		..		..	.	..	—
16,000	£10	..	Do. 8 per Cent. Preference	—		—		—	December and June	..	—
20,000	9	..	Manchester Edison-Swan "A" (£1 6s. paid)	—	¼	—	¼	—	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	41	43	41	43	5 11 0	March and July	..	..
£150,000	100	5%	Do. 5 per Cent. Bonds	100	109	104	107	4 13 0	January and July	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		—		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	—		..		..	—	..	..
£63,[illegible]70	10	10/0	W. T. Henley's Telegraph Works Ordinary	8½	9½	8½	9½	5 5 3	..	..	..
£30,000	10	..	Do. Preference	..		—	12	..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1%	City and South London Railway	42	44	43	45	2 4 5	May and November	45¾	44
7,000	10	5%	Do. 5% Perpetual Preference	13¾	14¼	13¾	14¼	3 10 2	..	..	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	124	126	124	126	3 3 6	May and November	125¾	..
37,500	£10	1%	Liverpool Overhead Railway	8¾	9	8¾	9	1 2 3	..	..	..
6,295	10	5%	Do. 5% Preference	13	13½	13	13½	3 15 6	..	—	..
125,000	Stock	4%	Do. 4% Debenture	112	114	110	112	3 11 5	January and July ..	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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NOTES.

The long-looked-for volume of the Proceedings of the International Electrical Congress at Chicago, 1893, has at last been issued, and is published by the American Institute of Electrical Engineers. The contents of most of the Papers and reports of the discussions have long ago appeared in our columns either in full or in abstract; but the volume forms a very useful book of reference. One Paper, of which nothing has been heard since the day of reading, is that by Prof. Ayrton on "Variation of Potential Difference of the Electric Arc with Current, Size of Carbons, and Distance Apart," but it will be searched for here in vain. Many Papers at this Congress were "read by title." This particular Paper is unhappily only published by title, and below the title we find the following note: "The substance of the above Paper was read by Prof. Ayrton, and a number of diagrams were shown. The manuscript was partially destroyed by fire through a most unfortunate accident. The Paper embodied an exhaustive study of the forms of electric arcs and carbons under various conditions." So elaborate was the research, and so detailed was the Paper, that it was impossible to print it before the meeting, and we understand that some of the experiments were continued under the superintendence of Mrs. Ayrton and Mr. Brousson, after Prof. Ayrton left for America, and the very latest results were sent bi-weekly to him by post, and were included in the Paper. It was not even read in full, and we understand that of the whole of the manuscript which was destroyed no copy exists. We have great pleasure in announcing, however, that an abstract of the original has been written by Mrs. Ayrton, and that in the new Paper much original work has been included. This Paper has been entrusted to us for publication, and we hope to commence it next week.

One of the most agreeable features of the progress of electric lighting in London is the recovery, to which reference is made in another column, of the London Electric Supply Corporation from the period of depression which followed its unfortunate series of accidents. In July last Lord Wantage, the largest shareholder, took temporary possession of the concern; temporary in the sense that if it eventually prospered, the shareholders, who are shareholders still, would retain and enjoy their property in the Corporation, which is still a Corporation, and indeed may buy out the mortgagee. But he took possession with the risk, and it must be confessed, no small one, that the business might collapse, and that his venture might have a calamitous ending. When Lord Wantage took possession, Mr. Bain became general manager, and to his energy, as well as to Lord Wantage's enterprise, the present state of the Company is due. One of Mr. Bain's first actions was to reduce expenses, and this naturally led to a concentration of the staff. One item of such concentration must be particularly gratifying to Mr. Ferranti; namely, the very small engine-room staff and supervision required at Deptford. Mr. Ferranti's ideal was a magnificent one, and part of this was the reduction of labour at Deptford to an insignificant quantity, in proportion to the output. This, at least, has been realised. Present day critics of the Deptford station forget that the whole scheme was devised without any precedent whatever to go upon, and those Continental and other engineers who "design" station after station so identical in general plan and in detail that but for its outline they would be puzzled to distinguish the drawings of one from another, would, perhaps, have achieved less than did Mr. Ferranti when he was called upon to design the present system of the London Electric Supply Corporation.

During the past four months, such confidence has been restored among consumers that more than 5,000 lamps have been added, making a total of more than 75,000. At this rate, and there is no reason to suppose that it will diminish just yet, Deptford station will be fully loaded by the middle of next winter, and the question of provision of more plant has had to be faced. The colossal alternator has, alas, been sold for scrap iron! Whether Mr. Ferranti could have completed this enormous machine, and whether it could have run successfully, we do not venture to discuss; it is not surprising that Mr. d'Alton shrank from attempting the task. Tenders have, therefore, been invited from the leading makers in this country, Germany, and America; and after the severe and close competition we have great pleasure in congratulating Mr. Ferranti on the order which has been given to his firm for the building of a 1,000-kilowatt alternator. This machine, of which we have been allowed to see drawings, will run at 156 revolutions per minute, and will give 100 amperes at 11,000 volts, and with a frequency of 83. The characteristic will be similar to his present machines, and the regulation will be improved. He offers an excitation of 2 per cent. at full load and 0·8 per cent. electrical loss in the armature, giving altogether an electrical efficiency of 97 per cent. There are many companies, we will not say individuals, who, if not tacitly blaming their bold engineer for some at least of their misfortunes, would have declined to invite him to tender for new plant, and the London Electric Corporation are equally with Mr. Ferranti to be congratulated upon this choice. The engine will be built by Messrs. Plenty and Co. of Newbury, to the design of Mr. P. W. d'Alton, and will consist of three sets of compound engines with inverted tandem cylinders working in parallel on a three-throw crank shaft. They will generate 500 I.H.P. under 140lb. indicated steam pressure, and are to take 20lb. of steam per I.H.P. per hour.

The satisfactory prospects of the Corporation are due to careful economies in many details. The condensing plant, which was at one time a rather formidable problem, is working perfectly; the feed water, ordinary filtered Thames fluid, when turned into high-pressure steam, seriously corroded the pipes and engines, and the boilers would surely have suffered had not a 6-in. artesian well been sunk and secured a plentiful supply of good water and a saving of some £700 a year. Although there is river frontage at Deptford a coal steamer cannot lie alongside, and the discharge of coal was, until the last few weeks, a serious expense. A steam crane working a grab has now been erected, and plunging direct into the barges it takes up some 35 cwt. of coal in one handful and drops it straight into the coal store. Three men, alas! are thus thrown out of work, but the coaling, which used to cost 9d. per ton, is now done for 2d. The future of London electric supply is an interesting subject for speculation. Is a big continuous-current station, in years to come, supplying, on the Oxford system, the present low-pressure stations, impossible? Is the turning of the present alternate-current stations into big transformer stations out of the question? Mr. Ferranti's dream may yet be realised, and Deptford would not be a bad station for the alternating work; and might not even the continuous current systems be run by alternate currents, either from dynamotors or revolving commutator transformers?

The trouble which has been brewing in the bosom of the Worcester City Council is but one sample of an apparently widely extended disturbance. This city having gone in for a brand new electric supply station, is naturally desirous of having a competent electrical engineer to work it. When the appointment of an electrical engineer came before the Council the matter was referred back to the committee, on the ground that it was generally understood that the duties of this post would devolve upon the city engineer. The result of this action was that the Electrical Committee tendered its resignation, which was not accepted. The City of Worcester is so large and important, and the electric supply station is so far removed from the Guildhall, that it would seem a little parsimonious to try to roll these two offices into one; and it is doubtful if the experiment would be a successful one from the point of view of satisfactory lighting. Speaking generally, a city or town or village must afford just what it can pay for; and there are, no doubt, many small places where £200 or £250 per annum would be a serious, not to say prohibitive, addition to the expenses of an electric supply station. In such places the Lord High Executioner may coincide with and be identically the same person as the Lord High Everything Else; but in a town of any importance it would often be positively cheaper to spend more money on salaries.

The latest development of the Worcester trouble is that at a meeting which was held on Monday last, the Electrical Committee came before the City Council and stated that they had come to an "intensified conviction of the imperative necessity" for the appointment of a separate electrical engineer. After a long discussion and the rejection of several amendments it was decided to appoint Mr. Ruthven Murray and to reduce the salary of the present City engineer. This seems rather hard on the City engineer; and, in point of absence of principle, is like reducing the salary of a stipendiary because anew constable has been appointed.

Another interesting example of municipal parsimony in the matter of electric lighting hails from Taunton. There the Town Council not only exacts the sum of £100 as a premium from its pupils at the electric supply station, while only grudgingly granting pittances of £75 and £65 per annum to the assistant electricians; but it has also been inclined to close its fist rather tightly over the premium when one of its pupils had the misfortune to be killed by its machinery. Only after a squabble over the matter did the Council at length agree to pay back half the premium to the representatives of the unfortunate lad. "After all," says our contemporary, the *Journal of Gas Lighting*, in commenting on this state of affairs, "something must be allowed to the Corporation of a small town saddled with an electric lighting venture which stands them in a loss of £1,250 a year or thereabouts; and if they find it consistent with their municipal dignity to trade in this Pecksniffian manner upon the innocence of parents and guardians, that is only what is done to an exaggerated degree by nearly every electrical engineering firm in existence." We may add, however, that electrical engineering firms of standing and importance have this great merit, not possessed by the Taunton Council, that they can find and frequently do find remunerative posts for their pupils at the expiration of their term of apprenticeship, and they can and do afford opportunities for gaining a varied practical experience, and, indeed, provide by such apprenticeship the only legitimate mode of entering the engineering profession.

In our correspondence columns will be found a letter from Mr. Robert Mond, giving the results of certain experiments bearing upon observations of Dr. Borchers relating to the direct conversion of the chemical energy resulting from the oxidation of carbon monoxide into electrical energy. Dr. Borchers' Paper, being a noteworthy publication, was abstracted into *The Electrician* of Nov. 30th last, and an American criticism of the methods adopted and deductions made by its author appeared last week, and was commented upon in this journal. In that comment we pointed out that Dr. Borchers' original critic failed to adduce each conclusive experimental evidence as seemed to us requisite to complete the conclusion that an advance in the direct conversion of chemical into electrical energy had been made. We indicated, however, that the most vulnerable point in Dr. Borchers' defences was his omission to show that the source of the current obtained by him was independent of the nature of the electrodes, and that it was equally existent when the electrodes were of unattackable material, *e.g.*, carbon (in place of copper).

Mr. Mond has made a determination of the voltage of a cell consisting of two carbon electrodes, the one immersed in a solution of cuprous chloride in hydrochloric acid, and supplied with air, and the other in the same liquid supplied with carbon monoxide, and finds a value of 0·0015 volt. This compares rather curiously with the figures (0·05 – 0·4) obtained by Dr. Borchers for an arrangement identical with that of Mr. Mond, save that one electrode was of copper instead of carbon (*The Electrician*, November 30th). The obvious deductions to be made from these statements is that the production of a current is due to the corrosion of the copper electrode, and not to the oxidation of carbon monoxide. If this be substantiated, *cadit questio*. Counter-evidence from Dr. Borchers is certainly to be expected. It is to be regretted that Mr. Mond has not tried an experiment precisely parallel with that quoted, save for the substitution of copper for carbon at one electrode; and, further, that he gives no direct quantitative proof of the production of current at the expense of the copper. It would also be interesting to learn why in certain of his experiments he used a solution of "copper oxychloride" in hydrochloric acid, and wherein it could be expected to differ from one of cupric chloride in the same solvent. The whole matter is so full of immediate interest and future potentialities as to merit complete elucidation.

The voluntary reduction of rates by electric supply companies is a healthy sign. The Kensington and Knightsbridge Company recently dropped suddenly from 8d. to 6d., and now they are revising their rent for meters. They start with the modest sum of 2s. 6d. per quarter for a 5-ampere meter, and offer time meters to take up to 10 amperes at 1s. 6d. per quarter.

Stated in a general way as an abstract proposition, the popularisation of science is admirable; nevertheless, it gives rise occasionally in this workaday world to curious results. A few days ago an eminent professor was lecturing some juveniles, and as an illustration of the exceeding great sensitiveness of modern electrical measuring instruments, exhibited a galvanometer, which was so greatly agitated by the passage through it of the microscopic current derived from a pin and a needle immersed in an orange, that its "spot" went clean off a 30ft. scale. This object-lesson was duly misdescribed in all the daily papers, and was duly misread by the British public. One family of eager experimentalists forthwith purchased a dozen best blood oranges, and sought out seven other spirits worse than themselves and invited them to come in and see the sparks and receive the shocks which it was confidently expected would be obtainable from 24 half-orange cells arranged in series. Did not one single cell send a spot of light wildly off to infinity? The sparks and shocks not being on tap as anticipated, the enraged assembly fell upon the oranges, and they were, when last seen, in a severely mangled condition.

Interdependence of Patents.—The article on this subject was credited by mistake on p. 266 of our last issue to the *Law Times*; it appeared in the *Law Journal* of the 29th ult.

Abolition of Free Rides for American Police.—At the commencement of this year in the United States, policemen, being classified by lawyers as "public officers," were deprived of their privilege of riding free on the street railways.

Electrical Standardising, Testing, and Training Institution.—On Thursday, the 10th inst., Mr. James Swinburne commenced a series of lectures to the students of the above institution on "Dynamo and Transformer Construction."

The Trans-African Telegraph Line.—A Reuter's cablegram, dated Cape Town, January 7, states that the Portuguese have ceased to obstruct the progress of the African Transcontinental telegraph, and the line is expected to reach the Zambesi this month.

Where was the Steam Reserve?—Owing to the dryness of the weather the electric lighting station at Trient, in the Tyrol, which is usually driven by water-power, has been inoperative during the last few weeks, recourse having to be had to petroleum lighting.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
Aden—Zanzibar	Dec. 21	Jan. 10.
Latakia—Cyprus	Nov. 27	—
Cadiz—Teneriffe	Dec. 26	—
Hong-Kong—Macao	Dec. 31	—

A Direct-Connected Arc-Light Station.—According to the *Electrical World* of New York, the first direct-connected arc light station in the United States was started on the night of December 17th, at the Station of the Mutual Electric Light and Power Company, Chicago. The plant consists of Willans' engines direct-connected to 125-light Brush dynamos running Brush-Adams lamps.

Worcester.—As some misapprehension appears to exist perhaps it should be stated that Mr. Davenport, Mr. Preece's representative in Worcester, did not apply for the post of City electrical engineer, and was not, therefore, one of the rejected. The effect of the resolution of the Council on Tuesday will probably be to keep the Brush Company some time longer in the control of the Corporation works.

Institution of Civil Engineers.—Amongst the transfers from the class of associate member to that of member we note the name of Mr. W. B. Esson. Amongst the members elected at the last monthly ballot was Mr. J. S. Raworth, and among the associate members were Mr. John Hubert Davies (Johannesburg), Mr. Alfred Herbert Dykes, Mr. Robert Cattley Jackson (Newcastle-on-Tyne), and Mr. Henry Alexander Mavor (Glasgow).

A Telephone Complaint Office.—A compartment has been set aside in the magnificent Hotel des Téléphones in the Rue Gutenberg, in Paris, for the purpose of receiving the complaints of subscribers. When a subscriber has a complaint to make, all that he will have to do in future will be to ask the operator at the exchange to place him in communication with the complaint office, and his grievance will there and then be telephonically settled. We understand that this dangerous precedent will not be followed in London.

A 1,200-H.P. Steam Engine in Canada.—According to the *Canadian Engineer*, the Laurie Engine Company, Montreal, have built for the Toronto Street Railway Company the largest engine ever manufactured in Canada for a similar purpose. Its normal capacity is 1,200-H P. It cost over £10,000. The fly-wheel weighs 36 tons, is 20ft. in diameter, and is built directly on the shaft and put up in 10 sections. The combined weight of the fly-wheel, armature, shaft and generator is upwards of 70 tons.

Personal.—We understand that Mr. J. S. Cunnington, who has been for over 10 years chief electrical engineer and manager of the electrical department of B Verity and Sons, Covent Garden, has now severed his connection with the firm.——Mr. W. H. Preece has presented Mr. Henry Eaton, late Superintending Engineer of the Metropolitan District, who recently retired under the age limit, with a testimonial on behalf of the whole of the Metropolitan engineering staff, numbering some 400 officers and men.——Mr. Stephen Sellon has resigned his appointment with the Electric Construction Company.

Secondary Battery Patents Expiring This Year.—The following secondary battery patents expire this year in addition to the Faure patent, referred to in another column, and which expired yesterday :—

Dated 1881.	No.	Name.	Title.
April 16	1,676	C. A. Faure	Secondary, electric, or galvanic batteries.
May 24	2,272	J. W. Swan	Secondary batteries or apparatus for storing or conserving electricity.
September 10	3,926	J. S. Sellon	Improvements in secondary batteries or magazines of electricity.
December 15	5,494	J. W. Swan	Secondary voltaic cells
December 23	5,631	J. S. Sellon	Improvements in the construction of secondary batteries.

Lightning.—The tower of St. Columb Church, Cornwall, was struck by what is described as a thunderbolt on Sunday night last. The service had just commenced when a flash was followed by a crash. The congregation fled from the building, and the service had to be abandoned. The discharge travelled down to the belfry and then up the middle aisle, where "it presented the appearance of a huge ball of fire and sparks." One of the ringers was thrown out over the railings into the church, a distance of 25ft., and sustained a bad cut on the head. His companions were stunned. All the glass in the belfry window was blown to pieces, and the inside of the wall was torn. The gas meter was struck, and a slight explosion occurred, setting fire to the floor, but the flame was extinguished before much damage was done.

Municipal Electric Lighting for Liverpool.—As a result of a long discussion on Wednesday the Liverpool City Council adopted, by 29 votes to 13, a recommendation of the special Lighting Commitee that the council offer to purchase from the Liverpool Electric Supply Company the whole undertaking of the Company as a going concern this year, instead of waiting until the period when the Corporation could compel the Company to sell, at price, terms, and conditions as may be agreed upon between the Company and the Committee, and, failing such agreement, as may be settled by arbitration. The Committee were authorised to take the necessary steps to carry out the objects of the resolution. Alderman Forwood said if arbitration were resorted to he would not be surprised if the Company preferred a claim for £500,000, and he deprecated giving the Committee what might be called a blank cheque.

Patents in 1894.—The number of patents applied for last year was 25,372, an increase of about 250 over the preceding year. Omitting parts of 100, the figures since 1885 are as follows :—

Year.	Applications.	Year.	Applications.
1886	17,100	1891	22,800
1887	18,000	1892	24,100
1888	19,100	1893	25,100
1889	21,000	1894	25,300
1890	21,300		

As a rule, says "G. B. E." in the *Law Journal*, some 46 per cent. of the total applications are completed ; and although the increase in the number of applications has not been so great in 1894 as in former years, yet it will prove that the number of completed applications will be beyond the average.

Bath.—The Lighting Committee of the Bath Corporation invited Mr. F. H. Medhurst to confer with them last Monday, and to advise them with regard to their proper procedure in opposing the application of the Bath Electric Lighting Company for a Provisional Order. The Urban Sanitary Authority had already passed a resolution refusing its consent to the application of the Company ; but Mr. Medhurst was of the opinion that a purely negative policy would not be likely to avail with the Board of Trade, and he cited the decisions of the Board of Trade with regard to Newmarket and Bedford in support of his view. Finally, Mr. Medhurst's advice was adopted, and a resolution carried that his worship the mayor be requested to call a special meeting of the Urban Sanitary Authority for Friday (to-day) in order to consider, and if thought fit, to pass a resolution that the authority itself apply for an Electric Lighting Provisional Order at the earliest possible date.

The Pacific Cable.—According to a Reuter's cablegram, dated Washington, January 9th, the following message from President Cleveland was transmitted to Congress on that date :—

I submit herewith certain despatches from our Minister in Hawaii and the accompanying documents. They disclose that Hawaii desires to lease to Great Britain one of the uninhabited islands as a station for a submarine telegraph cable between Canada and Australia, with connection between the island leased and Honolulu. Both Hawaii and the representatives of Great Britain in the negotiations concede that the proposed lease cannot be effected without the consent of the United States, owing to our reciprocity treaty with the King. The latter agreed that as long as the treaty remained in force he would not lease, otherwise dispose of, or create a lien upon any port, harbour, or other territory in his dominion, or grant any special privilege or right of use therein to any other Power, State, or Government. At the request of Hawaii this subject is laid before Congress for its determination upon the question of so modifying the treaty as to permit of the proposed lease. It will be seen that the correspondence between Hawaii and the British negotiators negatives the existence on the part of Hawaii of any suspicion of British unfriendliness or fear of British aggression. The attention of Congress is directed to the following statement contained in the communication addressed to Hawaii by the representatives of Great Britain :—"We propose to inform the British Government of your inquiry whether they would accept the sovereignty of Neckar Island, or of some other uninhabited island, on condition that no subsidy be required from you. As we have explained, we have not felt at liberty to entertain that question ourselves, as we were definitely instructed not to ask for the sovereignty of any island, but only of a lease simply for the purpose of the cable." I hope Congress will see fit to grant the request of Hawaii, and that our consent to the proposed lease will be promptly accorded. It seems to me we ought not, by a refusal of this request, to stand in the way of the advantages to be gained by isolated Hawaii through telegraphic communication with the rest of the world, especially in view of the fact that our own communication with that country would thereby be so greatly improved, without apparent detriment to any legitimate American interest.

Electrical Communication with Lighthouses.—Referring to the resolution recently passed by the Plymouth Chamber of Commerce, to which reference was made on p. 266 of our last issue, Lord Mount-Edgcumbe writes to the *Western Morning News* :—

Sir,—My connection with the Royal Commission, which is primarily responsible for recommending the establishment of electrical communication with lighthouses and lightvessels, renders it obviously impossible for me to enter into a public discussion upon the course which that Commission has adopted, or is likely to adopt, with regard to special cases : but perhaps I may, without indiscretion, offer a few remarks upon the discussion which took place in the Plymouth Chamber of Commerce last Thursday. I remember it being said not long ago that no other maritime nation would allow its outlying lighthouses to remain unconnected ; but I would ask those who think this if they can point to any one instance in which any other nation has attempted to connect a lightvessel in a seaway, or such a lighthouse as the Bishop. The Fastnet was connected by Lloyd's some years ago, but the connection was so repeatedly destroyed that it had to be abandoned. The Royal Commission recommended the renewal of the attempt by means of a new system. The Bishop would present, if anything, greater difficulties than the Fastnet, and every witness whom we examined in the Scilly Islands expressed a confident opinion that the sound signals now employed at the lighthouse could at all times be heard in the islands, which are now all electrically connected with each other. I do not say that the Eddystone would present similar difficulties, nor would it be right for me to say anything as to the opinion of the Commissioners with regard to that particular lighthouse. No one, however, who has studied the wreck charts for the last 10 or 12 years can fail to recognise that there are many places round our coasts where casualties have not only been far more numerous, but where the chances of such casualties occurring must always be far greater. There can be no comparison, for instance, between the danger incurred, with ordinary care and knowledge, in passing the Eddystone, and those presented by the great outlying shoals on the East Coast. These are, of course, guarded by lightvessels, four of which (as well as one pile lighthouse) have been connected on the recommendation of the Commission. In each case new moorings, with four anchors, and in some cases, I believe, new vessels, have had to be provided ; and the destruction of the cable in one case has already shewn that the difficulties which have to be contended with have not yet been overcome. I need hardly say that the Trinity House has not the funds at its disposal for dealing with these costly operations. As regards shore lighthouses, with which alone, I believe, other nations have dealt, the number which have been connected during the last three years is very large. I would only add that commercial considerations are excluded from the purview of the Royal Commission.

ELECTROMAGNETIC THEORY.—LXII.*

BY OLIVER HEAVISIDE.

(*Continued from page 213.*)

§ 238. In order that the problem of the propagation of electrical disturbances along a telegraphic or telephonic circuit shall reduce practically to that of the diffusion of the electric displacement after the manner of heat in the celebrated theory of Fourier, it is necessary for the self-induction to be ignorable, and that the external disturbances to which circuits are liable should be removed. It would not be at all desirable to bring a practical telegraph circuit to such a state closely, because it is a state of relative inefficiency, accompanied by the greatest possible distortion in transit, and is therefore a state to be avoided by, as before explained, making self-induction be of importance, if efficient rapid signalling with little distortion be required. The nearest approach to the theory of diffusion being in slow signalling through a long cable, we make believe now that this case is truly represented by the reduced forms of the more general equations appropriate to elastic diffusion.

On this understanding the two circuital equations, when suitably transformed as explained in §§ 200-202, reduce to

$$-\frac{d\mathrm{C}}{dx}=\mathrm{S}p\mathrm{V}, \qquad -\frac{d\mathrm{V}}{dx}=\mathrm{RC}, \tag{1}$$

where R and S are the resistance and permittance per unit length of line, whilst V and C are the transverse voltage and the circuital gaussage of the more general theory, but which may now be called the potential difference of the wires and the current in them, if there be a pair of wires. Or, if we have a cable in question, using only one wire, then we may call V simply the potential and C the current.

From (1) we derive the characteristic

$$\frac{d^2\mathrm{V}}{dx^2}=\mathrm{RS}p\mathrm{V}=q^2\mathrm{V}, \text{ say.} \tag{2}$$

In order to translate to heat problems, perhaps the easiest way is to consider the longitudinal conduction of heat in a rod. Then V is the temperature and C the flux of heat, whilst R^{-1} and S are the conductance and capacity for heat per unit length of rod. But the rod should be insulated laterally. It is easy to insulate a rod electrically; but it is much harder, if not impossible, to insulate it thermally to an equivalent extent. So, if the flow of heat in a real rod be rejected for want of a sufficiently close similarity to the electrical problem, we may imagine an infinite number of rods fitted together in contact side by side. Just as jerry-built houses in a street mutually support one another, and prevent the collapse that would occur were they separated, so will the rods prevent the lateral escape of heat from their neighbours, and we can have a longitudinal flux of heat in the same way as in a perfectly insulated rod. This is the case of the linear flow of heat in an infinite homogeneous conductor. These remarks are to enable the reader to translate from electrical to heat problems readily. On the whole, the cable is preferable in the study of diffusion, on account of the facility with which terminal and other auxiliary arrangements can be imagined, and, if need be, practically realised. The heat problems are not so convenient in this respect. On the other hand, there is no doubt greater scientific interest in heat problems when they concern such stupendous questions as the age of our common mother earth; but since this is primarily an electrical work, I cannot go on further with that question, but leave it to David and Goliath.

§ 239. We have now to consider a number of problems which can be solved at once without going to the elaborate theory of Fourier series and integrals. In doing this, we shall have, preliminarily, to work by instinct, not by rigorous rules. We have to find out first *how* things go in the mathematics as well as in the physics. When we have learnt the go of it we may be able to see our way to an understanding of the meaning of the processes, and bring them into alignment with other processes. And I must here write a caution. I may have to point out sometimes that my method leads to solutions much more simply than Fourier's method. I may, therefore, appear to be disparaging and endeavouring to supersede his work. But it is nothing of the sort. In a complete treatise on diffusion Fourier's and other methods would come in side by side—not as antagonists, but as mutual friends helping one another. The limitations of space forbid this, and I must necessarily keep Fourier series and integrals rather in the background. But this is not to be misunderstood in the sense suggested. No one admires Fourier more than I do. It is the only entertaining mathematical work I ever saw. Its lucidity has always been admired. But it was more than lucid. It was luminous. Its light showed a crowd of followers the way to a heap of new physical problems.

The reader who may think that mathematics is all found out, and can be put in a cut-and-dried form like Euclid, in propositions and corollaries, is very much mistaken; and if he expects a similar systematic exposition here he will be disappointed. The virtues of the academical system of rigorous mathematical training are well known. But it has its faults. A very serious one (perhaps a necessary one) is that it checks instead of stimulating any originality the student may possess, by keeping him in regular grooves. Outsiders may find that there are other grooves just as good, and perhaps a great deal better, for their purposes. Now, as my grooves are not the conventional ones, there is no need for any formal treatment. Such would be quite improper for our purpose, and would not be favourable to rapid acquisition and comprehension. For it is in mathematics just as in the real world; you must observe and experiment to find out the go of it. All experimentation is deductive work in a sense, only it is done by trial and error, followed by new deductions and changes of direction to suit circumstances. Only afterwards, when the go of it is known, is any formal exposition possible. Nothing could be more fatal to progress than to make fixed rules and conventions at the beginning, and then go on by mere deduction. You would be fettered by your own conventions, and be in the same fix as the House of Commons with respect to the despatch of business, stopped by its own rules.

But the reader may object, Surely the author has got to know the go of it already, and can therefore eliminate the preliminary irregularity and make it logical, not experimental? So he has in a great measure, but he knows better. It is not the proper way under the circumstances, being an unnatural way. It is ever so much easier to the reader to find the go of it first, and it is the natural way. The reader may then be able a little later to see the inner meaning of it himself, with a little assistance. To this extent, however, the historical method can be departed from to the reader's profit. There is no occasion whatever (nor would there be space) to describe the failures which make up the bulk of experimental work. He can be led into successful grooves at once. Of course, I do not write for rigourists (although their attention would be delightful) but for a wider circle of readers who have fewer prejudices, although their mathematical knowledge may be to that of the rigourists as a straw to a haystack. It is possible to carry waggon-loads of mathematics under your hat, and yet know nothing whatever about the operational solution of physical differential equations.

§ 240. Now, consider the characteristic equation (2) above. If q were a constant, its solution would obviously be

$$\mathrm{V}=\epsilon^{qx}\mathrm{A}+\epsilon^{-qx}\mathrm{B}, \tag{3}$$

where A and B are any constants. That is, there are two independent functions of x which satisfy (2). The constancy of A and B means independence of x.

It is equally true that (3) is the solution in the same sense when q^2 has the operational meaning RSp, because the formal satisfaction by test is the same. The constants are still constants with respect to x, but they are now any functions of t. That is, (3) is a form of the general solution of the characteristic. To go further, we have to find A and B to suit special cases, and then by the execution of the processes

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implied by the exponential operators convert the solutions from operational to algebraical form. There is a lot of assumption here; for example, that the operations can be effected, as they involve preliminarily unintelligible ideas. The best proof is to go and do it.

The easiest solutions are those relating to the effects produced at a given spot by causes acting there. Those produced at a distance can be easily deduced later. So, now we take some special cases to begin the treatment. Let an infinitely long cable be laid in any depth of water. It need not be laid straight, so by winding it about, even the finite size of the seas of the earth might be sufficient to contain a sufficient length for our purpose, which is, that the near end of the cable is to be freely at our disposal to operate on, whilst the far end is so very far off that it cannot react sensibly on the near end, and to a great distance therefrom, in a large interval of time.

Let the cable be initially free from charge, and be then operated upon by a battery of voltage e and no resistance at its beginning, where $x=0$. That is, one end of the battery is put to line, and the other to earth, the absence of resistance being merely a practical simplification. The impressed voltage e may be regarded as any function of the time t (real, of course, but not necessarily continuous). The effect is to raise the potential at the beginning to $V_0=e$, and V_0 may be regarded as the sole cause of disturbance in the cable itself further away. Then $A=0$ and $B=V_0$ in (3), making

$$V=\epsilon^{-qx}V_0, \tag{4}$$

for the characteristic is satisfied, and $V=V_0$ at $x=0$, and there is no other imposed condition. Other cases, in which A is not zero, will come later.

By (4), and the second of (1),

$$C=\frac{q}{R}V=\frac{q}{R}\epsilon^{-qx}V_0; \tag{5}$$

the first equation giving C in terms of V at the place, the second in terms of V_0, We also have

$$C=\epsilon^{-qx}C_0, \tag{6}$$

if C_0 is the current at $x=0$; and also

$$C_0=\frac{q}{R}V_0=\left(\frac{Sp}{R}\right)^{\frac{1}{2}}V_0. \tag{7}$$

The last equation is the simplest in general, because V_0 can be made simple. The operator q/R turns potential to current. It is, therefore, the conductance operator of the cable. Similarly,

$$V_0=\frac{R}{q}C_0=\left(\frac{R}{Sp}\right)^{\frac{1}{2}}C_0. \tag{8}$$

So the resistance operator is $(R/Sp)^{\frac{1}{2}}$.

We see at once from (7) that the current entering the cable depends only upon the *ratio* of S to R. Its propagation in the cable itself depends on their product.

§ **241.** Now let V_0 be such a function of the time as to be zero before and constant after $t=0$. What is C_0? To find it, we require to know the meaning of $p^{\frac{1}{2}}V_0$. Now the problem stated is a well-known one in Fourier's theory of heat conduction; and when by Fourier's methods we develop the solution we find that it is

$$C_0=\left(\frac{S}{R\pi t}\right)^{\frac{1}{2}}V_0. \tag{9}$$

Comparing with (7), we see that we require to have, on removal of unnecessary constants,

$$p^{\frac{1}{2}}1=(\pi t)^{-\frac{1}{2}}, \tag{A}$$

a fundamental formula. The 1 means that function of the time which is zero before and unity after $t=0$. We are only concerned with positive values of the time. This way of finding the meaning of a fractional differentiation of a given function is purely experimental. Any problem involving $p^{\frac{1}{2}}1$ in the operational form of solution will do for the determination of its value, by comparison with the solution by Fourier's method. On the other hand, the result is a simple fundamental one in fractional differentiation, and does not need Fourier. But the reader presumably cannot take in the idea of a fractional differentiation yet. So, for the present, let it be taken as a fact that the value of $p^{\frac{1}{2}}1$ *is* $(\pi t)^{-\frac{1}{2}}$. We can make use of this fact extensively in Fourier mathematics with much advantage, without necessarily going a step further in the direction of fractional differentiation.

By (9) we see that the current entering the line is infinite at the first moment (because of the absence of self induction), and then falls, according to the inverse square root of the time, to zero. At first, the slope of V in the line is infinite at its beginning, and so is C_0. But as the cable gets charged the slope gets smaller. Finally, the potential is V_0 everywhere and the current is zero. Or we may say that the final current is zero, because the resistance is infinite. There can only be current when the charge is increasing. It really never stops increasing, but the potential at the near end gets to be so nearly V_0, as to prevent the very distant parts of the cable receiving their charge except at an insensible rate. Mathematically speaking, we say that $V=V_0$ everywhere, when $t=\infty$.

The final states of V and C may also be seen from (4) and (5). Put $p=0$ in them and they reduce to $V=V_0$, and $C=0$. This process is general. Putting $p=0$ in an operator destroys time-variation, and gives the ultimate steady form, when there can be a steady state.

Another way of looking at the matter is to consider how we get the simply periodic solution out of an operational solution, when the impressed force is simply periodic. If the frequency is $n/2\pi$, we put $p=ni$ in the operator. Now $p=0$ is equivalent to $n=0$, or an infinitely prolonged period, which means a steady state.

In the present case, the simply periodic solution is, by (7),

$$C_0=\left(\frac{Sni}{R}\right)^{\frac{1}{2}}V_0=\left(\frac{Sn}{2R}\right)^{\frac{1}{2}}(1+i)V_0. \tag{10}$$

Here i means p/n; that is, differentiation with respect to nt; so (10) is complete when V_0 is given in amplitude and phase. Say it is $e\sin nt$, then

$$C_0=\left(\frac{Sn}{2R}\right)^{\frac{1}{2}}(\sin nt+\cos nt)e. \tag{11}$$

It should be understood, though, that time must be allowed to enable this state to be arrived at.

§ **242.** Still keeping to the beginning of the cable, let us examine the effect of a terminal arrangement. Let $V=ZC$ be its equation *per se*, so that Z is its resistance operator. Now, that of the cable is $(R/Sp)^{\frac{1}{2}}$, as before seen; so if Z is put between the cable and earth with the impressed voltage acting, we have

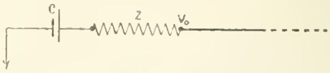
$$C_0=\frac{e}{Z+(R/Sp)^{\frac{1}{2}}} \tag{12}$$

to express the current through Z and entering the cable. This is because the operators are additive like resistances. Also, we have $V_0=(R/Sp)^{\frac{1}{2}}C_0$ as before; consequently by (12)

$$V_0=\frac{e}{1+Z\left(\frac{Sp}{R}\right)^{\frac{1}{2}}}. \tag{13}$$

This finds V_0, the potential at the beginning of the cable, in terms of e.

The operational solution (13) may be readily algebrized (or converted to algebraical form) in various cases of Z, practical and unpractical. One case will do to begin with to illustrate the conversion.



Let Z be the resistance operator of a coil, say

$$Z=r+lp, \tag{14}$$

where r is its resistance and l its inductance. Then

$$V_0=\frac{e}{1+(r+lp)\left(\frac{Sp}{R}\right)^{\frac{1}{2}}} \tag{15}$$

is the operational solution giving V_0 in terms of e.

This may be algebrized as follows. By division,

$$V=\left\{1-Z\left(\frac{Sp}{R}\right)^{\frac{1}{2}}+Z^2\frac{Sp}{R}-Z^3\left(\frac{Sp}{R}\right)^{\frac{3}{2}}+\ .\ .\ .\right\}e. \tag{16}$$

Here in Z we have only complete differentiations, therefore in union with the even powers of $(Sp/R)^{\frac{1}{2}}$ we still have complete differentiations. All these terms, therefore, may be ignored when e is, as we shall suppose, constant after $t=0$, having previously been zero. So (16) reduces to

$$V_0=\left\{1-Z\left(1+\frac{Z^2Sp}{R}+\frac{Z^4S^2p^2}{R^2}+\ldots\right)\left(\frac{Sp}{R}\right)^{\frac{1}{2}}\right\}e. \tag{17}$$

We know $p^{\frac{1}{2}}1$ already, so the solution is found by complete differentiations performed upon it. Thus,

$$V_0=e-e(r+lp)\left\{1+(r+lp)^2\frac{Sp}{R}+\ldots\right\}\left(\frac{S}{R\pi t}\right)^{\frac{1}{2}}. \tag{18}$$

This makes a series in descending powers of $t^{\frac{1}{2}}$. In the case of no self-induction, when it is a mere resistance that is concerned, (18) becomes

$$V_0=e-er\left(\frac{S}{R\pi t}\right)^{\frac{1}{2}}\left\{1-\frac{r^2S}{2Rt}+1.3\left(\frac{r^2S}{2Rt}\right)^2-\ldots\right\}. \tag{19}$$

When t is big enough, the only significant term is e, the final value. When t is smaller, the next becomes significant. When smaller still another term requires to be counted, and so on. But we must never pass beyond the smallest term in the series. As t decreases, the smallest term moves to the left. As it comes near the beginning of the series, the accuracy of calculation becomes somewhat impaired. When it reaches the first t term, so that the initial convergency has wholly disappeared, then we can only roughly guess the value of the series. So (19) is unsuitable when t is small enough to make the initial convergency be insufficient.

It is said that every bane has its antidote, and some amateur botanists have declared that the antidote is to be found near the bane. We have an example here. The antidote is got by algebrizing (15) in a different way. Keeping for the present to the simple case of a resistance only—$l=0$ in (15)—we may write

$$V_0=\frac{\left(\frac{R}{r^2Sp}\right)^{\frac{1}{2}}e}{1+\left(\frac{R}{r^2Sp}\right)^{\frac{1}{2}}}; \tag{20}$$

or, by division,

$$V_0=\left\{1-\left(\frac{R}{r^2Sp}\right)^{\frac{1}{2}}+\left(\frac{R}{r^2Sp}\right)-\left(\frac{R}{r^2Sp}\right)^{\frac{3}{2}}+\ldots\right\}\left(\frac{R}{r^2Sp}\right)^{\frac{1}{2}}e. \tag{21}$$

This we may split into two series, viz. :—

$$\begin{aligned}V_0=&\left\{\frac{R}{r^2Sp}+\left(\frac{R}{r^2Sp}\right)^2+\ldots\right\}\left(\frac{r^2Sp}{R}\right)^{\frac{1}{2}}e\\&-\left\{\frac{R}{r^2Sp}+\left(\frac{R}{r^2Sp}\right)^2+\ldots\right\}e.\end{aligned} \tag{22}$$

In the second line we have complete integrations to perform on e. This is done by

$$p^{-n}1=\frac{t^n}{\underline{n}}, \tag{B}$$

which is obvious enough, when, as at present, n is integral; viz., 1, 2, 3, &c. In the first line we have to make the same complete integrations upon the function $p^{\frac{1}{2}}1$. This is also done at sight by (B), when the matter of fractional differentiation is understood. But at present we can do without it, and integrate directly thus

$$p^{-1}t^{-\frac{1}{2}}=\frac{t^{\frac{1}{2}}}{\frac{1}{2}},$$

$$p^{-2}t^{-\frac{1}{2}}=\frac{t^{\frac{3}{2}}}{\frac{1}{2}\cdot\frac{3}{2}},$$

and so on, which is easy enough. So, by using (A) in the first line of (22) we obtain the complete solution in the form

$$V_0=2e\left(\frac{Rt}{r^2S\pi}\right)^{\frac{1}{2}}\left\{1+\frac{2Rt}{3r^2S}+\frac{1}{3.5}\left(\frac{2Rt}{r^2S}\right)^2+\ldots\right\}-e(\epsilon^{Rt/r^2S}-1). \tag{23}$$

We see now that we can calculate V_0 conveniently when t is small. But (23) is bad when t is big. Then we may consider (23) the bane, and (19) the antidote. They are complementary, though not mutually destructive.

(To be continued.)

IS THE MAGNETIC QUALITY OF IRON AFFECTED BY OFTEN REPEATED REVERSALS?

BY PROF. EWING, F.R.S.

This question is suggested by the observations of Mr. Partridge, published in *The Electrician* of December 7th. It appears that the dissipation of energy in the iron of a transformer is generally less when the transformer is new than after it has been working for some weeks. In the instances described by Mr. Partridge the loss increases by something like 30 or even 40 per cent. of its original amount.

It is matter of common knowledge that the first applications of reversed magnetising forces do affect the magnetic quality of soft iron, making its susceptibility diminish so that the range of induction due to reversal of a given force contracts during several repetitions of the reversal. In testing iron, especially in the region of moderate force used in transformers, it is necessary in general to reverse the force some dozens of times before a magnetising process becomes sufficiently cyclic to give a satisfactorily closed figure for the B – H curve.

In commenting on Mr. Partridge's Paper, at the editor's request, I said that it would be interesting to see whether any continued change occurred during millions of reversals, of a kind to account for the phenomenon he observed, and that direct evidence should be sought by testing the magnetic quality of a sample before, and again after subjecting it to very many reversals.

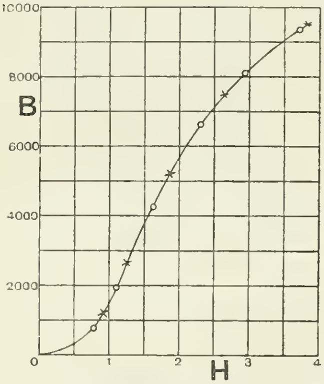


Fig. 1.—Tests for Permeability before and after exposing the iron to repeated reversals.
Before exposure to reversals, O. After exposure to reversals, X.

I at once set on foot an experiment with this intention, being then unaware that the matter was engaging the attention of Dr. Fleming, Mr. Mordey, Mr. Smith, and Mr. Bláthy, who have published observations upon it in *The Electrician* of December 14th and 21st. Mr. Bláthy makes the important remark that artificial heating of the transformer for several hours to a temperature of about 150°C., has a like influence in raising the iron loss by some 25 per cent., and Mr. Mordey's experiments show that a still more moderate amount of heating, if long continued, suffices to produce the effect. They have led him to a number of highly interesting conclusions, chief of which, for our present purpose, is that the baking which a transformer generally subjects itself to accounts for the deterioration of magnetic quality that gradually occurs after it is set to work.

In my experiment the iron was exposed to a long-continued series of reversals without having its temperature raised by more than a very trifling amount. Three small rings were taken, each built out of 20 annular discs of transformer plate 0·345 millimetres thick. The section of the iron in each ring was rather less than one square centimetre. Each ring was wound with a magnetising coil of 111 turns in a single layer. The magnetic quality was carefully examined, to begin with, by putting each ring separately through a graded series of cycles and determining the B – H curve for each cycle ballistically in the manner described in a Paper published in the *Philosophical Transactions* of the Royal Society, Vol. CLXXXIV., p. 985. Curves for these cycles having been drawn, the values of the hysteresis loss, or $\int H\,dI$, were determined by measuring the enclosed areas. On November 29th the rings were connected to the service wires of the Cambridge Electric Supply Company, the three rings being arranged in series, with a lamp to serve at once as resistance and indicator that the current was passing. The current was 0·50 virtual ampere, making the induction B reach values ranging from 9,000 to 11,000 in the three rings. The current alternated with a frequency of about 80 periods per second. The rings remained under this action continuously for eleven days, till December 10th, when they were removed and at once tested in the same way as before, cyclic curves of B and H being again drawn in order to measure the enclosed area for various values of the extreme magnetisation B.

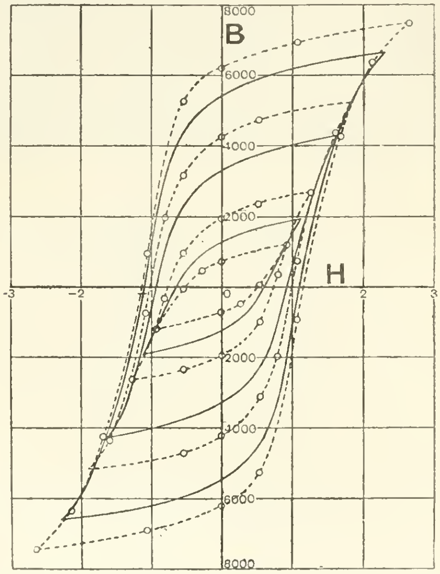


Fig. 2.—Cyclic Processes before and after exposing the iron to repeated reversals

Before exposure to reversals, ————. After exposure to reversals, - - - - - -.

The result may be stated in a word. There was not a trace of change in the magnetic quality of the iron. It will suffice to quote the figures obtained for one out of the three rings.

Observations of B *and* H *for determining the Permeability.*

Before exposure to reversals.		After exposure to reversals, Nov. 29—Dec. 10.	
H.	B.	H.	B.
0·79	780	0·93	1,200
1·11	1,930	1·27	2,630
1·62	4,270	1·87	5,200
2·30	6,610	2·65	7,480
2·91	8,100	3·81	9,540
3·72	9,360		

These are shown in Fig. 1, where the points marked with a circle are observations made before November 29th, while those marked with a cross were made on December 10th after the reversals. All the points lie remarkably well on a single curve.

Again, the cyclic curves of B and H determined before and after the process are shown in Fig. 2, the earlier ones being distinguished by full lines, and the later ones by broken lines. An inspection of this figure shows that no change has been brought about in the general character of the cyclic process. The characteristic form is wholly retained, and all the cycles drawn in the figure look as if they belonged to a single group of tests. The areas have been measured as follows:—

Hysteresis Losses before and after Exposure to Reversals.

Before.		After.	
B.	$\int H\,dI$.	B.	$\int H\,dI$.
780	67	1,200	140
1,930	290	2,630	510
4,270	1,060	5,200	1,470
6,610	2,130	7,480	2,590
8,100	2,920		

These are drawn in Fig. 3, where the circles refer to the earlier and the crosses to the later measurements. All lie on a single good curve.

The experiment has turned out less interesting than I hoped it would, for its results are absolutely negative. The period of exposure to reversals, though comparatively short, was at least long enough to show some change, if the effect described by Mr. Partridge had been due to molecular fatigue induced by reversals of magnetisation. The treatment while it lasted was severe, the limits of B (10,700 in this particular ring) being much higher than would be found in a transformer. It is at least something to know that this treatment is so entirely without effect on the quality of the iron as these experiments show it to be.

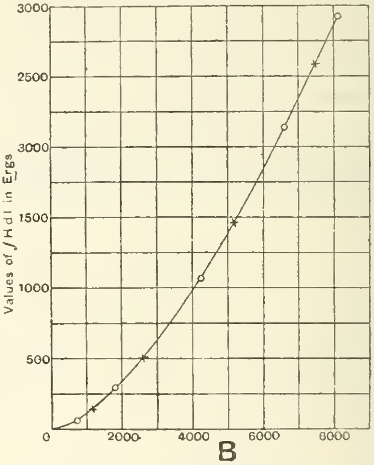


Fig. 3.—Hysteresis Losses before and after exposing the iron to repeated reversals.

Measurements before exposure to reversals, O. Measurements after exposure to reversals, X.

Here, as I have said, there was no baking of the sample. The small volume and relatively large surface prevented it from becoming more than just perceptibly warm. It would be interesting, in the light of Mr. Mordey's experiments, to make a further comparison of the cyclic B – H curves before and after prolonged baking, in order to see what is the character of the magnetic change which causes the hysteresis losses to become increased.

Electric Traction in New South Wales.—The experiments made by the New South Wales Railway Commissioners in running the tramcars by means of accumulators on the tram lines in Sydney are stated to have given fairly satisfactory results, but a further trial is to be made before the question of abandoning the use of steam motors is finally considered.

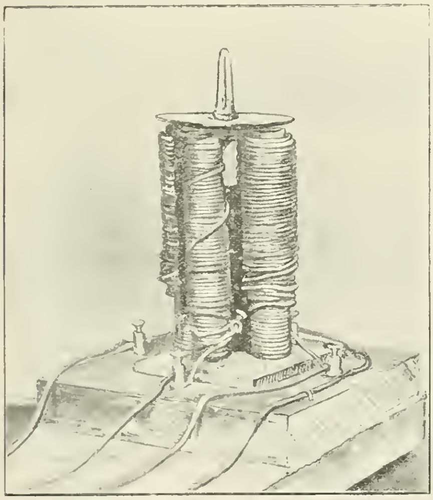
THE FIRST POLYPHASE MOTOR.

BY PROF. S. P. THOMPSON, D.SC., F.R.S.

Amidst the crowd of modern inventions little note has been taken of the modest beginnings of the polyphase motor, the birth of which dates from 1879. By the kindness of Mr. Walter Baily I am able to describe the elementary motor which he exhibited to the Physical Society of London, on June 28, 1879, on the occasion of his reading a Paper entitled "A Mode of Producing Arago's Rotations."

Down to that date the only mode of producing the Arago rotations of a copper disk had been by rotating beneath it a steel magnet. Baily, instead of rotating any material magnet fixed it; but caused its magnetism to shift progressively between four successive poles, thus producing in the copper disk pivotted above them eddy-currents, which by their reaction gave the disk a mechanical motion in the direction of the progression of the poles.

The disk in this primitive model is about 2⅝in. in diameter; the four magnet cores are about 4in. high, joined to a common yoke; and each is wound with about 150 turns of insulated copper wire 2·5mm. in diameter. The coils are connected two and two in series, like two independent horseshoe magnets set diagonally across one another. The two circuits are brought down separately to an ingenious revolving commutator built up of a simple arrangement of springs and contact strips mounted on a bit of wood, with a wire handle by which it is turned. On rotating it the currents from two batteries are caused to be reversed alternately in the two circuits, giving rise to the following successions of polarity in the four poles:—



Walter Baily's Polyphase Motor (1879).

N O   N N   O N   S N   S O

→   ↓   ↙   ←   ↖

O S   S S   S O   S N   O N

and so forth. Mr. Baily had very clear views as to how far this really represented a rotatory magnetic field. His own words are as follows:—

"The rotation of the disk is due to that of the magnetic field in which it is suspended, and we should expect that if a similar motion of the field could be produced by any other means the result would be a similar motion of the disk.

"Possibly the rotation of the magnet may be the only practicable way of producing a uniform rotation of the field; but it will be shown in this Paper that the disk can be made to rotate by an intermittent rotation of the field effected by means of electromagnets." The author then goes on to discuss the result of the increase in strength of a pole while a neighbouring pole of the same sign decreases in strength, and suggests that if a whole circle of poles were arranged under the disk, and successively excited in opposite pairs, the series of impulses all tend to make the disk move in one direction around the axis; adding: "In one extreme case, viz., when the number of electromagnets is infinite we have the case of a *uniform* rotation of the magnetic field, such as we obtain by rotating permanent magnets." He then returns to the case of his actual model with two pairs of poles $a\,a'$ and $b\,b'$, and points out that if the $b\,b'$ pair are arranged to be reversed *before* the $a\,a'$ pair, the rotation will be in one direction; whilst, if the $b\,b'$ pair are reversed *after* the $a\,a'$ pair the rotation will take place in the other direction. He goes on to show how the reversal of the direction of rotation may be effected either by reversing the action of the commutator, or by reversing the connections of one of the two batteries. The diagram accompying the original Paper suggests that the cores should be of laminated iron; but those of the actual model are solid. In a final paragraph the author remarks that the effect on the disk might be much increased by placing four other electromagnets above the disk, each opposite one of the lower magnets, and connected with it so as to present an opposing polarity.

The model runs exceedingly well when four dry cells are used to excite the electromagnets.

On the occasion, now 15 years ago, when the Paper was read, and the model shown, the late Prof. Guthrie asked jokingly how much power it was expected that the motor would give. To which Mr. Baily modestly replied that at present he could only regard it as a scientific toy.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, January 11th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. The following Papers will be read: (1) "The Ampthill Second Tunnel on the Midland Railway," by Edward E. Matheson; (2) "Tunnelling; with special reference to Ampthill and Elstree Second Tunnels on the Midland Railway," by the Hon. H. W. Holmes à Court.

MONDAY, January 14th.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

7 p.m. Council Meeting at the Palatine Hotel, Hunt's Bank, Manchester.

8 p.m. General Meeting. Presidential Address by Mr. Henry Edmunds.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture: "The Arc Light," by Prof. S. P. Thompson, F.R.S.

TUESDAY, January 15th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Discussion on the Papers read last week.

WEDNESDAY, January 16th.

ROYAL METEOROLOGICAL SOCIETY.

7:30 p.m. Ordinary Meeting at 25, Great George-street.

8:15 p.m. Annual General Meeting. Report of Council, Election of Officers and Council for 1895, and Presidential Address by Mr. R. Inwards.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read: "Commercial Synthesis of Illuminating Hydrocarbons," by Prof. Vivian B. Lewes.

THURSDAY, January 17th.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Annual Meeting. Presidential Address by Mr. A. D. Michael.

FRIDAY, January 18th.

INSTITUTION OF ELECTICAL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "Electrical Transmission of Power (with special reference to mining operations)," by H. T. Haws.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Phosphorescence and Photographic Action at the Temperature of Boiling Liquid Air," by Prof. Dewar, F.R.S.

⁂ Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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SPECIAL NOTICE.

With next week's number of "THE ELECTRICIAN" will be issued a COLOURED MAP, showing the Streets in the Metropolis in which Mains for Private Lighting are actually laid, up to January, 1895, together with the areas allotted to the different Supply Companies.

THE VETO OF LOCAL AUTHORITIES.

WE print to-day in another column a copy of a report by the Board of Trade explaining their reasons for dispensing with the consent of the Local Authority of Guildford to the Provisional Order granted in 1894 to the Holloway Electricity Supply Company (Limited) for lighting that town. The Electric Lighting Act, 1888, provides by section 1 that no Provisional Order shall be granted except with the consent of the Local Authority of the district, "unless the Board of Trade in any case in which the consent of such Local Authority is refused are of opinion that, having regard to all the circumstances of the case, such consent ought to be dispensed with, and in such case they shall make a special report, stating the grounds upon which they have dispensed with such consent." The present report is made in pursuance of this section, and although dated May 28, 1894, has only recently been printed, so that it has not previously been accessible to the public.

In 1889 many of the local authorities in London withheld their consents to the various applications for Provisional Orders, which were afterwards granted in that year. These, however, were the first transactions under the new Act, and the long inquiry held before Major MARINDIN dealt with such a multiplicity of matters, and resulted in so many compromises, that no precedent was clearly established as to the grounds on which the consents of local authorities would in future be dispensed with. The views of Major MARINDIN on the subject are, however, stated in the conclusions of his report on the inquiry as follows :—"It seems to me, that although the wishes and opinions of the local authorities in the areas proposed to be supplied should be consulted and deferred to as far as possible, the mere objection by a local authority to the introduction of a company proposing to supply electric light upon general grounds should not be considered sufficient to exclude such company, unless the Local Authority should express its intention to undertake the supply and give evidence that it proposes to apply for permission to do so."

Since 1889 there have only been three instances in which the Board of Trade have dispensed with the consent of the Local Authority to a Provisional Order, none of which forms a precedent of much importance. In the case of the Moss Side and Stretford Electric Lighting Order, 1890, two different Local Authorities had given consents for their respective districts; but one afterwards sought to limit its consent to an Order dealing with its own district only. The New Cadogan and Belgrave Order, 1891, merely raised a minor question as betweeen the Chelsea Vestry and the London County Council, which Parliament ultimately decided in favour of the Vestry, who were the Local Authority, overruling the decision of the Board of Trade. In the third case, which was the Newmarket Order of 1893, the Local Authority did not contest the undertakers' request to the Board of Trade that their consent should be dispensed with, provided the undertakers were prohibited from opening the streets during race weeks, which restriction the Board imposed.

On the other hand, the annual returns of the Board of Trade on electric lighting applications over and over again record the fate of embryo undertakings under this monotonous epitaph :—"The promoters failed to produce the consent of the Local Authority or to satisfy the Board of Trade that it should be dispensed with, and the Board refused to grant the Order." Whether or not the Board of Trade have always been ready to act up to the policy advocated by Major Marindin in 1889, or whether promoters have not taken the right ground when seeking for the dispensing power of the Board, it is the fact that until the decision in the Guildford case there has been no clear enunciation of the policy which is indicated by that decision. The consequence has been that the veto of the Local Authority has hitherto been regarded for all practical purposes as an almost absolute one, and promoters have made haste to purchase the required consent by concessions of a more or less onerous nature, involving in some cases a serious curtailment of the period of 42 years which the Act of 1888 provided should elapse, before giving compulsory power of purchase to the Local Authority. Concessions of this kind wrung from the weakness of too eager promoters have gone far to stultify this cardinal provision of that Act. The legislation of 1888 was based upon the experience derived under the Act of 1882, that the 21 years' period laid down by the first Act was too short, and it was then conceded that nothing less than 42 years was a reasonable time to enable investors to obtain a fair return for their money, and thus attract the capital which had previously held aloof from the new industry. It is much to be regretted that the firm attitude taken up by the promoters of the Guildford Order has not been evident upon an earlier occasion. They appear to have been, if not the first to stand firmly upon the principle which is the basis of the Act of 1888, at all events the first to successfully argue before the Board of Trade that this principle is not to be frittered away by Local Authorities, who have no reason to allege against the grant of an Electric Lighting Order, except that they are in a position to squeeze the promoters into making a bargain, from which an Act of Parliament was passed expressly to protect them.

It is no doubt the fact that Parliament intended to grant, and has, in fact, granted to local authorities very important privileges, which might, if they had pleased to make use of them, have amounted to a monopoly of public electric lighting throughout the country. We believe, however, that the exact scope of these privileges has been to some extent misunderstood. There were good grounds for providing that any interference with streets by electrical works of an experimental character should be wholly dependent on the goodwill of the Local Authorities. Accordingly, Parliament gave the latter an absolute veto on all applications for licenses, which, being limited to periods of seven years, might not be regarded as serious undertakings. With regard to Provisional Orders, it has always been different. The Act of 1882 only required notice of the application to be given to the Local Authority, who could oppose the grant before the Board of Trade. One of the rules issued by the Board of Trade under that Act laid down, that in case of competing applications for the same district, the Board would always prefer that of the Local Authority. This rule throws some light on the subsequent legislation by the section of the Act of 1888 referred to above. That section adopted the policy laid down by the Board of Trade in the rule; and, although the terms are somewhat different, we conceive the intention of the section to be simply this: that whenever the Local Authority *bonâ fide* intends to undertake the task of lighting their own district, no one shall stand in their way, and the Board of Trade is to be the arbiter as to the *bona fides* of such intention. Had the Legislature intended to go beyond this, and to give a veto to be used, whether for mere obstruction or as a lever to obtain public improvements at a ruinous cost to private investors, this could have been easily done, simply by making Provisional Orders subject to the clause in the Act of 1882 relating to licences, for which the consent of the Local Authority is a condition precedent in all cases. The decision of the Board of Trade in the Guildford case has done much to elucidate what we conceive to be the true intention of the Act, and to define how far a Local Authority may go in the exercise of their privileges granted by the Electric Lighting Acts. We only regret that the decision has not come earlier in the day, in time to prevent some improvident bargains being made.

THE FAURE PASTED PLATE PATENT.

From to-day the English electrical world is free to use the invention of M. Camille Faure "of Paris in the Republic of France," disclosed in his Patent No. 129 of 1881.

The Provisional Specification was filed on January 11th, and the final on July 7th, an important disclaimer being put in on January 10, 1882. The full title of the original patent was "Improvements in Galvanic Polarisation Batteries, or Magazines of Electricity, and the Application of the same, and in Apparatus connected therewith."

The invention, it is stated, "relates to what are known as galvanic polarisation batteries, which are incapable of themselves of producing electricity; but which, when charged from any source of electricity (such, for example, as a battery or machine), become magazines of electricity, and are then capable of furnishing electric power in proportion to the electric energy which has been transmitted to them, which they have stored up. The invention has reference also to *an economical and expeditious preparation of the elements of these batteries by covering them by mechanically coating, electro plating or chemical precipitation or deposit with a layer of spongy or porous lead of suitable thickness*, whereby it is rendered possible to impart to such batteries a considerable power of absorbing and storing up electrical energy. . ." Further on it is pointed out that these "piles" may be employed "as powerful regulators of electricity," and their application to vehicular propulsion is foreshadowed.

In carrying out the invention it is stated that "leaden plates or blades are *principally* employed as a support for the porous or spongy materials with which they are covered. . . . . In order to render these supporting plates capable of storing up a sufficient quantity of electricity, the plate or pair of plates or elements are prepared by covering them with a coating composed of metallic salts or oxides, intimately mixed with inert substances, for example, by employing a coating of sulphate of lead mixed with pulverised coke, which mixture may be moistened with a small quantity of gelatine." It is then pointed out that if such plates be immersed in a suitable liquid, such as dilute sulphuric acid, and be placed in electrical communication with a source of electricity, and the current reversed at suitable intervals, two sets of electrodes are ultimately obtained, one of which is covered with peroxide of lead and the other with reduced porous lead. The much-desired deposit of porous lead may also be obtained, it is pointed out, by "depositing the lead from a soluble salt of lead by means of galvanism and in a pulverulent condition, by employing a powerful current of electricity." Copper "elements" and coke or carbon "elements," surrounded with oxides or salts of lead, are also suggested.

The text of the patent is elucidated by five drawings. Fig. 1 is a vertical section of a battery with flat plates. Fig. 2 (reproduced) is a vertical section of a battery with circular plates. Fig. 3 gives a vertical section, and Fig. 3A a side elevation of a flat-plate battery, the plates being positive on one side and negative on the other, and intended for high-tension purposes. Fig. 4 is a diagram illustrating the application of the Faure battery to electric traction; belt gearing, and coupled-wheels being indicated. Fig. 5 is a diagram of a switch for varying the number of cells in circuit.

In the arrangement illustrated in Fig. 2, A is a lead cylinder coated internally with a porous mixture, B is a rod of lead or carbon, C is a porous pot, the electrolyte being H_2SO4 contained in the vessel D. The annular space between the porous pot C and the central rod is filled in the first instance with sulphate of lead and coke intimately mixed, a certain quantity of coke in a granular condition being also introduced into the mixture with saw-dust or such substance. The space between porous pot and external electrode may, it is stated, also be filled up in a similar manner, or a second porous pot, arranged externally and concentrically with the first, and leaving a clear annular space for the liquid, may be used.

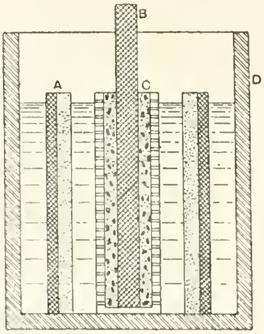


Fig. 2.

The original claims were four in number.

First: The improved secondary batteries enabling a large quantity of electro-chemical force or energy to be stored up in a small space and small weight substantially as hereinbefore described.

Second: The process of obtaining plates or supports capable of retaining and preserving electro-chemical force or energy by covering them with a layer of porous or spongy metallic *matter* deposited to any desired thickness by galvanising, chemically precipitating, or mechanical adhesion substantially as hereinbefore described.

Third: The employment of linings of india-rubber, felt, and other suitable materials for maintaining and holding up to or against the supporting plates the coating or layer of metallic substance mixed or not with inert matter.

Fourth: The combination with a wheeled carriage or other vehicle, or boat or barge, of an electro-dynamic machine, carried on the said carriage or vehicle and a secondary or polarisation battery capable of being recharged at the end of a journey.

By the disclaimer filed on January 10, 1882, claims 3 and 4 were abandoned, the last eleven words of the title were deleted, and the body of the text altered to suit.

It will be observed that the terms "force," "power," "energy," and "work" are all apparently interchangeable. The italics throughout are our own.

NALDER'S PERMANENT MAGNET VOLTMETER.

An instrument combining the advantages of a d'Arsonval suspended coil, with iron core, and a permanent magnetic field, as in the Weston instruments, has been recently brought out by Messrs. Nalder Bros. The working part of this instrument is shown, full size, in Fig. 1 in perspective and in Fig. 3 in section. The moving coil A surrounds two iron cores, C C. The coil works on jewelled bearings, B B, screwed into the brass frame. The interesting feature of this instrument is the method by which the current is led into and out of the coil. Two very light springs, S S, shown on an enlarged scale in Fig. 2, are carried on ebonite strips fixed to the coil, and press very lightly against fixed points exactly in the axis of rotation, with the minimum possible friction. The points are made of platinum-iridium, and the springs are tipped with the same alloy. This ingenious method of bringing the current to the coil obviates the use of spring or flexible connections, which may exert a controlling force. The control is effected by the small magnet M attached to the coil, and working in the space between the cores. The control thus varies with any change that may take place in the permanent magnet (not shown), and the deflection of the coil is thus unaffected by any change in the permanent magnet. The instrument is very dead beat, and only takes about $\frac{1}{30}$ ampere, or 2 watts for 100 volts. The coil is balanced, so that the instrument can be read in any position, and is not affected by neighbouring conductors or magnets.

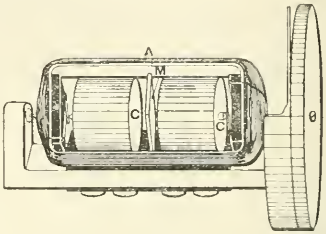
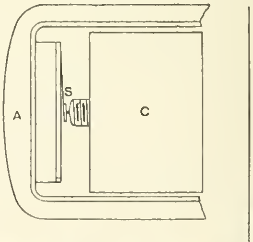


Fig. 1.

Fig. 3.



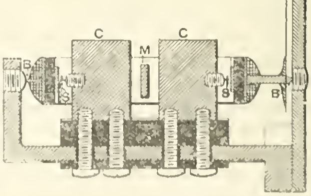


Fig. 2.

PARKER'S CONTINUOUS-CURRENT DYNAMO.

After his long experience in the business of dynamo building, Mr. Thomas Parker has now an opportunity of starting afresh, and the type of dynamo which he has chosen is naturally of considerable interest.

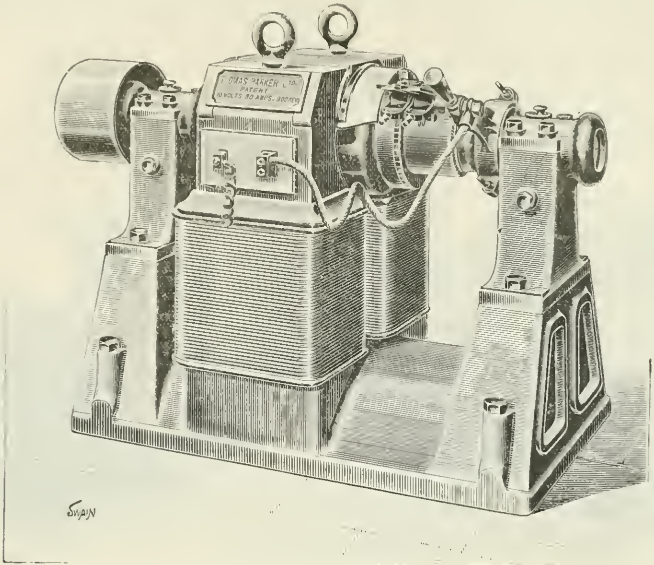


FIG. 1.—Parker's Continuous-Current Dynamo.

One of the special features of this machine is the cutting through of the pole-pieces, and hinging these so that they can be turned back to allow of examination or taking out of armature by a direct vertical lift, and without unsetting the bearings. The hinge is placed at the angle of the pole-piece, so that when turned back half-way, the magnet ferrule can be lifted off (after the armature has been removed) without uncoupling the hinged piece. This arrangement allows of machines being fixed in confined spaces, which would not be suitable with the ordinary type of machine, where armature has to be threaded "into" or "out of" the magnets. There is also considerably less risk of damage in withdrawing or replacing the armature. There is an oil well in the pedestal underneath the bottom of the bearing (the bottom bearing being continuous), a ring runs in this well and over the top of the shaft, giving continuous lubrication. Where machines are coupled

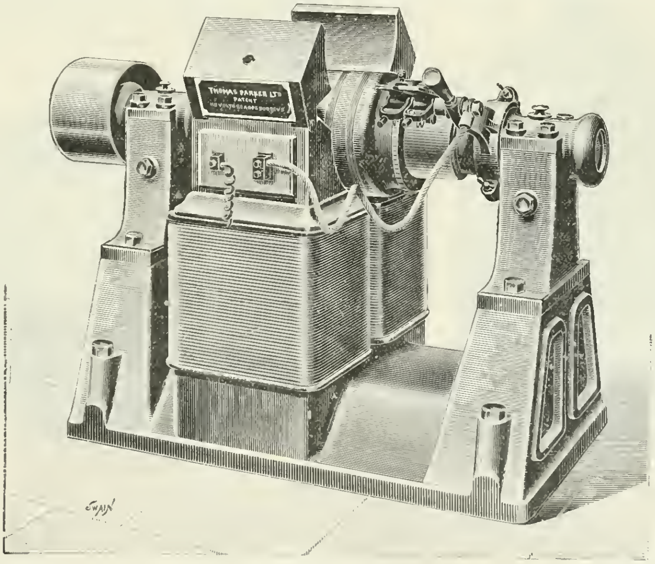


FIG. 2.—Parker's Continuous Current Dynamo, showing Polepieces Hinged Open to Allow the Armature to be Removed.

direct to high-speed engines, the armatures are at the bottom, the pole-pieces in this case also being cut through, so that the upper portion of the magnets can be lifted away and the armature then lifted out. With these new arrangements the putting in or taking out of an armature is much more simple, and occupies far less time than is required by the old method. All armatures will be coil wound, under the Eickemeyer patents.

SMALL MOTORS AND DYNAMOS.

There seems to be a considerable demand in this, as well as in other countries, for electric motors, which, while yet not toys or models, are designed for small amounts of power, or for speed rather than for work. There is also some demand for correspondingly small dynamos. It often looks as though the makers of this class of apparatus regarded the questions of efficiency and good workmanship as being quite irrelevant, as though the loss of power in such a tiny affair was too trifling to be noticed, however large it might be as a percentage. It is satisfactory, however, to find that the leading firms of manufacturers recognise that whether a machine is large or small it can only run satisfactorily if it is well designed and built to have a reasonably high efficiency of working. Among these firms we may mention the Crypto Works Company (Limited), who are manufacturing a variety of small dynamos and motors, some of which we illustrate this week.

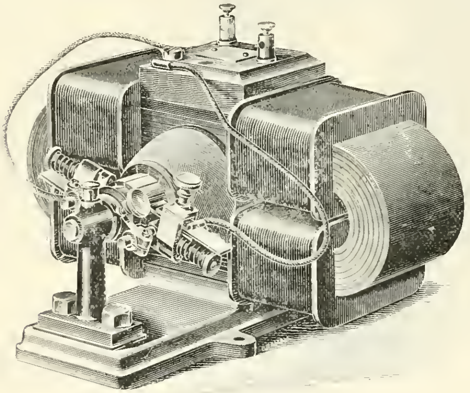


Fig. 1.

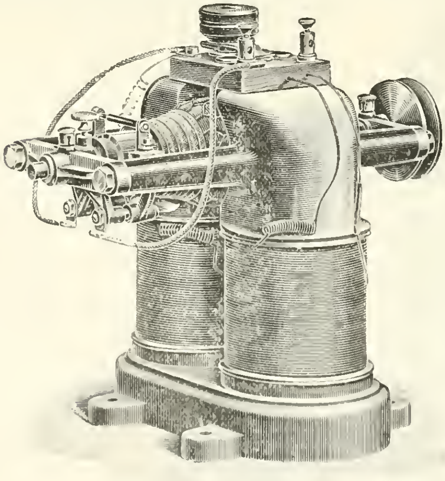


Fig. 2.

In point of careful design and finished workmanship the motor shown in Fig. 1 struck us as being the most worthy of notice among the stock we have examined. The choice of materials and the design of the details, have been as carefully carried out as is usual in the case of large motors intended for heavy work, with the result that a machine having a very high power per unit of weight has been produced. The field magnets are laminated, and so constructed that there is no air gap or contact resistance, except, of course, at the polar surfaces. The carcase may be wound for either continuous or alternating current; and, although we have not yet had an opportunity of verifying the statement, we are informed that it runs very cool on an alternate-current circuit. The smallest size, which stands about 6½in. high, develops about ¼ H.P. and runs at 2,500 revolutions per minute; the largest size develops 10 H.P. This motor has recently been used direct-coupled to a barnacle scraper for cleaning ships' bottoms. Where lightness and high efficiency are of less importance than primary cost, the type of motor shown in Fig. 2 is recommended. This motor has solid cast-iron field magnets, but is wound in the same manner as the former machine. It is found suitable for running fans and ventilators, or, arranged with a pulley, for any kind of light work.

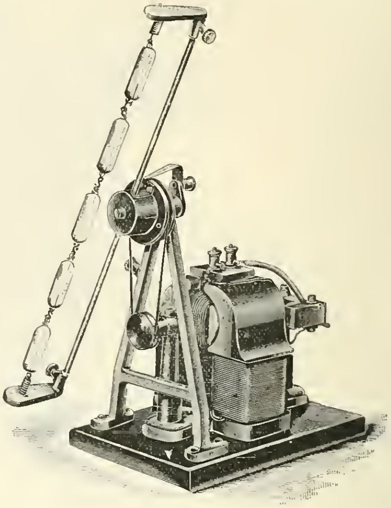


Fig. 3.

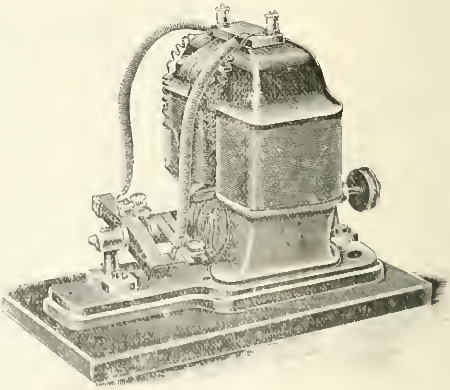


Fig. 4.

An interesting little motor is shown in Fig. 3, and is intended for forming an attractive advertisement in shop windows. The motor is coupled in series with a set of straight-filament glow lamps in variously-coloured bulbs; and the whole is so designed that it will be brilliantly lit and set in rapid revolution when connected to the ordinary lighting circuit, either continuous or alternating.

A handy little dynamo, capable of developing up to 60 watts, is shown in Fig. 4. It is shunt wound, and has a well laminated shuttle armature, and is provided with a rocking brush gear. At a speed of 3,000 revolutions per minute this dynamo develops 10 volts, and is capable of giving a current of six amperes. It should prove useful to students and for lecture table and laboratory experiments.

[We should point out that the business of the Crypto Works Company, Limited, in motors and dynamos is exclusively wholesale and for the trade.]

THE BRITISH SCHOOL OF ELECTRICIANS.*

When reading Continental technical journals again and again one finds references to the British school of electricians, and to the views of the British school on magnetism and kindred matters, as though these views constituted a distinct order of ideas. Such is indeed the case.

The fact is, that with Faraday there came in into the twin sciences of electricity and magnetism a wholly new way of looking at, thinking about, and expressing the phenomena already discovered; and with the adoption of these new methods of thought and language there has come an astonishingly abundant discovery of other facts. The industrial outburst of electrical and magnetic inventions, in telegraphy, in telephony, in the dynamo, the electric light, and the electric motor, is the outward counterpart of a great scientific development which received its main impulse from the work of Faraday, his own discoveries, and the new ideas which he instilled into the followers who trod in his steps.

Newton, in his immortal "Principia," had shown that the planetary motions could be deduced mathematically and mechanically from a single fundamental principle, the law of gravitation. Behind this law lies the assumptions that bodies can act on one another at a distance, and that the forces which result are forces which act in straight lines. Thus the force between the sun and the earth, tending ever to draw them together, is an action that takes place across a distance of 90 million miles, and is always in the direct line joining the two. So perfect was the Newtonian theory that none dreamed of questioning its assumptions. Cavendish, working on the Newtonian ideas, weighed the mass of the earth against that of a great sphere of lead by comparing together the attractions exercised by each on a smaller leaden ball. The comparison was effected by the aid of John Michell's torsion balance. Thenceforth the law of inverse squares, as embodying the principle of action at a distance, dominated all natural philosophy. To doubt it were worse than the most pestilent heresy. So for the next fifty years attempt after attempt was made to reduce into similar mathematical consistency the erractic forces of attraction and repulsion manifested by magnets on one another and on pieces of iron, and the equally erratic forces manifested by electric charges. Eventually, at the hands of Coulomb, using a delicate torsion balance akin to that employed by Cavendish, there was triumphantly deduced an approximate law of inverse squares both for magnetism and for electricity. Coulomb's law is in the mouth of every schoolboy, regardless of the fact that not a single magnet or electrified sphere obeys any such simple rule. It was the triumph of the mathematician over the experimenter. Coulomb had succeeded in eliminating from his laboratory all the cases likely to arise in practice, and had, with infinite pains, selected the only cases in which such a law is even approximately obeyed. But upon these, his results, Laplace and Poisson then reared a splendid superstructure of physico-mathematical theories, which speedily became classical, and dominated the science. To doubt the adequacy of the theory of electricity, or the theory of magnetism as so constructed and elaborated, became a worse heresy than to doubt the theory of gravitation. And so, in the year of grace 1894, we may still read in French treatises such deliverances as the following:

"Depuis que Poisson en 1811 créa la théorie des phénomènes électriques, les travaux des savants se sont succédé sans relâche et forment l'un des plus vastes ensembles scientifiques."

It is, however, no exaggeration to say that the work of Poisson has, on the contrary, contributed nothing to the splendid development of electrical science during the past half-century; nay, has, perhaps, tended to retard it. The ideas that are to-day triumphant are not those of Poisson, they are those of Faraday; and the great advances, both in knowledge and in practical applications, have originated with the followers of Faraday, not with those of Poisson.

What Faraday, with little mathematical training beyond the simple rule-of-three, accomplished some 60 years ago, he achieved by quite other means. Living amongst his apparatus, experimenting for himself with a simplicity and candour of mind rare indeed, even amongst scientific men—equalled in this, perhaps, only by Darwin in our own day—Faraday gained an insight into facts that had escaped the wise and prudent mathematicians. Letting his thoughts play freely around the phenomena with which he was incessantly occupied, he saw with fresh eyes that which they had missed. First, he was confronted with the actual fact that in the vast majority of cases under his hand the forces did not act in straight lines. Next, he had to recognise the very perplexing circumstances that in the action of a magnet pole upon a wire carrying a current the force does not act in the line joining the two, and is not either an attraction or a repulsion, but is exerted at right angles to that line. Thirdly, the amount of the force depends on the nature of the surrounding medium. Without consciously reckoning out these weighty considerations, or weaving them into any connected theory, he instinctively grew into his own new way of regarding the subject. He frankly abandoned the fundamental assumption of action at a distance and substituted in its place the fundamental conception of action in a medium. In 1821 he wrote to De la Rive: "I find all the usual attractions and repulsions of the magnetic needle by the conjunctive wire are deceptions, the motions being not attractions or repulsions, nor the result of any attractive or repulsive forces, but the result of a force in the wire, which, instead of bringing the pole of the needle nearer to or further from the wire, endeavours to make it move round it in a never-ending circle and motion whilst the battery remains in action." He had not yet arrived at abandoning action at a distance, but the germ was working in his mind. In 1831, immediately after his great discovery of the induction of electric currents by magnets—the basis of all the modern dynamos—he wrote to his friend Phillips that he had discovered a condition of matter (in the presence of moving magnets) in an "electrotonic" state. In 1833 comes this entry in his note-book: "Doubt attraction by poles altogether." By November, 1837, he was ready to lay down the definite counter-proposition that "electrical action at a distance never occurred except through the influence of the intervening matter"; and, after proving that different media—such as air, turpentine, sperm-oil, sulphur, and the like—possessed specific inductive properties, he established the further proof that this inductive influence takes place along curved lines. The curved patterns assumed by iron filings in the neighbourhood of a magnet had for years possessed a sort of fascination for him. They had been known to Gilbert, to Musschenbroek, and to Walker; but Faraday first brought out their significance as indicating an action going on, invisibly otherwise, but always going on, in the surrounding medium. He conceived these magnetic lines as mapping out in a definite physical way the properties of the medium, as constituting closed circuits through the magnets with which they were associated. He showed that all the apparent attractions and repulsions were explicable if to the magnetic lines of force were attributed the physical properties of a longitudinal tension or tendency to shorten, and a lateral pressure or tendency to move apart. He introduced the conception of "cutting" these invisible lines as the fundamental operation of moving the conducting wire in the neighbourhood of the magnet in the magneto-electric generation of currents. No little misunderstanding seems to have followed from this novel mode of treating electric and magnetic problems. Tyndall, who followed the Continental mode of thought, combated Faraday's modes of expression. On the problems of diamagnetism he differed from his master, and became mixed up in a hopeless tangle on the alleged diamagnetic polarity. Lord Kelvin seems to have been the first to understand that Faraday's conceptions were not irreconcilable with mathematical precision. Already in 1842 he had begun to translate into symbolic language some of Faraday's notions on magnetism. But it was reserved to the lamented Clerk-Maxwell to formulate in mathematical shape the great revolution of ideas. Maxwell, indeed, knowing that there was supposed to be a difference between Faraday's methods and those of the mathematicians, deliberately abstained from studying the existing mathematical treatises on electricity, with their old traditions about forces acting at a distance, until, "as a first step to right thinking," he had mastered Faraday's experimental work. To Faraday himself he wrote in 1857: "As far as I know, you are the first person in whom the idea of bodies acting at a distance by throwing the surrounding medium into a state of constraint has arisen as a principle to be actually believed in. You seem to see the lines of force curving round obstacles and driving plump at conductors, and swerving towards certain directions in crystals, and carrying with them the same amount of attractive power, spread wider or denser as the lines widen or contract." Of Maxwell's all too short life 15 years were spent in casting into appropriate mathematical mould, and in elaborating and developing, the Faradaic conceptions. And therein came his exceeding great reward. Faraday had in the same year written to Maxwell concerning "the time required for the assumption of the electrotonic state round a wire carrying a current," and had surmised that the time "must probably be short as the time of light"; adding, "the greatness of the result, if affirmative, makes me not despair." Twelve years before, with infinite pains he had shown that magnetism exercises a definite rotatory effect on the waves of light. And in 1846 he had written to Phillips a marvellous speculation entitled "Thoughts on Ray Vibrations," which Maxwell, in 1864, described as setting forth substantially the same electromagnetic theory of light which he had then himself begun to develop. Maxwell, in fact, found himself impelled to the same conclusions as Faraday—namely, that the same medium which conveyed the waves of light, the ether, was concerned in the propagation of all magnetic and electric actions; nay more, that light itself consists simply of electric waves, and that the velocity of light is simply the velocity of propagation of electric ripples. With this far-reaching theory Maxwell's name will be imperishably associated. For ten years, however, Maxwell's voice was as of one crying in a wilderness. Even after the appearance in 1873 of his epoch-making treatise, his writings were often pronounced unreadable, save by the few younger men, Chrystal, Rowland, Rayleigh, Lodge, Heaviside, Hopkinson, J. J. Thomson, Fitzgerald, and Poynting, who have since done so much to extend and promulgate the modern views. Abroad, Faraday was still regarded as vague and illogical in his methods. His researches had never been translated. Not until after Maxwell's treatise had been current for ten years was it translated into German. Then followed, just three years ago, a German translation of Faraday's volumes of 1855! Neither Faraday nor Maxwell has yet found a French translator. Slowly but surely, however, the leaven worked. Though neither Kelvin nor Helmholtz, the giants of mathematical physics, was prepared to accept Maxwell's electromagnetic theory of light, both had long adopted Faraday's fundamental ideas—the rest was bound to follow sooner or later. Joule's work on magnetism in 1843, followed a generation later by the researches of Hopkinson and of Ewing, strengthened the modern views. The growth of ideas about magnetic circuits had brought the treatment of that subject out of the hopelessly academic state in which the ideas of Coulomb and Poisson, with their hypothetical distributions of imponderable magnetic fluids, had left it. French electricians might protest as hard as they pleased against such bizarre notions as magnetic lines of force; but when they were brought face to face with the practical necessity of calculating the elements of construction of dynamo machines, the men who still dwelt under the shadow of the great mathematicians were helpless beside the followers of Faraday and of Joule.

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* From the *Saturday Review*, January 5th.

The year 1881 marked an epoch, not only by reason of the adoption by the International Electrical Congress at Paris of the British Association's system of electrical units, but equally in that it witnessed Helmholtz's noble eulogy of Faraday's methods and ideas. Maxwell's work, too, was spreading in Germany, and the younger German thinkers fell with avidity into the ways of the British school. And if 1881 marked an epoch, so also did the year 1888, when Lord Kelvin at last gave up his spring-shell molecules and other attempts to construct an optico-elastic theory of electricity, and accepted the electromagnetic theory of light; and when also Hertz, the rare spirit all too early snatched away, crowned Maxwell's theory by experimental demonstrations of the most convincing kind. He showed, in fact, how to track electric waves, from their source at one oscillating spark to their subsidence in a second spark at some distant point; and, in so tracking them, proved them to possess all the optical properties hitherto known to be characteristic of light waves.

We now know that two similar magnet poles do *not* repel one another; they are thrust apart by the stresses in the intervening medium. We know that two opposite electric charges do not attract one another—they are urged together by forces external to both. We know that the magnetism of a magnet does not reside upon its poles, as though they had been painted over with imaginary magnetic fluids. We know that the impulse that sends a message across the Atlantic is not propagated, as our forefathers in telegraphy supposed, along the copper wire of the cable, but is really conveyed by the surrounding so-called non-conducting medium. More than all, we have learned that the science of optics does not stand apart: it is only one small domain in the modern realm of electricity.

These things are but a part of the scientific heritage won for mankind by the British school of electricity.

Arc Lighting at Munich.—The Town Council of Munich have voted the sum of £100,000 for the extension of the street electric lighting, and have entrusted the work to the Elektricitäts-Actiengesellschaft vormals Schüekert and Co. The present plant comprises 210 ten-ampere and 66 five-ampere lamps; 456 ten-ampere lamps and 48 lamps of five amperes are to be added. The additional power required, about 400 H.P., will be taken from the Isar. The total of about 800 arc lamps will probably form the most complete case of street electric lighting in Europe.

SPECIAL REPORT OF THE BOARD OF TRADE UNDER SECTION 1 OF THE ELECTRIC LIGHTING ACT, 1888.

The Holloway Electricity Supply Company (Limited) applied for a Provisional Order in respect of the Borough of Guildford. The Corporation, who are the Local Authority under the Electric Lighting Acts, consented to the application, on condition that the Order should contain a provision authorising them to purchase the undertaking within six months from the expiration of ten years from the grant of the Order, or within six months from the expiration of any subsequent period of five years on the terms specified in Section 2 of the Electric Lighting Act, 1888.

The Order, when deposited, did not contain a provision to this effect, and the Corporation objected to it, and stated that they were considering whether they should not adopt measures for supplying electrical energy themselves. The promoters contended that the conditions asked for by the Corporation were unreasonable, and would prevent them from raising the necessary capital for the undertaking, and asked the Board of Trade to dispense with any further consent of the Corporation, and to grant the Order in the usual form, or with such modifications of the statutory conditions of purchase as the promoters could agree to.

Before deciding whether the application should be proceeded with the Board of Trade invited the representatives of the Corporation and the promoters to attend at this office to discuss the matter. A meeting was held on March 31st, at which the Mayor of Guildford and the town clerk, who attended on behalf of the Corporation, stated that the Corporation desired to retain in their own hands the right to supply electrical energy to the town, but that they had several public works on hand, and were not prepared to apply for a Provisional Order at present, or to place any limit on the time within which they would apply. They stated that the Corporation would, however, consent to the grant of the Order on the conditions originally agreed to by them. The representatives of the Corporation were informed that, as the Corporation were not prepared to give any undertaking as to the period within which they would apply for an Order, the Board of Trade would not be justified in refusing to proceed with the promoters' application. The Board were unable, however, to impose on the promoters the condition as to purchase asked for by the Corporation, which appeared to them to be an unreasonable modification of the terms established by Parliament, but they intimated their readiness to consider any further proposals the Corporation might submit.

Subsequently the Corporation suggested that the period at which the option of purchase on the terms of Section 2 of the Electric Lighting Act, 1888, should arise should not exceed 30 years. The promoters were unable to accept this proposal, and urged that a reduction of the statutory term was not reasonable without some corresponding concession on the part of the purchasing authority. On the suggestion of the Board of Trade, however, they agreed to accept a provision that the period of 42 years fixed by the Electric Lighting Act, 1888, should be reduced to 35 years, and the Board of Trade decided to grant the Order on these terms. This decision was communicated to the Corporation, with an intimation that the Board of Trade would be glad to hear that they were prepared to give their consent. The Corporation, however, replied that they were not prepared to consent to the grant of the Order in the form proposed.

FRANCIS J. S. HORWOOD,
Assistant Secretary.

Board of Trade, May 28, 1894.

THE USE OF ELECTRIC LIGHT ON BOARD VESSELS.

The following alterations and amendments have been made by the General Committee of *Lloyd's Register of British and Foreign Shipping* in the regulations referring to the use of electric light on board vessels. These rules are intended to take the place of all previous rules issued by *Lloyd's Register*:—

Leads or Circuits.—The sectional area of the copper wires in the cables should be at least in the proportion of one square inch per 1,000 amperes carried. No single wire of greater size than 14 or of less than 18 standard wire gauge should be used. For portable leads cables composed of stranded wires should be used having sufficient conductivity and flexibility for the purposes intended. The copper used in all wires or cables should have a conductivity of at least 98 per cent. that of pure copper. The insulation resistance of all wires, including portable leads, should be not less than 600 megohms per statute mile, after 24 hours' immersion in sea water. The insulating material used must not appreciably soften if subjected to a temperature of 180 F. If india-rubber insulation is used, the wires should be first covered with a layer of pure rubber, then with a separator, then with a layer of vulcanising india-rubber, and then with a layer of india-rubber coated tape. The whole should then be vulcanised together. The cable should afterwards be satisfactorily protected, preferably with a braided covering of water-proof fibre. Wires which are insulated with any other material than india-rubber should fulfil the same conditions as to insulation resistance, and should be of equal durability with those above specified.

Joints.—Joints in branches, or of branches with leads of small circuits, must be made in properly constructed water-tight junction boxes, or should have the copper wires thoroughly soldered and the insulation carefully carried out, all the joints being made watertight. Joints in flow and return wires should not be made opposite one another. All joints should be in accessible positions, none being made in bunkers, cargo spaces, or spaces which may at any time be used for carrying cargo, stores, or baggage. For soldering wires, resin only should be used as a flux. Where practicable, the leads should be placed where they can always be accessible; if they are laid in wood battens the covers should be screwed on, not nailed, and care should be taken that the casings are so arranged that water will not lodge in them. Cables which are properly covered with protective metal sheathing, or which are protected by galvanised wire armouring, may be unencased. They should, however, be secured by screwed clips, not by staples. All sharp bends in cables should be avoided.

All cables which are liable to be exposed to the weather or moisture should be lead covered, or be otherwise specially protected. Where great heat is experienced no wood casing should be used; but the cables should be protected by iron casings, or if they are not exposed to mechanical injury they may be armoured with galvanised wire and fastened to decks or bulkheads with clips spaced not more than 12in. apart. If cables are led through cargo spaces, coal bunkers, or spaces which may at any time be used for carrying cargo, stores, or baggage, or which are not at all times accessible, they should be strongly protected against damage, preferably by iron casings. If they are led through metal tubes these must be strongly secured, and should be fitted so that water cannot lodge in them.

Where cables pass through beams, bulkheads, or other iron work, they should be led through special fittings of sheet lead, hard wood, or vulcanised fibre to prevent their being chafed, and where they pass through decks they should be led through metal tubes lined with wood or vulcanised fibre, and securely fastened to the decks, standing at such a height above the deck level that water cannot stand above them. Where cables pass through watertight bulkheads the fittings should be provided with brass watertight screwed glands.

In vessels having spaces allotted alternately for passengers and cargo the lamp fittings in these spaces should be removable, and the terminals so arranged that they can be properly covered up with strong metal covers, or the whole of the fittings should be similarly provided with strong metal covers. The main switches and cut-outs should be outside these spaces, or, if placed inside, they should be in strong iron boxes provided with iron covers, or otherwise securely arranged to prevent the fittings being tampered with.

Distribution.—A main switchboard should be fitted in the dynamo room, to which all the main circuits throughout the ship should be brought, a switch and cut-out being fitted thereon for each circuit. The auxiliary switchboards for further sub-division of the current should be placed in conveniently accessible positions, and each such switchboard should be similarly fitted with a separate switch and cut-out for each small circuit. If vessels are wired on the double-wire system, cut-outs should be fitted to each wire of all circuits, including lamp circuits. In cases where electric lights are used for the mast-head light and side lights, the switches controlling these lights should be placed in a position where they can be controlled by the officer of the watch, or other responsible person, and cannot be tampered with by other members of the crew, or by passengers, &c.

The switchboards should be of slate or other incombustible material. The switches should be on the quick break principle, and should be so constructed that they must be either full "on" or completely "off"; that is, they must not be able to remain in an intermediate position. They should have ample rubbing surfaces and their conductivity should not be less than that of the wires connected to them. Cut-outs should be fitted to each main or auxiliary circuit, on the switchboards, as near as possible to the switches of these circuits. If the switchboard is not fitted near the dynamo, or if more than one dynamo may be used on any one circuit, then cut-outs should also be fitted to the main cable as near as possible to each of the dynamo terminals. All other cut-outs should also be in easily accessible places, and as near as possible to the commencement of the cables or wires they protect. They should be mounted on slate or other incombustible bases, and be arranged so that the fused metal may not be a source of danger, and where fitted with covers these should be incombustible.

All fuses should be of easily fusible and non-oxidisable metal, and should be so proportioned as to melt with a current 100 per cent. in excess of the normal current; that is, they should melt with a current in the proportion of 2,000 amperes per square inch of section of the wires they protect. The fuses for branch wires to single lights should, however, if of tin wire, be of not greater size than 22 S.W.G. The fuses for each cable should be made of standard dimensions, so that a large fuse cannot be used for a small cable by mistake, or, if wire fuses are used, permanent instructions should be fitted on or near each switchboard, giving particulars of the proper size of fuse for each circuit.

In shaft passages and in damp places all lamp switches and cut-outs should be of a strong watertight pattern, or should be placed in watertight boxes having hinged or portable watertight covers. No switches or cut-outs are to be placed in bunkers. There should be no joints in the cables leading from the dynamo to the main switchboard, nor in those leading from the main to auxiliary switchboards, nor should branches to single lamps be taken off these cables. A voltmeter should be supplied with each installation. If more than one dynamo is fitted, neither being capable of the whole of the output, an ampere meter should be supplied with each dynamo.

Joints with Hull.—In vessels fitted on the single-wire system, all the joints with the hull should be placed in accessible positions. Those for single lamps or for small cables should be made with brass screws not less than three-eighths of an inch in diameter, carefully tapped into the iron or steel, having white brass washers, between the wires and the vessel, or the wires should be soldered to brass-faced washers. For larger cables and for the pole of dynamo the cable wires should be properly sweated into brass or copper shoes, which should be bolted to the vessel. The iron or steel where contact is made should be filed bright, and the area of contact should not be less that eight times the section of the copper of the cable.

Vessels Carrying Petroleum.—The single-wire system must not be adopted for any part of the installation. Switches and cut-outs must not be fitted in places liable to the accumulation of petroleum vapour or gas, and all lamps in places where it is possible for gas to accumulate must be made with an outer glass globe made air tight. All wires in such places are to be lead covered, or the insulation of the cables employed is to be of such a nature as not to be affected by petroleum. No joints of cables, switches, or cut-outs should be fitted in the pump room; but the wires for each lamp therein should be carried to the lamp from a distributing junction box placed outside the pump room or companion.

The following paragraphs referring to the effect of the Electric Light Installations upon the Compasses are issued as Suggestions, not as Rules:—

Position of Dynamos and of Electric Motors.—The position and type of dynamos and electric motors should be such that the compasses will not be affected. Dynamos and large motors should be at least 30ft. from the standard compass.

Cables.—In vessels fitted with continuous-current dynamos, and wired on the single-wire system, no single cable should be carried within 15ft. of any compass, and cables conveying heavy currents should be fixed at still greater distance. If it is necessary to fix any cables within this distance, then for all parts of the vessel lighted from this cable the concentric or double-wire system should be adopted, the return wire being carried as near the flow as possible in the vicinity of the compasses.

Adjustment of Compasses.—The compasses should be adjusted with the dynamo not working, after which the vessel's head should be put upon the different courses, with the dynamo running at full speed, and on each course the indications of the compass should be noted with the dynamo running with open circuit and with all possible combinations of the current switched "on" and "off" all circuits passing near the compasses. These indications should be compared with those obtained with the dynamo stopped, and any serious deflections of the compasses remedied before the vessel sails.

THE LONDON ELECTRIC SUPPLY CORPORATION.

When in July last it was known that Lord Wantage, as sole debenture-holder in this Company, had in the exercise of his powers entered into possession, it was generally thought that the beginning of the end had come to an undertaking, which, however brilliant in conception, had been most unfortunate in its working. Those who thought so did not know Lord Wantage. Connected with this Company from its commencement, he has in the most conclusive manner possible shown his belief in the future of the undertaking, inasmuch as he is not only the sole debenture-holder but by far the largest holder of the Ordinary and Preference shares. When it had become impossible to carry on the business of the Company without additional capital, and it was found that the shareholders declined to raise such capital, Lord Wantage took the action, as stated above, an action which, in view of subsequent events, must meet with the approval of the shareholders, who have every reason to feel satisfied at the consideration and pluck he has shown.

The first and most important duty devolving upon Lord Wantage when he entered into possession, and one upon which much of the future success of the Company would depend, was the appointment of a receiver and manager. Lord Wantage appointed the then secretary of the Company, Mr. R. Stewart Bain, chartered accountant, to this responsible position. Subsequent events have proved how well advised Lord Wantage was in making this appointment. Mr. Stewart Bain had been connected with the Company for more than six years, and was thoroughly conversant with everything connected with its working; but in addition to this he has had an extensive and varied experience, which well fitted him for the position. After qualifying as a chartered accountant in one of the largest accountant's offices in the kingdom Mr. Bain thereafter for six years held a very responsible position in one of the largest shipbuilding firms in the north of England, and the experience he has obtained in these various positions is now making itself felt in the management of this Company.

Although Lord Wantage has only been in possession for barely six months, great strides have been made in that short time in the improvement and value of the undertaking. Administration expenses have been materially reduced. The expensive and inconvenient premises in Adelphi-terrace have been let, and the offices removed to rooms at the distributing station in Cockspur-street. By means of sinking an artesian well at Deptford the supply of water to the boilers is now obtained at a comparatively small cost and great saving has been effected in the cost of discharging the coal from barges. Probably the greatest improvement, however, is in the increase of the number of lights (during the last four months 5,000 new lights have been added), and the engineering department, under Mr. D'Alton, have never been so busy, not only in connecting new customers but in laying new mains. What, however, will please the shareholders most of all is the knowledge that the supply during the period in question has been most reliable and efficient.

The steady increase of new business made it necessary some time ago to consider the desirability of increasing the plant at Deptford to enable the expected load of the winter of 1895-96 to be successfully dealt with. Tenders for a new 1,000-unit dynamo, and engines to indicate 1,500 H.P., were obtained from some of the leading engineers in the country, and after a very keen competition the firm of Messrs. S. Z. de Ferranti (Limited), of Charterhouse-square, were successful in obtaining the order for the dynamos, and the firm of Messrs. Plenty and Son (Limited), of Newbury, the order for the engines, which were designed by Mr. D'Alton. The placing of an order of this magnitude, after the experience of the last nine years, shows the confidence Lord Wantage has in the future of the Company.

THE EXPLOSION IN THE EUSTON-ROAD.

BOARD OF TRADE INQUIRY.

Major Cardew, R.E., yesterday (Thursday) opened an inquiry into the explosion of a street box which occurred in the Euston-road on December 29th last. Prof. Henry Robinson, consulting engineer to the St. Pancras Vestry, upon whose system of electric lighting the accident occurred, attended on behalf of the Vestry. Mr. Bassett Hopkins and Mr. Gunning represented the London County Council, and Mr. Foulger, engineer, the Gas Light and Coke Company.

Police-constable DIPROSE, 436 D, stated that at midnight on the 29th ult. he was at the corner of Gower-place and Endsleigh-gardens when he heard the report of an explosion in the direction of the Euston-road, and turning in that direction, he saw the flagstones, or cover of the manhole, blown into the air about 20ft. Almost immediately a second explosion occurred at the corner of Euston-road and Endsleigh-gardens, 20 yards away, and the cover of the manhole was blown 8ft. away. Forty or more yards of the pavement were raised. In the case of the first explosion he saw dense smoke issuing from the manhole. He took steps to inform the electric light people and the gas company, and the former sent men to fence in the spots where the explosions had occurred. Three-quarters of an hour afterwards two young men named Petrie and Govier came to him, and complained of having been thrown violently against the wall. They had been treated at University College Hospital, and were lame and covered with mud. There was a smell of gas where the explosion occurred, and he should say of coal gas.

CHARLES GOVIER, a farrier, of Drummond-street, said he was bidding a friend good-night at the corner of Endsleigh-gardens, when he saw a flash, and at the same time was hurled into the air; he fell on his back, and as he was trying to struggle to his feet the ground heaved and threw him into the gutter. He got up, and went along the road a little way, when he found his friend Petrie clinging to the railings; he said he felt dazed. They both went to the hospital, and were attended to there, but were not detained.

Mr. A. E. PYCRAFT. Chief Clerk to the Electricity Department of the St. Pancras Vestry, stated that he inquired at the hospital on the Monday morning, on behalf of the Vestry, regarding the cases of Govier and Petrie. The report of the surgeon was that Govier had a bruised side, and Petrie a sprained ankle, and that both were mild cases.

Mr. JAS. THOMAS BARON, M.I.E.E., chief engineer and manager of the St. Pancras installation, and having entire management of the works, stated that an outdoor inspector, Mr. Thomas, reported to him the results of the outdoor work, and it was his business to see that the manholes were systematically inspected. Each manhole would be inspected every four or six days. The two at which the explosion occurred had been inspected on the day previous. Inspection would be more frequent if there was suspicion of gas. No gas detectors were employed, the test being merely by smell. The presence of gas in culverts had been a source of trouble for some time past. The two manholes were reported constantly dry, with an occasional smell of gas. The culverts and manholes were drained and trapped from the sewers. No smell of gas had been reported from one of the manholes since July, but in the other gas was detected on November 15th and December 13th. Mr. Thomas wrote to the inspector of the Gas Company reporting this. No acknowledgment was ever sent to this or any similar communication. The Company, however, sent men who opened the ground at the spot. On Sunday morning, just after midnight, a policeman called on him at the works and reported that an explosion had occurred. Witness proceeded to the spot and found the manholes blown up and the roadway lifted up from two to three inches for a length of 30 yards. He distinctly smelt gas at one manhole. The two manholes, which were 10 yards apart, were connected by 8in. cast-iron pipes, in which were three strips of bare copper fastened on insulators. He examined the bare copper strips, so far as he could see, and also in the culvert, and found them in perfect order; there was no electrolysis whatever. The insulators had, however, been displaced by the explosion. There was no interruption of supply, and the tin strip fuses were not affected; these fuses should melt at 300 amperes. The brickwork of the manholes was greatly disturbed. On the Sunday morning he met the Gas Company's inspector, and in his company inspected the manholes in that neighbourhood. In one of the manholes there was a small incrustation on the negative side of the insulator. These incrustations were frequently found, and removed, but these were only found in the manholes. Arrangements were being made to prevent the recurrence of this, care being taken to prevent the insulators being so much exposed to moisture.

Major CARDEW: How often have you used these cast-iron pipes? This is a revelation.

Prof. ROBINSON: There are very few. They are used where there are crossings.

Major CARDEW: How do you know that this cast-iron pipe has not been damaged. Has the roadway been opened there?

WITNESS: No. There are several other pipes there—telegraph, gas, and water—and the cast-iron pipe is used to cross these.

Major CARDEW: Where you have a cast-iron pipe crossing a road, does it simply terminate in the manholes at each side?

WITNESS: Yes, the ends run into the brickwork.

After some further conversation upon the subject, it was arranged that the road should be opened, and the pipe examined, and the result made known to Major Cardew.

Examination continued: Since the report of Major Cardew to the Board of Trade, as embodied in the letter from the Board to the Vestry, steps had been taken as far as possible to comply with the suggestions made. There had been frequent inspection, and ventilating up-cast pipes had been put in in 11 places, three being in Endsleigh-gardens. Wooden shields had been put under the iron covers in a number of cases, but it was found that they got wet from condensation and swelled, and they had been obliged in some cases to remove them. As to the suggestion in the report that two or more small chambers should be substituted for large chambers, they had not been able to carry out that alteration. There had been about half-a-dozen explosions altogether since the works were first started. The insulation of the negative mains from earth was still low, and they had constantly tried to increase it by cleaning the insulators and removing all dampness.

By Mr. Bassett Hopkins: The roof of the culvert and also the floor were split, indicating that the expansion had taken place in all directions, and that there must have been gas in the culvert. Wherever cast-iron pipes were used to carry bare conductors they were 8in. in diameter, and where they contained cables 3in. in diameter. These pipes were in some cases about 18in. below the surface of the road. Customers' work was tested for insulation when the connections were first made, but not again unless faults were developed. The fact that the fuses were not affected showed that there had not been a short circuit. The only theory witness had formed was that coal gas was present in the manholes, and they might have fired it by means of a spark.

By Mr. Foulger: They had four men constantly employed in searching for gas and water, but it was not possible to inspect every manhole every day. Witness was aware that small machines, leak detectors, were used for the purpose of discovering the percentage of gas present, but he had never known of their working satisfactorily. He did not know whether their notices of leakage did or did not always receive prompt attention from the Gas Company, but they (the Vestry) never received any intimation from the Company. The mains were drawn fairly tight; it could not be said that they were laid loosely on the insulators, and he did not think they could be easily drawn together unless there were some extraneous cause. There was an instance in August, 1893, of the mains coming into contact in several places simultaneously. There was a great fire at Camden Town at the same time, but that was three-quarters of a mile away, and he could not say that it had anything to do with the disturbance of the main.

If there were moisture in the culvert would it not be possible by decomposition to form hydrogen gas?—There is never sufficient moisture on the insulators to cause an explosion.

In your opinion how much gas would be required to bring about the explosions in question?—Do you know the most explosive mixture of gas and air?—About 10½ per cent. of gas, I think.

Have you tested since for the presence of coal gas at these manholes?—Yes, and have smelt coal gas.

I suppose you know there is a smell from a gas main although there may be no escape, and that the smell of gas does not necessarily indicate an escape?—Yes.

Do you think if the alterations you now contemplate had been carried out the explosions would not have occurred?—I do not say that.

Are you aware that the Gas Company's officials have been testing daily since, and have not found the slightest trace of coal gas?—I have heard so.

By Major Cardew: WITNESS would not like to say that after his experience of bare conductors laid in culverts he would not recommend the putting down of such a system, nor that the system was one likely to conduce to explosions. He did not deny that a spark might have been caused probably by the incrustations on the negative, but there was no evidence of such a spark in the mains themselves.

Mr. WM. JOHN THOMAS, outdoor inspector of works, said he had charge under Mr. Baron of all the mains and connections of the system. He agreed with the evidence of Mr. Baron, except that he could state that every manhole was inspected once in three days. He went to the neighbourhood on Sunday, December 30th, and smelt gas at manhole 26, 26A, and 27, being those at which the explosions occurred. On the Monday he drew the attention of Mr. Gunning, the engineer to the London County Council, and the electrical inspector to the Council, to the smell of gas at another manhole, and they agreed that there was gas. He considered the leak detectors of the Gas Company useless, because they failed to show the presence of gas in the manholes when he knew there was gas there. He made reports verbally and in writing to the Gas Company when gas was found, but never received any acknowledgment of his communications, or learnt what took place upon them. He had tested the particular section of main, from manhole 26 to manhole 58, for insulation, and found the following figures: Positive to earth, 1,740 ohms; neutral wire to earth, 110 ohms; negative, 330 ohms; feeder main (shorter length), positive, 1,600; neutral to earth, 1,400; negative, 4,500. He should consider this, for a short length of main, a very low test. He considered 10,000 to 15,000 ohms an average test for mains that had been in use for two or three years. The insulation resistance varied greatly according to the condition of the atmosphere; but he should consider anything less than 1,000 ohms faulty. On December 31st he tested the section of main between manholes 26 and 27, going through 26A, and found a resistance of 10,000 ohms.

By Mr. Bassett Hopkins: He obtained as low a test as 200 ohms upon the occasion of the explosion in Endsleigh-gardens a year ago. He was not able to differentiate how much of the defective insulation was due to the mains and how much to the customers. To ascertain this it would be necessary to cut off all the customers, and this they had not the opportunity of doing.

Mr. FOULGER: Do you expect to make a culvert gas-tight with concrete?—It is faced with cement as well.

Do you know that water will pass through concrete?—Yes.

By Prof. Robinson: If the smell of gas was from the main, he should expect it to be constant, but it was not so in the case of these manholes; it could not be smelt that day, for instance.

By Mr. Foulger: In all probability the smell would be more easily detected when there was a heavy, humid atmosphere than on a bright day like that.

EDWARD BENNION, electrical jointer, stated that immediately after the explosion he examined the fuses and found them all right. He was with the Gas Company's inspector when the latter applied the leak detector to the manholes; the indicator did not move, but there was a smell of gas.

Mr. W. N. BLAIR, A.I.C.E., engineer and surveyor to the Vestry of St. Pancras, said that, seeing it suggested that the explosion might be due to sewer gas, on January 4th he made an examination of the nearest available sewer, at a spot 235ft. distant, and found no trace of coal gas, and the air in the sewer was unusually free from smell. The trap at the manhole where the explosion occurred was not effective. He never knew of an explosion of sewer gas, which was not *per se* an explosive compound; but he had known of explosions of coal gas in sewers.

By Mr. Foulger: He could not say that it was possible for people, contrary to the statutes, to send materials into the sewers which might generate an explosive mixture.

Mr. G. F. L. FOULGER, engineer to the Gas Light and Coke Company, elected, upon the invitation of Major Cardew, to make a statement. He said the Company denied that in this particular case the explosions were caused, or could have been caused, by the presence of coal gas, because the whole of the tests they had made to discover coal gas had signally failed to denote its presence anywhere near the culvert. He came there and made this statement out of respect to the Board of Trade, and not because they admitted any liability whatever with regard to the explosions.

By Prof. Robinson: He knew that explosions of coal gas had taken place in the culverts, the one in Endsleigh-gardens a year ago being undoubtedly so caused. But their men had entirely failed to find any leak in the vicinity of these manholes either before or since the explosions. Messrs. Aird and Son were in the habit of doing work for the Company, and it might be that they were now at work in the square, about 80 yards from the culvert, but whether they were replacing some iron pipes or not he could not say. He would undertake to ascertain and inform Major Cardew as to the nature of the work they were doing, and the reason for it.

By Major Cardew: The gas pipes in that neighbourhood were by no means old. His theory as to the explosions was that hydrogen gas was formed by the dampness in the culvert, and this passed into the manhole and was arrested by the cover of the box, there becoming diffused into the air in the box, forming an explosive mixture, and being fired by an electric spark.

By Professor Robinson: It might be that the manholes were quite dry, but they were dealing with the whole length of the culvert, and the moisture from condensation might cause the formation of hydrogen gas in small quantities

Major CARDEW: If this had been the case to any extent there must have been corrosion.

WITNESS: Exactly so; and we have no evidence of the culverts having been opened to prove that there was no corrosion.

Prof. HENRY ROBINSON said, without going into a question of whether it was the fault of the Gas Company or not, the fact that there was a considerable accumulation of gas had led him to advise the Vestry to carry out a more thorough system of ventilation, and his report was now under consideration of the Electric Lighting Committee, and whatever recommendations were made to the Vestry he was sure would be carried out with a view to the safety of the public.

Major CARDEW: Do you consider that by the adoption of the system of ventilation you now propose all danger of explosion will be removed?

Prof. ROBINSON: I am quite confident it will prevent the accumulation of gas in the culverts. I cannot answer for the Gas Company that they will remedy their defective mains.

Major CARDEW: It is the duty of the Vestry to protect their culverts and manholes from the accumulation of gas and water.

Prof. ROBINSON: I will undertake that they will do so.

Major CARDEW: Until they do so they are not complying with the regulations.

Prof. ROBINSON: I am speaking now of any ordinary accumulations of gas that may come through the soil, and not of the serious invasion of gas which might result from the breakage of pipes, such as they now found might occur.

Major CARDEW: But this was known a year ago, Prof. Robinson.

Prof. ROBINSON repeated that the Vestry would do all in their power to prevent the accumulation of gas in the culverts and manholes, and the inquiry terminated.

CORRESPONDENCE.

RE THE DIRECT CONVERSION OF THE CHEMICAL ENERGY OF CARBON INTO ELECTRICAL ENERGY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In view of the general interest excited even in competent circles by a Paper with the above title, read by Dr. Borchers at the first annual meeting of the German Electro-Chemical Society, a copy of whose *Proceedings* now lies before me, and an abstract of which Paper appeared in your issue of November 30th of last year, I have examined and tabulated the potential of the following combinations, which may prove of interest to your readers:—

Anode.	Solutions.	Cathode.	Volts.
Carbon ..	Hydrochloric acid 25 per cent.	Copper ..	0·6006
Carbon ..	Cupric chloride in hydrochloric acid	Copper ..	0·4655
Carbon ..	Cuprous chloride in hydrochloric acid ...	Copper ..	0·3774
Carbon ..	Carbon in copper oxychloride in HCl ... Copper in cuprous chloride in HCl	Copper ..	0·4315
Carbon ..	Carbon in copper oxychloride in HCl ... Copper in copper carbonic oxide chloride in hydrochloric acid	Copper ..	0·4407
Carbon ..	Carbon in cuprous chloride in HCl and air Carbon in cuprous chloride in HCl and carbonic oxide	Carbon ..	0·0015
Carbon ..	Carbon in cuprous chloride in HCl and air Carbon in cuprous chloride in HCl and coal gas	Carbon ..	0·0050

These figures seem to me to throw a strange light upon the source of electricity in Dr. Borchers' cell.—Yours, &c.,

The Poplars, 20, Avenue-road, Regent's Park, N.W., Jan. 4, 1895.
ROBERT MOND.

"LABOUR SAVING" APPARATUS AS AN INSTRUMENT OF EDUCATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am very much obliged to you for your letter calling my attention to the discussion on the mechanical equivalent of heat at the Physical Society. As you know, I am extremely and increasingly interested in questions of this kind, though I am unable to give to them the attention I should like.

I believe that the put-a-penny-in-the-slot-and-turn-the-handle system of teaching practical physics is subversive of all true education, especially with junior students, and I think it has the additional effect of completely spoiling the teachers. Some time ago an old student of a well known engineering college was appointed to take charge of a school possessing a small physical laboratory, in which there might have been room for a dozen students working at one time. This laboratory afforded the only accommodation available for storing and using the physical apparatus. The cost of the instruments recommended for purchase amounted to several hundreds of pounds, as for nearly every experiment proposed to be carried out a complete set of apparatus (including separate resistance box, galvanometer, &c.) was specified, obviously with the intention of fastening everything down on a board, with the connections arranged once for all. How the apparatus was to be stored on the premises was a problem beyond one's intellectual powers.

The use of this kind of apparatus in the elementary laboratory is akin to the employment of highly specialised automatic machinery in the workshop, the pocket book of engineering formulæ in the drawing office, or the manufacture of bread wholly untouched by hand in the bakeries of the A. B. C.; but there is this difference—for the productive purposes of the workshop, the drawing office, or the bakery, the machinery, whether mechanical or algebraic, may be justifiable, but for the educational purpose of the laboratory—no.

Most of us have seen a boy of two blow open a watch case, and his satisfaction with himself after the marvellous feat probably sufficiently represents the attitude of mind of the student who has determined J to these significant figures. I once saw a nigger minstrel sit down on the knee of a colleague and forthwith appear to discourse sweet music on a violin. When one of the troupe remarked, "Why, Bones, I did not know that you could play the violin before!" Bones honestly replied, "I was not playing it before; it was Sambo playing it behind." If the student appreciates the value of his work as clearly as did Bones comparatively little harm may be done; but does he?

I am by no means opposed to the use of "direct-reading instruments" in the laboratory, provided that their nature and purpose are understood by the student. In the mechanical laboratory, I see no objection to the use of a spring balance, but the student ought to know that the balance is graduated by means of weights. Similarly, I should not object to a student using an ampere-meter or voltmeter; but I should expect him first to know something of the nature of the electrical quantity to be measured in each case, of the standard experiments to which the readings of the instruments must be ultimately referred, and of the extent of the errors to which the readings are liable. Then I would allow the use of the apparatus as I would allow logarithms or integrating machines, simply as labour-saving appliances. The question of the desirability of using a resistance box has been raised. If the student is acquainted only with the outside of the box he certainly ought not to use it; but if he knows how the coils within are connected, that an ohm is the resistance of a certain column of mercury under certain conditions, that this resistance or any multiple of it can be imitated in German silver or other wire, and that the bobbins in the box contain such copies of the ohm or its multiples, then he is in a position intelligently to use the box, and it is not necessary that he should himself have adjusted the coils any more than that he should have fitted the brass plugs or polished the case.

A good deal has been said about the use by drawing office students of "engineering formulæ" where *l* represents the length in *feet*, *d* the diameter in *inches*, T the tensile strength in *pounds per square inch*, and W the safe load in *tons*. No one will question the value of well-designed formulæ in the everyday work of the drawing office as a labour-saving appliance, but I question very much whether anyone responsible for the design of a structure should be allowed to use formulæ unless he is able to deduce them for himself. To see, as I have seen, a practical man in doubt whether it is this or that formula which is applicable to the case before him is sufficient evidence of the desirability of never allowing a student, at any rate, to use a formula the meaning of which he does not grasp.

It seems to me that the use of such apparatus as that described by Prof. Ayrton and Mr. Haycraft is simply pandering to the popular demand for practical results. The student, on entering the physical laboratory, is to be impressed during the first week with the importance of the results which his unskilled hands are to obtain, and "determinations" which occupied masters of research during years of patient work are to be made by the student with still greater accuracy in a few minutes. Certainly, the Central Technical College affords the royal road to learning, and its training must be of incalculable value in practical life. But is not the work of the same character as the wonderful maps we used to trace, or the French lithographs of architectural or mechanical drawings, which we used to copy when we were small boys at a private school? When a boy who has gone through a course of automatic labour-saving experiments finds himself face to face with a practical problem, which he has to think out for himself and solve practically with scarcely any of the resources of the physical laboratory at his command, and no one to make his connections for him, will the labour-saving apparatus avail him much? Will not a few old-fashioned experiments with jam jars and sawdust, and bits of copper and zinc, and tangent galvanometers and so forth have done more to develop self-reliance and resource? I believe that all this is corrected later on in the course of Physics at the Central Technical College; but the question in hand is that of a particular experiment.

Finally, does the experiment described by Prof. Ayrton and Mr. Haycraft serve the purpose of making the mechanical equivalent of heat a "real thing" to the student? Does it appeal more to his reason than the "magic mirror" or the automatic fortune teller? Is it possible to conceive of a student who is unable to gain a clear idea of the mechanical equivalent of heat from Rumford's experiment of boring the cannon, and who, nevertheless, can appreciate the relations between the ordinary electrical units and the British gravitation units usually employed in stating the mechanical equivalent of heat?—Yours, &c., J.

[We have, contrary to our usual practice, inserted the above letter anonymously, as the writer has good and sufficient reasons for not wishing to write over his own signature.—Ed. *E.*]

LEGAL INTELLIGENCE.

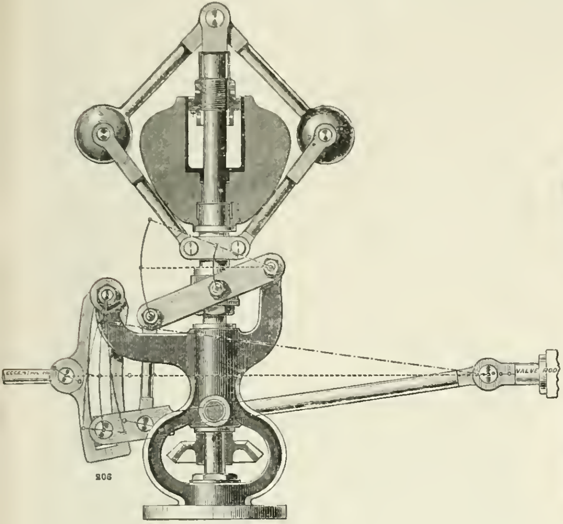
Collier Audible Telephone Syndicate (Limited).

Mr. S. Wheeler, the Official Receiver, has issued a summary of the affairs in this liquidation. A winding-up order was made on July 19th last. The nominal capital of the Syndicate (which was formed in 1891 to purchase and further develop the patent rights of Mr. Arthur Thomas Collier for an improved audible telephone, and to carry on a telephone and electrical manufacturing and supply company) was £9,000 in £100 Ordinary shares. The London and Colonial Finance Corporation (Limited)—now in voluntary liquidation—were the promoters of the syndicate, Mr. Harry Seymour Foster, M.P., being one of the signatories. The purchase price was fixed at £6,000, satisfied by the issue of 60 Ordinary shares as fully paid. £350 in cash was also to be paid to the vendor in respect of certain outlay. It was agreed that the promoting corporation should provide offices and pay all expenses down to the first allotment of shares, in consideration of which the Corporation should receive 30 of the 60 shares allotted to the vendor, the vendor to be managing director at a minimum remuneration of £400 per annum, and to have entire personal control and superintendence of all experiments for perfecting the inventions. Applications for 24 shares were received, representing £2,400 of capital, and six shares were subscribed for and allotted shortly afterwards, so that the 30 shares have been fully paid up. The syndicate's operations appear to have consisted almost exclusively of experimental work in connection with the vendor's inventions, which soon absorbed the capital, the Corporation providing further pecuniary assistance. A second prospectus, inviting subscriptions for an issue of £4,000 debentures bearing interest at 10 per cent. per annum, resulted in £1,000 being taken up by the Corporation at 90 per cent. Pending the placing of the balance a loan of £1,000 at 10 per cent. was raised from a concern called the Trustee Industrial and Investment Corporation (Limited)," upon security, and the whole £4,000 debentures had been taken up. On August 10, 1892, a new Company was registered under the title of "The Collier-Marr Telephone and Electrical Manufacturing Company (Limited), which took over the assets of the syndicate as a going concern, the consideration being £50,000, payable as to £46,000 in shares and £4,000 in cash. Mr. J. J. Graham and the Corporation were the promoters of the new company, and various agreements were entered into with Mr. Graham with reference to the promotion. By the first of these agreements Mr. Graham was to procure underwriting for £40,000 of shares in the new company, and was to bear all the costs and expenses of the promotion, the consideration being the sum of £10,000 in cash and £5,000 in shares of the new company. The Corporation agreed to underwrite or procure underwriting for one-half of the amount of £40,000, in consideration of receiving from Mr. Graham a moiety of all profits divisible under his agreement. Difficulties appear to have arisen in procuring underwriting contracts for £40,000, and that sum was reduced to £10,000. Supplementary agreements were entered into between the Syndicate, the promoter, and the trustee for the new company, modifying the purchase consideration to be paid to the Syndicate and the consideration to be paid the promoter. The Syndicate went into voluntary liquidation in October, 1892, and Mr. G. D. Ingall was appointed liquidator, which position he resigned in April, 1894, and Mr. Byron Davies was appointed by the shareholders in his place, and continued to act until the date of the order for compulsory winding-up. The Syndicate's accounts show an estimated surplus (subject to realisation) after meeting liabilities of the Company, subject to cost of liquidation, of £25,617, the gross liabilities being only about £645 This statement, says the Official Receiver, cannot be taken as correctly representing the position of the Syndicate. He adds that there are matters in connection with the conduct of the business of the Syndicate, and of the voluntary liquidation, which require further investigation The Syndicate went into voluntary liquidation for the purpose of carrying out the sale and transfer of its assets, and the cause of its present insolvency is attributed to an under-estimate on the part of Mr. Marr and the Directors of the amount of cash required to pay the creditors in full. It would appear that the promoters of the Collier-Marr Company took three-fourths of the total cash consideration receivable by the Syndicate on the sale of its assets.

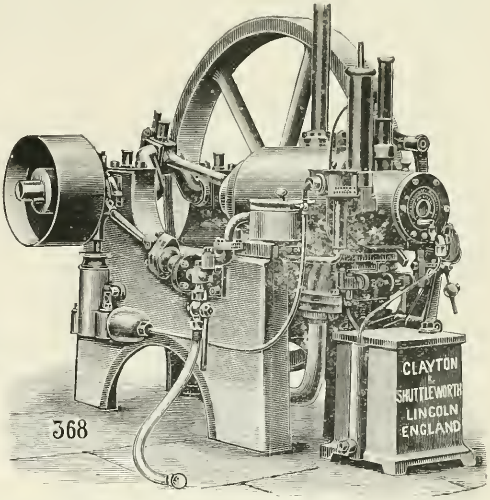
CLAYTON AND SHUTTLEWORTH'S ENGINES.

At the recent Smithfield Club's show Messrs. Clayton and Shuttleworth had on view an oil engine which attracted considerable attention from its compactness and solidity. This engine we illustrate below. These oil engines are made by Messrs. Clayton and Shuttleworth in various sizes, and work on the well-known Otto cycle. The following gives a general idea of their method of working :—

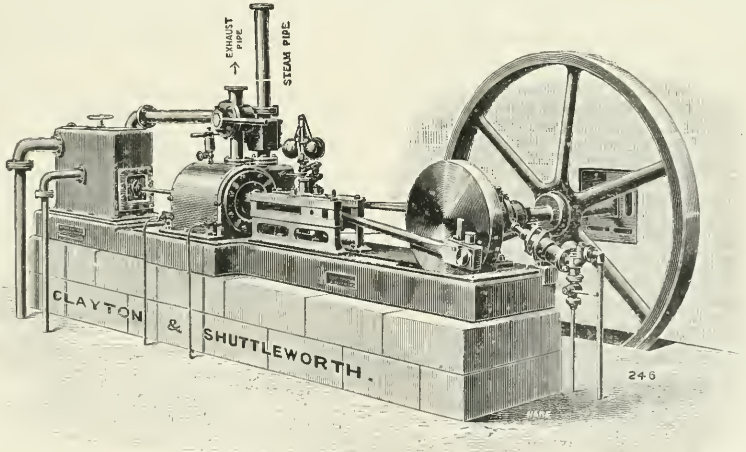
The oil to be used is contained in a separate square tank, placed in any convenient position, but preferably underneath the vaporiser. From this tank the oil is pumped automatically to a sufficient height to enable it to fall by gravitation into the vaporiser, which is bolted on to the end of the cylinder. A small gauge glass above the vaporiser enables anyone to see at a glance the amount of oil being used. The vaporiser is so constructed that the oil is conducted over a cylindrical heated surface, by which it is converted into vapour, and admitted to the back end of cylinder. Here it is mixed with atmospheric air, compressed, and fired by means of an ignition tube, kept at a red heat by means of a simple form of blow lamp, no timing valve being necessary. The governing of the engine is effected in a simple manner, as follows: The small oil pump and the vapour valve are both worked off the same vertical lever, which is actuated by means of inertia or a "hit-and-miss" governor. When the engine begins to run too fast the governor fails to move this lever, and consequently not only is the oil supply to the vaporiser stopped, but one or more charges of vapour to the cylinder are completely cut out. This simple arrangement has been found very effective, even under the somewhat severe test of driving a dynamo connected direct with several incandescent lamps. The engine speed can be varied at will almost instantaneously, within reasonable limits, while running. Efficient means of lubrication are provided for all wearing surfaces, and altogether the engine has been carefully designed, and is of excellent finish and workmanship.



Tyrrell and Deed's Patent Governor, with Automatic Expansion.



New Type of Oil Engine, made by Messrs. Clayton and Shuttleworth.



Long stroke Engine for Electric Lighting.

In addition to the oil engine above described, there was also on view one of Messrs. Clayton and Shuttleworth's fixed expansion condensing or non-condensing steam engines of the long-stroke type, to which, for electric lighting purposes, is usually fitted Tyrrell and Deed's patent governor, with automatic expansion gear, of which an illustration is also given. Very little description is required to explain the working of this engine. Reference to the illustration will show that it is of the horizontal type, with balanced disc crank and steel pin, one end of the crank shaft being carried in a bearing on the bed-plate, and the outer end in a plummer block resting on a brick or stone pier, or in the wall of engine house, as may be most desirable. Several of this type of engine, fitted as above described, are driving electric lighting installations most satisfactorily. These engines, being erected upon a cast-iron bed-plate, are very easily fixed in position, and occupy but little space. The cylinder and steam chest are efficiently provided with drain cocks and pipes. All covers are easy of access, to enable the piston with the slide and stop valves to be readily removed for examination. The lubrication of all wearing surfaces has also been well considered.

The same firm have proved by repeated experiments that it is impossible to adjust a single slide valve, so as to cut off the steam early in the stroke of the piston without hindering the free escape of the exhaust steam, thus causing back pressure and consequent loss of power. They therefore employ independent slide-valves, one for admitting and exhausting the steam, the other for cutting off the supply of steam at any desired point of the stroke. In Tyrrell and Deed's patent automatic expansion the throttle valve is entirely dispensed with, the steam entering the steam-chest at full boiler pressure. The speed of the engine is thus controlled directly by the governor, which as it rises lifts the die in the link, reducing the travel of the expansion valve, thus cutting off the supply of steam earlier in the stroke whenever the speed tends to increase. The vertical movement of the governor is steadied by the compression of the air underneath the small piston seen in the illustration within the brass-lined cylindrical recess in the central weight. This governor is claimed to be so proportioned as to be nearly isochronous, practically the same speed being maintained under extreme variations of load. In electric lighting, where uniformity of speed is most essential, this governor has been found to work well.

TRADE IN 1894.

Mr. Burns, the agent for the Delaware Hard Fibre Company, reports that the past year has been one of continual progress in the sale of the Company's specialities, and that, owing to increased demand, extended warehouse accommodation has had to be provided for the large stock needed to execute orders promptly. Stocks of sheets, rods, and tubes are now very large, and extra attention can now be given to orders for washers and special shapes.

The Manchester Edison Swan Company report an exceptionally busy time for the past year. Important installations have been carried out by the Company, including the complete contract for the central station of the Altrincham Electric Supply (Limited), the alternators used being of the Company's own make. A large switchboard has been supplied to the Bolton Corporation for central station use. A large number of private installations have also been completed, and in the Manchester, Birmingham, and Oldham districts contracts for the lighting of shops, hotels, warehouses, mills, &c., make a large total. The contracts already secured for 1895 show a largely-increased demand for the electric light in the districts in which the Company's operations are chiefly centred.

The patent Duplex Upright Tubular Boilers, for which Messrs. J. Weeks and Co., of King's-road, Chelsea, London, have for so many years been renowned, have during the past year met with even greater success than in previous years. In the long list of testimonials from actual users, which has been forwarded to us, the owners or managers of the principal gardens of England (both public and private) express their satisfaction with these boilers. For heating purposes, and especially for hot-house work, these boilers have an exceptional record.

Messrs. Willans and Robinson report that the output of the Willans engine still continues to increase, the orders during 1894 having exceeded all previous years. The following figures are interesting:

Willans' engines	ordered in	1891	......	11,000 H.P.
Ditto	ditto	1892	....	14,300 ,,
Ditto	ditto	1893	......	18,950 ,,
Ditto	ditto	1894	....	26,724 ,,

Much of this power is for central station work, both municipal and company. The orders received from or for municipalities amount to about 5,550 H.P., and about 1,850 of this is for stations where the Willans engines are already in use; and those for public companies to about 9,000, all of which is for existing stations using Willans engines. Among the central station orders received were:

For Companies.—Westminster Company (additions), 1,280 H.P.; City of London (additions), 5,600; Kensington and Knightsbridge Company (additions), 360; Liverpool Company (additions), 600; Norwich Company (additions), 270; Birmingham Company (additions), 300; Chelsea Company (additions), 655.

For Corporations.—Blackburn, 560 H.P.; Edinburgh, 1,750; Sunderland, 354; Yarmouth, 420; Cheltenham, 360; Brighton (additions), 600; Glasgow (additions), 720; Aberdeen (additions), 400; Tunbridge Wells, 300; Whitehaven Town and Harbour Trust additions), 120.

The largest of these orders (that for the City of London Company) includes eight engines of 700 H.P. each (ordered through the British Thomson-Houston Company) to be coupled direct to Thomson-Houston alternators running at 300 revolutions per minute. So far as we know these are the largest high-speed engines yet used for electric lighting, the largest hitherto used, we believe, being Willans engines of 360 H.P., running at 350 revolutions per minute. Among other lighting and power station orders the following may be mentioned:—Liége Lighting (Belgium), 390 H.P.; St. Petersburg Lighting, 600; Caen Lighting (additions), 250; Liége Electric Tramways, 720; Dutch State Railways (additions), 120.

In addition to the above a large number of Willans engines previously on order have been completed and supplied during the year, including those for the Local Authorities of Nottingham, 650 H.P.; Bradford (additions), 200; Dewsbury, 450; Bristol (additions), 360; Hampstead, 860; St. Pancras (additions), 400; the Hove Company (additions), 200; Rotterdam Lighting, 400; Biarritz Lighting, 180; and Glasgow Post Office, 240. The horse-power of engines ordered for public lighting in London alone amounts to 7,900, while that put in operation there reaches 1,260. About 13,000 H.P. of the engines ordered is for customers who are already users of the Willans engine.

For electric traction, about which so much interest is now excited, orders have been received for engines for the Liége tramway, which will not be the first Willans engines to be used for this purpose. Three engines of 200 H.P. each have been running the tramway in Hobart, Tasmania, for the last two years with success, and several important orders are pending in England.

Many orders for smaller engines for mill work, for driving mining stamps, electric lighting in mines, and private installations, and for driving air compressors, have been received. The compressors are also Willans engines, direct driven, and modified so as to work as pumps instead of motors. Messrs. Willans and Robinson are also building two engines of 1,400 H.P. each to drive the dynamos upon two electric locomotives on the Heilmann system, now being constructed in France. These engines are of special design, owing to the small space available and the small weight allowed. They will run at 400 revolutions per minute. The firm have recently purchased a site of about 25 acres at Rugby, upon which they propose to commence the erection of branch works to deal with the heavier class of work, and so relieve the shops at Thames Ditton, which have for a long time been overtaxed.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

IMMEDIATE.—The 1895 (thirteenth) edition of "**THE ELECTRICIAN**" **ELECTRICAL TRADES' DIRECTORY AND HANDBOOK** is in active preparation, and will shortly be ready. Subscription and advertisement orders should be sent in immediately. In addition to the old well-known features of the book, which will be brought up to date, a quantity of new and useful matter will be added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Alterations to existing entries and New Names must be sent in forthwith, and the Publisher requests that those who have received the circulars relating to the new edition will return them corrected at once.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices:*—

Laboratory Notes and Forms.—With the above title, we have in the press a set of Elementary (now ready) and Advanced Exercises (ready shortly) for use in Electrical Engineering classes. These have been prepared in Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is just out, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

Tenders Invited.—The Metropolitan Asylums Board require tenders for the supply and running of mains, and the wiring of the buildings and grounds of the North-Western Fever Hospital, Haverstock Hill, London, N.W. Some further particulars are given elsewhere, and sealed tenders must be sent in by eleven o'clock on Thursday, January 24th. Mr. T. Duncombe Mann is clerk to the Board, Norfolk House, Norfolk-street, London, W.C.

——— Mr. J. Bateson, of 10, Primrose-street, Nelson, invites tenders for the lighting of Stanley-street chapel, Nelson, by electricity. Tenders must be in by the 18th inst.

Tenders Accepted.—The tender of the New British Electrical Installation Contractors (Limited) has been accepted for wiring and fitting for the electric light the gas testing offices, portions of the police stations, &c., for the Worcester City Council, at £21. 5s. This was the only tender received.

——— The tender of Messrs. Laurence, Scott and Co. (Limited), of Norwich, has been accepted by the Yarmouth Corporation for the lighting of the Town Hall by electricity for the sum of £418. The town surveyors' estimate was £420.

——— The tender of Messrs. New and Mayne has been accepted by the Aberdeen Corporation for lighting the Municipal Buildings by electricity for the sum of £200.

——— The Stafford Town Council have accepted the tender of the Chloride Electrical Storage Syndicate for the supply of accumulators, at a cost of £822, and a tender from the Electric Construction Company has also been accepted for the sum of £524. 18s. for plant.

Appointments.—Mr. A. S. Giles has been appointed borough electrical engineer at Blackburn, at a salary of £200 per annum. ——Mr. Gilbert Bell, who was for some time at the Bristol Electricity Works, has been selected for the post of assistant to Mr. C. H. Wordingham, the City electrical engineer of Manchester, out of 108 applicants.——Mr. W. J. Hope Johnston has been appointed by the Town Council engineer to the Bedford Electricity Works, at a salary of £150 per annum. It was stated that Mr. Medhurst's estimate for staff salaries was £12. 12s. per week, but that Mr. Johnston estimated to be able to work the station efficiently for £10. 10s.

Vacant Appointment.—The Sunderland Town Council invite applications for the appointment of an assistant electrical engineer at a salary of £120 per annum. Some particulars are given in our advertisement columns, and applications must be sent in not later than 5 p.m. on Wednesday, the 23rd inst., to Mr. F. M. Bowey, Town Clerk, Town Hall, Sunderland.

Partnership Dissolved.—The partnership between Messrs. E. H. Berry and P. C. Pope, carrying on business under the style or firm of E. H. Berry and Pope, as electrical engineers and contractors, at Burnley, has been dissolved by mutual consent as and from the 24th day of December, 1894. The business will be carried on by Mr. E. H. Berry under the old title.

New Firms.—Messrs. F. A. Glover and Co. have just commenced business at 97, Queen Victoria-street, London, E.C., as electric light engineers and contractors.——Messrs. Ellis and Ward, who have both been connected with the Brush Company in London, have commenced business at 113, Edmund-street, Birmingham, where they are acting as agents for the Brush Company in that district.——Under the title of the Lister Electric Light and Power Manufacturing Company, Mr. W. J. Lister has added an electrical branch to the engineering and ironfounding business established in 1820 at Dursley, Gloucestershire.

Change of Address.—Mr. James Swinburne's new address is 66, Victoria-street, Westminster, S.W., instead of 4, Hatherley-road, Kew-gardens.

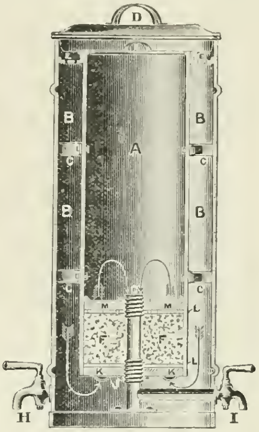
Bankruptcy.—A first dividend of 3s. in the £ has been declared in the bankruptcy of Messrs. Young and Buss, wholesale ironmongers, of 18, Blandford-street, Baker-street.

Messrs. Drake and Gorham.—This firm have secured the contract for the electric lighting of the new County Technical Institution Buildings, Stafford, in competition. There are to be about 300 lights.

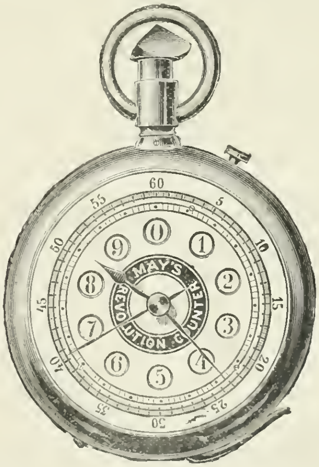
The Elmore Copper Companies.—It is satisfactory to learn that the Elmore Companies have been officially notified that their names have been placed upon the list of contractors to Her Majesty's India Office for the supply of copper tubes, copper cylinders, and copper tape, such as is used in the manufacture of cartridge cases and for electrical purposes. We hope this may prove a turning point in the fortunes of these undertakings.

Electric Construction Company (Limited).—On Saturday last Sir Daniel Cooper, Bart., Chairman of the Company, entertained the staff and employés to dinner at the Victoria Hotel, Wolverhampton, and during the evening an address was presented to Mr. Emile Garcke on the occasion of the expiry of his agreement as Managing Director of the Company.

Oil Filters.—No more useful device is to be found in a well-appointed engine or machinery room than a well-made oil filter for refining the dirty oil. On the score of economy alone, this useful apparatus is welcomed, and its advantages on the score of cleanliness are manifest. Messrs. W. H. Willcox and Co., who are well known as makers of and dealers in all kinds of engineers' stores, have placed upon the market a new patent oil filter, which is claimed to possess many advantages. It is cheap, ranging from £2. 10s. for a 6-gallon filter to £4. 10s. for a 20-gallon. It is self-filtering, and no steam is required. On the illustration below, A shows the clean and B the dirty oil chambers, F shows the filtering material, and H and I the clean and dirty oil taps. Many of these filters have been supplied to the Government departments, as well as to several of the principal electric lighting stations, where they have been tested and have shown a great saving of oil, especially where the oil is caught as it comes from dynamo bearings. For gas-engine plants an oil filter will always be found useful, as a considerable proportion of the waste oil can thus be saved. Fitted on a suitable bracket, the filters are easily kept in order. The filtering material can be renewed (this should be done annually). The construction of the filter here illustrated differs somewhat from those already in the market, as the dirty oil is put into the outer chamber, and is filtered by gravitation.



May's Speed-Counter and Chronograph.—We illustrate herewith May's patent speed-counter and chronograph, which is introduced by Messrs. O. Berend and Co., of 61, Fore-street, E.C. The instrument is non-magnetic, and indicates revolutions and time to the fifth of a second. The speed-counter has the advantages of May's revolution counters, and is fitted with automatic adjustment of the



May's Patent Speed-Counter and Chronograph.

figures (right or left) for reading and indicating the direction in which the spindle rotates. The instrument will also serve as a tachometer for measuring and determining irregular speeds, as a large number of successive and short measurements can easily and quickly be taken. As the works of the chronograph are non-magnetisable, readings are absolutely correct when taken from a dynamo or electric motor. Full instructions for use, which are simple and easily understood, are sent out with each instrument.

"Commudine."—Messrs. Mavor and Coulson send us a sample bottle of a new preparation for cleaning dynamo and motor commutators. They believe it is the only article made for the purpose, and claim that it removes greasy oxide with the greatest facility, and does not foul the brushes or injure the insulation between the segments, and allows the commutator to develop a hard surface not liable to abrasion. The label on the bottle informs us that the object of Commudine is to ensure clean metallic contact; and, with true Scotch caution, it is stated that "should the commutator be badly worn it should be turned up in a lathe, as it is not pretended that this liquid will restore a badly-worn commutator to a true condition."

Code Vocabulary.—As the result of a decision come to at the 1890 meeting of the International Telegraph Conference, the International Bureau at Berne were intrusted with the preparation of a vocabulary of words for use in code telegrams passing between European countries, to become obligatory three years from the date of publication. This vocabulary has now been issued, and contains over 250,000 words. A copy may be inspected on application and presentation of business card at the Information Department of the London Chamber of Commerce, Botolph House, Eastcheap, E.C.

"The Engineering Magazine."—The contents of the January number of this magazine (now ready) will be found not to fall behind those of its predecessors in variety and interest. The articles include the following:—"Silver Coinage Historically Considered," by H. D. McLeod; "Modern Theories as to Electricity," by Prof. H. A. Rowland; "The Drainage System of the Valley of Mexico," by the Hon. M. Romero; Practical Hints for City Officials—"The Architecture of Municipal Buildings," by E. C. Gardner, and "Planning the Site for a City," by Lewis M. Haupt; "Selecting Motive Power for a New Plant," by Charles E. Emery; "Plumbing Trade Schools and Their Influence," by E. N. G. Le Bois; "Laboratory Training for Mining Engineers," by R. H. Richards; "Operating Machine Tools by Electricity," by George Richmond; and "First Principles in Architecture," by William Henry Goodyear. Most of these are illustrated in the splendid manner which has placed this magazine in the forefront of illustrated periodicals. The extremely useful "Review of the Industrial Press" is extended, and contains not merely a list of articles and publications, but abstracts of the more important ones (in many instances with cuts). The European edition of the *Engineering Magazine* is published at 1, 2 and 3, Salisbury-court, Fleet-street, London, E.C.; price 1s. (post free 1s. 3d.) monthly, or 12s. 6d. per annum (post free).

"Engineering Diary, 1895."—We have received from Messrs. Straker and Sons, Bishopsgate-avenue, Camomile-street, London, E.C., a useful engineering and machinery diary compiled by Mr. J. Stephen Jeans. The diary contains a mass of useful information of the usual diary character, in addition to much that is specially useful to engineers. The book is interleaved blotting.

Catalogue.—We have received a neat pamphlet catalogue and price list of the wares of the "Shawmut" Fuse Wire Company, of Boston, U.S.A. The catalogue is well illustrated and shows a variety of fuses for all classes of electrical work, and printed instructions "How to Use Fuse Wires" are also given.

New Year's Gift.—The General Electric Company send us an interesting relic of bygone days. Years ago, when lamps and gas were used, matches were employed for kindling; and it was a common practice to use match-holders such as that which has been sent us. To emphasise the anachronism, the well-known trade-mark with the word "Electricity" is neatly printed on it. Perhaps, however, the device is intended for a pinholder.

Aberdeen.—It was stated at the last meeting of the Town Council that the Finance Committee had no time to look into the tenders received for electric lighting, but had remitted them to their electrical engineer, and if the tenders were in conformity with the specifications he proposed that the Committee have power to accept the lowest or the next lowest without waiting for the next meeting of the Council. It was agreed to.

Battersea.—The Vestry have appointed a special committee to consider the question of the electric lighting of the district.

Belfast.—Alderman Pirrie, in introducing the report of the Electric Committee at the last meeting of the Corporation, stated that it was with great pleasure he was able to report that the Committee hoped to place the electric light at the disposal of those who had applied for it during the current month.

Birkenhead.—Mr. Shoolbred has been requested to prepare and submit to the Finance Committee of the Town Council complete working plants, sections, specifications, conditions, and form of tender in connection with the erection of the central lighting station, and the necessary work in connection therewith. Tenders will shortly be advertised, the Council having applied to the Local Government Board for powers to borrow £18,424 for the purpose.

Birmingham.—At a supper given to the employés of the Electric Tramway route by the Directors of the Birmingham Central Tramway Company, Mr. B. J. Round, a Director of the Company, said he hoped they would shortly be able to get improved batteries to work the Bristol road cars more efficiently. Whether accumulators would answer or not he could not at present say, but he believed that science would eventually overcome that difficulty. He understood that electric cars in the South Staffordshire district had been worked at a cost of less than four-pence a mile, and if they could work at that rate it would be the salvation of the electric company.

Bradford.—A large number of applications have been made for the electric light during the present winter which the Gas and Electricity Sub-Committee of the Corporation have been unable to grant, as the motive power at command has not been sufficient to supply current to present consumers. At the last meeting of the Committee proposals were considered for providing new engines at the electricity works. Willans engines, equal to a total of 1,620 H.P., are at present in use, and it is probable that additional engines, equal to about 800 H.P., will be required. This will involve an extension of the works, and the matter was ultimately adjourned for future discussion.

Brighton.—The Post Office electric call system is to be extended to Brighton. Subscribers will be able at any hour of the day or night to obtain the services of Post Office messengers.

Brighton District.—The village of Rottingdean is to be lighted by electricity, and when the work is complete, Ovingdean, an adjacent village, is to be connected up.

Bristol.—Although the Finance Committee of the Corporation have decided to introduce the electric light into the Council House, it has been agreed to except the large committee room, where "a handsome gas chandelier is fitted." This resolution was come to "in the interests of history and art." The chandelier is to be furnished with a brand new set of burners.

Burglary.—A determined attempt to ransack the works of the London Electric Wire Company was frustrated by a commissionaire named James Robison, in the Company's employ. Unfortunately, in defending his employers' property, the man was seriously wounded, and was unable to be present in court when a man named Finn was charged with committing a felony and maliciously wounding. The prisoner was remanded in the hope that two men, his confederates, might be captured and brought to justice.

Bury.—An application is to be made to the Local Government Board for permission to borrow £30,000 for the installation of the electric light in the borough.

Chard.—At the Town Council meeting last week Councillor Gawler suggested the desirability of the Council acquiring the Chard reservoir, a sheet of water about 70 acres in extent, as a recreation place for the town. He thought the water might be utilised for power purposes for lighting the town by electricity. The suggestion was favourably entertained; but in view of other matters pressing for immediate attention its consideration was deferred.

Chester.—In this city the electric lighting question is exciting much attention, and, in order that citizens shall be fully acquainted with the various systems, the *Chester Chronicle* has engaged a special commissioner to describe the leading municipal lighting systems.

Christmas Tree Lighting.—Electric lamps have been extensively used in the large number of "Christmas tree entertainments" held recently, much to the enjoyment of the youngsters, whose interest in the proceedings has by this means been considerably increased.

Church and Chapel Lighting.—Reference was made in our last issue to the lighting of St. Peter's Church, Eaton-square. When the additions and alterations to the edifice, which are in progress, are completed there will be an equivalent of 260 16 c.p. lamps fixed. The scheme of lighting is from the designs of Mr. W. Howard Tasker, M.Inst.E.E., of Pembroke-road, Kensington. The contract for the work was secured by Messrs. Moody Brothers, who have carried out the work under Mr. Tasker's supervision. The actual lights are placed so as to be hidden from the eyes of the congregation as much as possible; and the full benefit of the reflecting power of the surrounding surfaces has been utilised. The lighting of the beautiful mosaics in the sanctuary is very effective.——Saul-street Church, Preston, which has recently been renovated and improved, has been fitted for the electric light.——The first place of worship in Leicester to which the electric light has been supplied is the Bishop-street Wesleyan

Chapel, where 134 16-c.p. incandescents are to be substituted for 137 gas burners previously in use. The work has been carried out by the Corporation under the personal superintendence of its engineer, Mr. Colson.

Commission of Sewers (London).—At the meeting of the Commission on Tuesday last Mr. Johnson asked if the Streets Committee had considered the question as to the possible reduction in the cost of the public lighting of the City streets, and in reply Mr. Burmester stated that certain experiments were being made in a system differing from the arc lighting now in vogue, which it was hoped would prove successful and more economical than the present system.

Conduits.—We are asked to state that Mr. F. Bathurst, representing the Interior Conduit and Insulation Company of New York, will shortly be introducing that Company's system of conduits into this country. The Company is well known in America, and has been responsible for the larger portion of the conduit work done in that country. In Germany the system is also well known. Mr. Bathurst's present address is 14, Greencroft-gardens, South Hampstead, N.W.

Dublin.—The Dublin Southern District Tramway Company have notified the Dalkey Town Commissioners of their intention to at once commence the construction of the electric tram line from Dalkey to Dublin.

Exhibition.—An international exhibition of art furniture is to be held at the Agricultural Hall, London, N., from April 16th to 22nd next. This is the third annual exhibition of the kind, and the management is in the hands of Mr. G. D. Smith, of 64, Finsbury-pavement, London, E.C.

Exhibition Awards.—In our issue of December 21st, page 229, reference was made to the action of a German firm of anti-friction metal makers in trading upon awards which, it was alleged, had, in fact, never been awarded. We have received from the representatives in this country of the German firm referred to a long statement on the subject; but as it would appear that legal proceedings are in progress we defer further reference to the subject for the present.

Fareham.—A motion is to be proposed at the next meeting of the Town Council, asking the Local Government Board to withhold their sanction to the proposed borrowing of £7,000 for the purchase of the Farcham Electric Light Company's undertaking.

Hampstead.—The Vestry is threatened with an action for damages in connection with one of its transformer chambers, constructed under the footway in front of a local butcher's shop. The butcher, Mr. Scarlett, has instructed his solicitor, Mr. Christmas, failing a satisfactory offer of compensation from the Vestry, to take legal proceedings.

Hertford.—The Town Council has recently taken counsel's opinion upon the legal position of gas shareholders in regard to their votes on the electric lighting question. A full account appears in the *Herts Guardian* of the 9th inst. At a special meeting of the Council, held on Tuesday, a resolution was passed that the requisite plans and specifications for the electric lighting of Hertford, prepared by Mr. J. A. McMuilen, be laid before the Brush Company, in order that that Company may tender for carrying out the same with a view to working the installation for a definite period, upon terms to be agreed upon between the Corporation and the Company.

The International Electrical Congress, 1893.—The American Institute of Electrical Engineers have just published a full report of the International Electrical Congress of 1893, copies of which can be obtained of "The Electrician" Printing and Publishing Company, Salisbury-court, Fleet-street, London, England, at the published price of 12s. 6d., or 13s. post free. Orders must be sent early, as a limited number of copies only can be supplied. The book consists of nearly 500 large octavo pages, contains a frontispiece portrait of the official delegates, a list of the members of the Congress, and a complete record of Papers read, and discussions thereon. The history of the Congress is given, written by Mr. T. Commerford Martin; and the stirring address of Dr. Elisha Gray, and the responses thereto by Von Helmholtz, Mr. Preece, Prof. Elihu Thomson, and Prof. Ayrton are included.

Kensington, London.—A resolution was passed at the last meeting of the Vestry, giving consent to the application of the Notting Hill Electric Lighting Company for a Board of Trade Order for the supply of electricity in that portion of the parish of St. Mary Abbotts, Kensington, situate north of the area comprised within the Company's principal Order of 1889.

Lectures.—The concluding lecture at the Royal Institution by Prof. Fleming, on "The Work of an Electric Current," proved even more interesting than the previous lectures. A crowded audience was the result.

Liverpool.—In accordance with arrangements referred to in our last issue, Mr. Harcourt Clare, deputy town clerk, has prepared a report on the general position of the Corporation with regard to the proposed purchase of the Liverpool Electric Supply Company's undertaking. From this report it would appear that the Corporation first took up the question of supplying electricity in 1878, and in 1879 obtained an Act authorising them to carry out certain experiments in public electric lighting, the period being for five years. This Act was not carried into effect, and the powers expired in 1884. When the Act of 1888 was passed, no application was made by the Corporation for powers thereunder, and in that year the Liverpool Company obtained, with the consent of the Corporation, a licence to supply electricity within a limited portion of the city area for a period of six years. In the following year, 1889, with the consent of the Corporation, the Company obtained a Provisional Order, one of the conditions being that the Corporation should have power to purchase at the end of 21 years. In 1890 the Company gave notice of their intention to apply for a further Order for the supply of electric current over an extended area, and to this the Corporation's consent was given. In 1891 the Company proposed to apply for a supplemental Order, fixing the period for compulsory purchase by the Corporation at 42 years, and for powers to extend the purchase clauses of the Orders already received to the same date, in order to place the whole of their undertaking under similar conditions. Although at first the Corporation's sanction was refused, ultimately, after negotiations with the Company, it was granted on condition that the Corporation reserved the power of purchasing the whole of the Company's undertaking in the city as a going concern on June 30, 1898, by giving not less than 12 months', nor more than 18 months', notice. The Corporation's proposal to extend the city boundaries, however, somewhat complicates their position with regard to the Company, as if the boundaries are extended, and no alteration is made in the Company's Order, the Corporation will only be able to purchase in 1898 the portion of the Company's undertaking within the existing city, leaving the remainder in the hands of the Company, and compensation for severance would then have to be paid. Negotiations had, therefore, been entered into with the Company, and it has been agreed that if the Company will consent to the Corporation having power to purchase the whole of their undertaking the Corporation would on their part consent to the period for compulsory purchase being extended by two years; that is, the Corporation will reserve power to give 12 months' notice in 1899 to purchase the whole undertaking in 1900. The Special Lighting Committee appointed to consider the whole subject has recommended the Council to authorise an agreement with the Company under which the purchase of their undertaking may take place some time during the year 1895, on a valuation similar to that which would arise at the purchase under the Order in 1900. As stated in the Notes, the suggestion has been adopted by the Council. After this decision had been come to it was further agreed to authorise the special Lighting Committee to take the necessary steps for preparing a scheme for lighting the principal public buildings of the city. About £4,000 a year is at present paid for gas lighting, and it is proposed to take expert's opinion as to the cost of substituting the electric light. Estimates are to be obtained from the Liverpool Electric Supply Company (Limited).

Liverpool is blest with an Exchange News Rooms Company, and the National Telephone Company, some two years ago, rented a room from the Company, and fixed therein six local telephones, two trunks with Manchester, and one with London. About 100,000 messages per annum are sent over these lines; but owing to the heavy rental demanded for the room (£150 per annum) the National Company find their instruments do not pay, and, it is said, are about to remove them. This is causing considerable agitation among merchants, shippers, brokers, and others using the news rooms, who pay three guineas per annum as subscription, and think they are entitled to every modern convenience in return for so large a subscription.

Llanelly.—The surveyor to the Local Board has presented his report upon the probable cost of supplying electric light to the market in place of gas. Unless some of the leading tradesmen of the town agree to take current the scheme is voted impracticable. The price of gas in the district is 4s. 2d. per 1,000, and the cost of lighting the principal streets of the town, the Town Hall, the Market Hall, and Athenæum by gas is about £557 per annum.

Maidstone.—A motion recommending that the Urban District Council should invite tenders for the purchase of their electric lighting order, which was to have been discussed at their last meeting, was postponed.

Morecambe.—A letter has been received by the District Council from the Directors of the Morecambe Electric Light Company notifying their intention of removing the electric light works from their present position to a site remote from the residential portion of the town; this removal will be effected as quickly as possible. It will be remembered that complaints have been made against the electric light works, and as there appears to be some difficulty in satisfying the demands of the complainants, it has been decided to remove the works from their present position.

Newcastle.—The City Lighting Committee are taking expert advice in regard to the proposed purchase of the undertakings of the two local electric light companies and the adoption of a comprehensive scheme for lighting the whole of the Newcastle district by electricity under the control of the Corporation.

Personal.—Mr. W. J. Furse, electrical engineer, of 17, Burton-street, Nottingham, has been elected chairman of the West Bridgford District Council, an appointment which places Mr. Furse on the bench of magistrates for his native county.

Portsmouth. One hundred electricity meters have been ordered by the Electric Lighting Committee of the Corporation, and £3,056, part of a total sum of £20,000 already sanctioned for electric lighting extensions, is to be spent in supplying Arundel-street, Marmion-road, Castle-road, Lake-road, St. Mary's road, and the Infectious Diseases Hospital with the electric light. Mr. Alderman Ellis, in presenting the Committee's report, said he had no hesitation in declaring that, from a commercial point of view, they had done better with their electric light undertaking than any other town in England.

Rangoon.—The Public Works Sub-Committee of the Rangoon Municipality has decided to recommend the general committee to call for tenders for lighting the town by electricity.

Skating by the Electric Light.—At Cambridge Mr. Bartholomew has again flooded his land in view of the favourable prospects for skating. Considerable improvements are introduced, a building having been erected for the use of ladies. This also will be lighted by the electric light. When completed about 300 lamps will be in use, those on the trees being of various colours. Messrs. Russell and Co. have supplied the plant, which is working satisfactorily. The previous efforts by Mr. Bartholomew in the same direction have met with a full measure of support.

Taunton.—The Electric Light Committee of the Corporation reported to the last meeting that the Local Government Board had sanctioned the borrowing of £5,000 for electric lighting purposes, to be repaid in 25 years.

Walsall.—At their meeting on Monday next the Town Council will consider the acceptance of a tender from Messrs. Thomas Parker (Limited), of Wolverhampton, for supplying the generating plant (except mains) for the electric lighting station, for the sum of £5,061, and a tender from the Callender Company for supplying and laying down the electric mains for the sum of £4,000.

Wells (Somerset).—At the monthly meeting of the Town Council, just held, a letter was read from the agent of Mr. Brown, electrical engineer, stating that the Board of Trade, while not declining to grant a licence for electric lighting, were prepared to grant a Provisional Order if applied for. The further discussion of the subject was deferred.

Worcester.—As mentioned in our last issue, a meeting of the City Council, held to consider the question of the appointment of an engineer to manage the electric lighting station at Powick, decided to refer the Lighting Committee's recommendation back for reconsideration. Upon this the Committee resigned, but the Council refused to accept the resignation. A special meeting was held on Monday to further consider the matter. At this meeting the proposal made by Mr. Williamson, Chairman of the Committee, that Mr. Ruthven Murray should be appointed engineer was agreed to.

Yarmouth.—The report of the Electric Lighting Committee has been adopted by the Town Council, and includes a scheme which has been for some time deferred for lighting by electricity the St. Andrew's Ward, at a cost of £11,000.

York.—The Streets and Buildings Committee of the City Council have deferred to their next meeting any recommendation upon the tenders received for the electric lighting of the City from Messrs. Siemens Brothers and Co., the Brush Company, the Electric Construction Company, and Messrs. C. A. Parsons and Co.

BOOKS RECEIVED.

"Forty-three Graphic Tables or Diagrams for the Conversion of Measurements in Different Units." By R. H. Smith. Price 7s. 6d. (London: C. Griffin and Co.)

"The Franco-German War, 1870-71." Translated from the German of J. Scheibert, by Major and Mrs. J. A. Ferrier. (Chatham: Royal Engineers' Institute. 1891.)

"Electrical Engineering as a Profession: How to Enter it; and Guide to the Engineering Profession." By A. D. Southam. Price 3s. 6d. (London: Southam and Co. 1895.)

"Annuaire pour l'An 1895." Price 1s. 3d. (Paris: Gauthier-Villars et Fils.)

"Traité Théorique et Pratique des Moteurs à Gaz." By A. Witz. Vol. II. (Paris: E. Bernard and Co. 1895.)

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

December 24, 1894.

25,031. G. Hookham. London. Improvements in electricity meters.

25,066. L. B. Atkinson. London. Improvements in electro-magnetic devices for varying the self-induction of any electric apparatus also applicable to dynamos and motors.

25,074. R. O. Lorenz. London. Process and apparatus for the production of zinc and lead by electrolysis of the melted chlorides.

25,076. A. J. Boult. London. Improvements in or relating to telegraphic transmitters and recording apparatus therefor. (C. Spiro, United States).*

25,079. A. J. Boult. London. Improvements in or relating to telegraphic transmitters and recording apparatus therefor. (C. Spiro, United States.)*

25,080. T. T. Oliver. London. Improvements in or relating to the separation of metals by electric action.*

25,082. A. J. Boult. London. Improvements in or relating to electrical fire and burglar alarms. (S. Spiegel, M. Taussig, and I. Wolf.)*

December 27. 1894.

25,132. J. C. Dagoneau. London. A method of and means for economically producing electricity.

25,142. H. Bremer. London. Improvements in the means for fixing electric conductors to walls and other supports.

25.145. J. C. Mewburn. London. Improvements in the production of copper by electrolysis and in apparatus employed therein. (La Société L'Electrolyse, France.)

December 28, 1894.

25.197. G. Platner. London. Improvements relating to the charging materials for primary and secondary galvanic elements.

25,125. H. C. Baker and H. Stone. Kansas City, U.S.A. Improvements in electrically-propelled vehicles.*

25.221. L. B. Atkinson. London. Improvements in dynamo-electric generators and motors.

25,231. R. Dunbar Radcliffe and C. L. Phillips. London. Incandescent electric lamp gauge.

December 29, 1894.

25.263. R. Rogg. London. An improved arrangement of electric call bell and alarm.

25,264. J. Baxeres Torres. London. Improvements in electric or galvanic batteries.

25,285. G. F. Kenyon and W. Reynolds. London. Improvements in the production of electrical illuminative effects, especially applicable for exhibition upon the human body, and also for illuminative stage and scenic effects in theatres and the like.

25,289. V. Ludvigsen. London. An improved primary battery.*

December 31, 1894.

25.312. W. Hewitt and A. Casey. London. An improvement in the construction of electric arc lamps.

25,840. J. Leith and The Electric-Chemical Company (Limited). London. An improved system of conductors for electrical decomposing tanks.

25,344. W. C. Johnson and L. J. Steele. London. Improvements in safety devices for electrical circuits.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1893.

23.669. Schoor. Electrolytic vessels for primary and secondary batteries, &c.

23.687. Delany. Telegraphy.

23.883. Aron. Switches or relays for alternating currents.

24.951. Nalder and Others. Electrical measuring instruments, &c.

1894.

46. Sykes and Evans. Electrically controlling single lines of railway.

546. Muirhead and Green. Electric telephony and telegraphy.

1,605. Tee. Incandescent lamps and burners.

2,548. Kerson. Electric contact makers.

2.623. Mordey. Regulating and controlling dynamos.

2,733. Mountain and Carew. Electric arc lamps.

2,965. Geissenheimer and Lessing. Incandescent electric lampholders.

4.235. Ewart. Electric lamp fitting for pianofortes.

11.280. Gliell. Joining electric conductors.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1894, pages 274-300, *&c. &c.*]

COMPAGNIE GENERALE DES LAMPES A INCANDESCENCE. Under this title a company has been formed in Paris, with a capital of 800,000fr., to take over the undertaking of the Compagnie Générale des Lampes Incandescentes, which is in liquidation owing to effluxion of time.

MAGIC BOX (LIMITED).—This Company was registered on January 3rd with a capital of £5,000 divided into 2,500 Preferred and 2,500 Deferred shares of £1 each, to carry on the business of machine and other manufacturers, electricians, mechanical and electrical engineers, and manufacturers of and dealers in electrical apparatus.

E. K. WILSON AND SONS (LIMITED).—This Company was registered on January 4th with a capital of £12,000 in £10 shares, to carry on the business of an ironmonger, and mechanical, electrical and general engineer, carried on by Edward K. Wilson at South Kensington and Chelsea.

LAMINA ACCUMULATOR SYNDICATE (ELIESON'S BRITISH PATENT) (LIMITED).—The annual return of this Company, made up to and filed on January 3rd, shows that 10,007 shares have been taken up out of a capital of £12,000 in £1 shares. Of these 6,250 have been issued as fully paid, and a call of 15s. per share has been made on the remaining 3,757 shares, resulting in the payment of £2,737. 10s., and leaving £80. 5s. in arrears.

LAURENCE, SCOTT AND COMPANY (LIMITED).—The annual return of this Company, made up to November 2nd, has been filed. The nominal capital is £30,000 in £10 shares, and 1,406 shares have been taken up and allotted. Of these 500 have been issued as fully paid, and the full amount has been called and paid on the remaining 906 shares.

CITY NOTES.

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ended January 6th were £1,004, as against £990 in the corresponding period of 1894, being an increase of £14.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of December, 1894, amounted to £55,598, against £55,579 in the corresponding period of 1893.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The interest on this Company's Four per Cent. Mortgage Debenture Stock for the half-year ending January 31st inst. will be paid by warrant on February 1st next. The Stock Register will be closed from the 28th to the 31st inst., both days inclusive. The traffic receipts of this Company for the month of December, 1894, amounted to £39,783, and to £36,906 in the corresponding period of 1893.

THE ELECTROPHONE (LIMITED).—This is the title of a Company just established to take over and develop the business of the Electrophone Syndicate, which has entered into "an exclusive and reciprocal agreement" with the National Telephone Company (Limited) to "supply installations for private houses and secure premises for the electrophone at places of public resort." The electrophone is described as an instrument which "transmits performances direct from theatres, churches, courts of justice, and it is shortly *expected*" (so says the prospectus, the italics being ours) "to add the transmission of Parliamentary debates, to subscribers, and depôts, which latter are places where the public can "have hearings." The arrangement with the National Telephone Company gives the Electrophone (Limited) the advantages of the National Company's system at the reduced rates for private residences. The grounds upon which these sanguine *expectations* are based are not given in the prospectus, and it would be specially interesting to learn the progress made up to the present with the Royal Courts of Justice installation, as also of that in connection with the Parliamentary debates, and with the Post Office for transmission of the opera from Paris. The capital of the new Company is £20,000, in £5 shares, and a rough and ready estimate of the probable receipts shows a net estimated profit of £5,700, "sufficient to pay 25 per cent. on the entire capital of the Company, and to allow a balance for a reserve fund, without reckoning this Company's percentage on installations and telephone subscriptions." The prospectus must be referred to for other matters of interest to subscribers, and which they should carefully consider before subscribing.

GILBERT GILKES AND CO. (LIMITED).—Mr. Gilbert Gilkes writes: "In order to give my colleagues, Mr. D. J. Pennington and Mr. N. F. Wilson, who have helped me in the conduct of this business for many years, an opportunity of connecting themselves more directly with it, I have formed a small private limited company, and we shall henceforth carry on these works, and our engineering business, under the style of Gilbert Gilkes and Co. (Limited). I shall retain the position of Governing Director, and my friends will each take the office of Director."

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company for the month of December, 1894, amounted to £21,800, and from January 1st to December 31st, 1894, £285,800. In the corresponding months of 1892 and 1893 the amounts were £266,400 and £269,200 respectively.

JOINT STOCK ENTERPRISE IN 1894.—From figures published in the *Investors' Guardian* it would appear that during 1894 limited liability companies dealing with electrical and kindred subjects were formed, with a nominal value of £2,387,107, against £2,045,000 in 1893, £1,596,825 in 1892. This is in addition to the establishment of telephone enterprise with a capital of £236,000, as against £31,000 in 1893 and £260,000 in 1892. The statistics given relating to Scotland and Ireland make no mention of electrical companies being established during 1894 in either country.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 6th inst. amounted to £926. Corresponding week last year, £688.

SALISBURY ELECTRIC LIGHT SUPPLY COMPANY (LIMITED).—The prospectus is issued of this Company, which is formed with a capital of £20,000 in £1 shares and £10,000 debenture capital. The estimated cost of the works and machinery required for the complete supply of the district with the electric current is £1,000, which includes the cost of land and premises, and a further £1,000 for the erection of a central station building. The Directors announce that subscriptions have already been promised for over 4,000 of the shares, and the balance is offered to the local public.

SMOKE AND FUMES ANNIHILATOR (LIMITED).—This is the portentous title of a company just formed to acquire the "British patents of Elliott's Patent Smoke and Fumes Annihilator, together with the trade marks and goodwill of the vendor relating to the sale of the disinfectant produced therefrom." The process is described as of an ingenious, simple character, and the apparatus as strong and simple in construction and working. Some four years since a small machine built under these patents was exhibited in London, and since this time it has been commercially developed, the recovery of the residuals worked out, and severe practical tests applied. It is now stated to be in constant work at the Mint, Birmingham, where it is connected to the largest chimney, and is stated to be working satisfactorily. The capital of the Company is £120,000 in £5 shares. The inventor, Mr. Samuel Elliott, of Newbury, Berks., is the vendor to the Company, and there are, it is stated, no intermediate profits. Mr. Elliott joins the Board of Directors after allotment.

STOCK EXCHANGE NOTICES.—Application has been made to the Committee to appoint a special settling day in, and grant a quotation to, provisional scrip certificates of a further issue of £200,000 Five per Cent. Debenture Stock of the City of London Electric Lighting Company (Limited).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended January 4th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,253.

WESTERN UNION TELEGRAPH COMPANY.—The following is the report of this Company for the quarter ended December 31, 1894:—The following statement exhibits the condition of the Company at the close of the quarter ended September 30, 1894:—

Surplus July 1, 1894, as per last quarterly report		$7,007,633. 54
Net revenues, quarter ended September 30, 1894		1,813,563. 60
		$8,821,197. 14
From which, deducting for dividend of 1¼ per cent. paid October 15th	$1,191,922. 50	
Interest on bonded debt	222,806. 50	
Sinking funds	20,000. 00	
		$1,434,729. 00
Left a surplus October 1, 1894, of		7,386,468. 14
During the quarter the telegraph lines and property of the American Rapid Telegraph Company, with 5,500 shares ($550,000. 00 par value) of capital were purchased stock, issued out of the increased stock that was authorised by the stockholders on October 12, 1892.		
The net revenues of the quarter ended December 31st instant, based upon nearly completed returns for October, partial returns for November, and estimating the business for December, will be about		1,600,000. 00
		$8,986,468. 14
From which, appropriating for—		
Interest on bonds	$222,800. 00	
Sinking funds	20,000. 00	
		242,800. 00
		$8,743,668. 14
It requires for a dividend of 1¼ per cent. on the capital stock issued about		1,192,000. 00
Deducting which leaves a surplus, after paying dividend, of		$7,551,668. 14

In view of the preceding statements, the Committee recommend the payment of a dividend of 1¼ per cent. on the capital stock of the Company on 15th January. The dividend may be collected through any bank on or after the 15th inst.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company, for the half month ended December 31, 1894, were £1,928 as compared with £2,570, in the corresponding period of 1893.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Jan. 2.		Price Wednesday, Jan. 9.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 9.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£1,012,880	Stock	9/0	Anglo-American	38	39	39½	40½	4 18 9	Jan., Apr, July, Oct.	39½	..
£2,993,560	Stock	18/0	Do. Preferred	71½	72½	73½	74½	5 7 5	,, ,,	74½	72
£2,993,560	Stock	6/0	Do. Deferred	6¼	6¾	6½	7	..	..	6½	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer) xd	100	103	101	104	3 16 11	January and July	..	..
130,000	£10	3/0	Brazilian Submarine xd	10¼	10¾	10¾	11¼	5 15 7	Mar., June, Oct., Dec.	11	10½
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906) xd	109	113	109	113	4 8 6	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock xd	140	150	140	150	4 13 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12½	13½	12½	13½	5 18 6	February and August	13½	..
6,000	10	10%	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	,, ,,	..	..
12,931	5	1/8	Direct Spanish (fully paid)	4¼	4¾	4	4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¼	9¾	9½	10	5 0 0	,, ,,	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each xd	105%	108%	103%	105%	4 5 9	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8¼	8¾	8½	9	5 0 0	Jan., Apr., July, Oct.	8¾	8¾
400,000	10	2/6	Eastern	16	16¼	16⅛	16⅜	3 19 6	,, ,,	16 5/16	16⅛
70,000	10	6%	Do. 6 per Cent. Preference	16¾	17¼	17	17½	3 8 7	,, ,,	17 5/16	17¼
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	120	123	121	124	3 4 6	May and November	122½	121¾
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	110	106	110	4 13 0	February & August	..	..
250,000	10	2/6	Eastern Extension	16⅛	16⅜	16¼	16½	4 4 0	Jan., Apr., July, Oct.	16½	16 3/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	119	123	121	124	3 4 0	February & August	..	..
£62,700	100	5%	* Do. 6 p. c. (Austln. Gov. Sub.) Debs. 1900 xd	101	105	102	106	4 14 4	January and July ..	104¾	102½
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900 xd	101	105	102	106	4 14 4	,, ,,	104	—
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.) ..	105	108	105	109	3 14 9	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	109%	112%	111%	114%	3 10 6	May and November	111¾	..
180,227	10	1/3	Globe Telegraph and Trust	8¾	9	8⅞	9⅛	4 18 8	Jan., Apr., July, Oct.	9⅛	8⅞
180,042	10	6%	Do. 6 per Cent. Preference	16	16¼	16¼	16½	3 12 9	,, ,,	16⅜	16⅛
150,000	10	5/0	Great Northern xd	21½	22	21¾	22¼	3 17 2	Jan., April, and July	21¾	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	..	—
17,000	25	12/6	Indo-European	47	49	48	50	5 0 0	May and November	48¾	48½
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	102	106	102	106	5 15 5	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942 xd	103	106	104	107	3 14 9	..	..	—
11,839	8	4/0	Reuter's	2	4	2	4	..	April and October	..	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	110	115	110	115	6 4 4	,, ,,	..	..
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	101	104	4 18 0	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902 xd	96	101	96	101	7 18 5	June and December	..	..
88,321	10	6d.	West India and Panama	1	1¼	1	1¼	..	..	1¼	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	6 6 8	May and November	11⅛	10¾
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.) .. xd	107	110	107	110	4 10 11	June and December	..	..
64,242	15	3/0	Western and Brazilian	11¼	11¾	11	11½	4 7 6	May and November	11½	11¾
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	..	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	4¾	5¼	4¾	5¼	..	..	5⅛	4 15/16
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 17 1	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 17 1	,, ,,	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	112	118	115	120	5 17 8	May and November	118	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 17 8	March & September	102½	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	—	..	..	..
224,850	10/0	2⅞d.	Consolidated Telephone Const. & Maintenance ..	1/16	3/16	1/16	3/16	..	May and November	..	—
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	¼	⅜	¼	⅜	..	Yearly	—	..
484,597	5	3/4	National	5⅛	6⅜	5¼	6½	4 10 11	June and December	5 7/16	5¼
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 15 0	,, ,,	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	,, ,,	15¾	..
119,234	5	3/4	Do. 6% Non-Cumulative 3rd Pref.	5¾	6	5⅞	6⅛	4 1 8	—	6 1/16	6
1,000,000	Stock	4½%	* Do. Debenture Stock, 4½% (red.)	..		..		4 1 3	January and July	103¼	103¼
68,000	5	1/0	United River Plate	1	2	1	2	..	,, ,,	..	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.) .. xd	86	91	86	91	5 9 11	,, ,,	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	14	15	14	15	..	—	..	..
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15	16½	15	15½	3 18 8	..	15½	15½
£100,000	Stock	5%	Do. 5% Debenture Stock (red.) xd	130	133	130	133	3 15 2	June and December	131½	130
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	4½	5½	4½	5½	3 12 9	—	..	..
£57,400	£100	6%	Do. 6 per Cent. Debentures, 1900	..		..		..	—	..	..
8,322	£5	..	House-to-House Electric	..		..		..	..	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		—	—	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		—	January and July	..	—
45,000	£5	2/6	Liverpool Electric Supply (fully paid)	7 5/16	7 7/16	7 5/16	7 7/16	—	—	..	—
111,000	5	..	London Electric Supply	½	¾	½	¾	—	..	..	—
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	10	10½	9¾	10¼	2 8 9	..	10 7/16	10
£150,000	Stock	4½%	* Do. 4½% Debs. (Bonds of £10, £20, and £40) xd	115	118	116	119	3 15 8	June and December	..	..
6,452	£10	..	Notting Hill Electric	7¼	7¾	7¼	7¾	—	..	..	..
19,980	£5	2/0	St. James and Pall Mall	7¾	8¼	7¾	8¼	..	..	..	..
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8¾	9¼	3 15 8	..	..	..
59,900	5	2/0	Westminster Electric Supply (fully paid)	7¼	7¾	7¼	7¾	2 18 1	..	7⅝	7½
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	8	1/6	Brush Electrical Engineering	2½	2¾	2⅝	2⅞	5 5 3	..	2¾	2 11/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2¼	2½	4 10 0	..	2⅝	2⅝
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	111	114	111	114	19 10	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	3	3½	3	3½	—	January and July	..	..
12,139	5	..	Edison and Swan United	—		—		—	..	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		..	—	—	..
120,000	2	..	Electric Construction	½	¾	½	¾	—	—	..	..
12,845	2	2/0	Do. 7 per Cent. Cumulative Pref.	1½	2	1½	2	..	—	—	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1¼	1½	1¼	1½	..	—	1⅜	1 5/16
20,000	5	..	Fowler-Waring Cables (fully paid)	¾	1¼	¾	1¼	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	25½	26½	25½	26½	4 14 4	February & August	26⅜	26
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1800	102	104	102	104	4 7 7	March & September	..	—
15,995	£10	0/4	International Okonite Ordinary	..		..		—	—	..	—
16,000	£10	..	Do. 8 per Cent. Preference	—		—		—	December and June	..	—
20,000	9	..	Manchester Edison Swan "A" (£1 5s. paid)	—	¼	—	¼	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	41	43	41	43	5 11 6	March and July	42¾	41½
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 13 6	January and July	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	—		—		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		—		..	—	..	..
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	8½	9½	8½	9½	5 5 8	..	..	..
£30,000	10	..	Do. Preference	—	12	..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1%	City and South London Railway	43	45	43	45	2 4 5	May and November	44	44
7,000	10	5%	Do. 5% Perpetual Preference	13½	14½	13½	14½	3 10 2	..	14	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	124	126	125	127	3 3 0	May and November	..	..
37,500	£10	1%	Liverpool Overhead Railway	8¾	9	8¾	9	1 2 3	..	—	..
0,295	10	6%	Do. 5% Preference	13	13½	13	13½	3 15 6	..	—	—
125,000	Stock	4%	Do. 4% Debenture	110	112	110	112	3 11 5	January and July	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

THE ELECTRICIAN:

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NOTES.

The series of Cantor lectures on "The Electric Arc," which are being delivered by Prof. S. P. Thompson before the Society of Arts, would lose much of their interest if merely reported and printed without diagrams and other illustrations, and we, therefore, await their publication in the *Journal* of the Society before presenting an abstract of them to our readers. The first lecture dealt with the history and with the physics of the arc. The origin of the arc, in the form of "a bright spark visible in daylight," was traced back to a considerably earlier date than the one usually given. After showing arcs between different metals and arcs under water and oil, and arcs with 1,000 volts, both continuous and alternating, Prof. Thompson drew attention to the numerous formulæ which have been proposed to represent the relations of current, volts, and resistance in the continuous current arc. The theory of the back electromotive force in the arc has often been disputed, but it was treated by the lecturer as an established fact. Many of the various branches of the physics of the arc were described, and the results of different investigators were shown in the form of curves.

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When the Chicago nigger had succeeded in lighting his master's fire with Prof. Ayrton's Paper on the electric arc, he cast aside the curves for another day, and, happily, they got well lost, and so were saved, and specimens of them will be found elsewhere in the present issue. Mrs. Ayrton's comments on them are much too brief; but when her own researches are published, the remarkable points which are now expressed only by the curves will no doubt be more fully explained. One of the features of the investigation is the time required for the arc to become normal, particularly with small currents. Many of the singular phenomena which are present in the normal arc do not get to work for some time after the arc is struck. This was, indeed, well exemplified by Prof. Thompson at the Society of Arts on Monday, but unintentionally. An arc had been arranged for projection, and had been allowed, before the lecture, to arrive at a normal state; it was then extinguished, but when it was struck, during the lecture, it misbehaved, and though coaxed and worried by the lecturer it declined to hiss, and went through none of its performances but the propagation of mushrooms. It was lighted again at the close of the lecture, and allowed to take care of itself; and before the last of the audience had left it was burning admirably. The early stages which are passed through by an arc a few minutes after it has been struck have never been intentionally investigated, so far as we are aware; but they necessitated the rejection of a large number of experiments by Prof. Ayrton and his students. Curious looped curves were obtained instead of the single lines which we publish to-day; and, though these loops no doubt have their significance, they have little or nothing to do with these particular experiments.

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The use of cored carbons is necessary if the experiments on arcs are to have any bearing on the practical use of arc lamps, but they introduce additional complications into an already intricate matter. It would seem advisable to study the behaviour of solid carbons first, even if the resulting arc be somewhat troublesome, for the cores of different makers vary more than the carbons themselves, and their action has not yet been clearly explained. The two-fold alternatives of pressures and current, if we may use such an expression, have been clearly explained in this Paper. One of these alternatives exists with short arcs, through which a certain current may be forced by one of two different pressures; but these approach gradually together, as is seen in Fig. 5, and there is no discontinuity or instability. The other alternative phenomenon is better known, but we have never seen it so clearly expressed. When an arc is shortened nearly to hissing point there may be one of two currents through it, the normal, or a larger one. With the larger one hissing takes place, and the volts fall; but under no circumstances can any intermediate current be established, there is complete discontinuity and instability. Prof. Thompson referred to the hissing arc as a boiling of the carbon; but whether this is the cause, or whether it is only an effect of a change of electrical conditions, this sudden drop of pressure may have some resemblance to the "bumping" of certain liquids when boiled in smooth flasks.

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The three distinct noises heard in the arc are alluded to at the close of the first portion of Mrs. Ayrton's article, which we print this week, and their careful description indicates the thoroughness of this research. Little attention has been paid by those who have studied the physics of the arc to these noises. They undoubtedly point to some phenomena which have not hitherto been explained; and it will be found that in order to separate and study them, the arc must be maintained by very delicate regulation at some constant condition. An ordinary mechanical feed is quite out of the question, and hand-regulation with an extremely fine adjustment is necessary.

In the important educational discussion which has been started by the recent Paper of Prof. Ayrton and Mr. Haycraft at the Physical Society, the controversialists have ranged themselves into two parties; and, since parties must be dubbed with names, we venture to call them the educationalists and the technologists. The educationalists are so numerous that we should have no difficulty in filling our correspondence columns for several weeks with letters from all educational centres, from Cambridge downwards; but it is difficult to find anyone who will thoroughly and unreservedly support Prof. Ayrton. We have naturally turned to Prof. Perry, and our readers will find that he is ready to fight shoulder to shoulder with his old colleague against the world. To appreciate their point of view, the educational value of science must be put on one side, and attention mainly directed to the market value of the instruction. We have long objected to the phrase "technical education," and prefer to call it "technical instruction." Instruction it is, and useful instruction; equipping the student for practical work, and enabling him to afterwards become an engineer, if he goes through a proper apprenticeship afterwards. Whether the instruction is devoid of proper foundation is not altogether to the point. Prof. Perry is justified, from a technological point of view, in imparting a knowledge of the result of Euclid I. 47 by experiment, whatever he may mean by the "truth" of the proposition, and if educationalists are scandalised, let them carefully consider his point of view, which is logical. But it is not always a compliment to say that a point of view is logical.

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The first number of the journal of the *Proceedings* of the Physical Society of London in its new form—that is to say, with the appendix of "Abstracts of Physical Papers from Foreign Sources"—will be welcomed by all students of physics into whose hands it falls. A list of twenty-five abstractors, in which many well-known names appear, is given on the cover, and their work, under the editorship of Mr. J. Swinburne, will be widely appreciated. Abstracting is no easy task; but the mere abstracts give no idea of the labour of searching for suitable Papers. This first set contains many very interesting subjects. We are glad to see that the journal is published and is for sale to non-members.

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Developments of municipal electrical enterprise are becoming almost of daily occurrence. About a fortnight ago we reprinted a paragraph from the *Manchester Guardian* announcing that the promoters of the Epping Forest Railway had deposited a Bill which amongst other things authorised the London County Council and the City Corporation to enter into contracts for the construction, management and maintenance of the line, to contribute funds and to hold shares. The clause as thus summarised is surely the *ultima thule* of socialistic county councildom, since under it there is obviously no room for the company promoter, and but little for the contractor. However, as we suspected, this is not a self denying ordinance on the part of the promoters. Their *intention* is merely to secure the financial support of the County Council and the eight other local authorities interested in the construction of the line; a support which we understand will be willingly given, though we presume upon conditions. What these terms may be is of no immediate interest to the electrical industry; its only concern is to hasten the construction of this and other similar railways. At the same time it would seem as if there must be something rotten in a policy which results in the necessity for a piteous appeal for municipal subsidies in the case of a line with such a splendidly remunerative trace as the one in question.

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Two other characteristic outbreaks of the municipalisation fever are the decision last week of the Liverpool City Council to purchase forthwith the flourishing business of the Liverpool Electric Supply Company as a going concern, and the decision this week of the Bath City Council to make immediate application for an Electric Lighting Provisional Order. The Liverpool Company, we are glad to think, is in a position to meet its enemy in the gate with considerable equanimity, and the action of the City Council is only instructive as an instance of the overpoweringly attractive force which the electric lighting business exerts on the municipalities of to-day. The Bath episode is yet another object lesson, if such were needed, of the curious inability of local authorities to deal fairly by electric lighting companies unless obliged to do so by *force majeure*. The electric lighting of Bath has been undertaken largely by local capitalists, and, although conspicuous neither as an engineering nor as a financial success, it has proved a magnificent advertisement for Bath. Everything connected with it, one would have therefore thought, entitled the Company to generous treatment when it desired to consolidate its position by a Provisional Order. The argument that "it did not become an Authority to be the servant of a Company," and the marauder suggestion that it would be a good thing to get "the whip hand" of the Company, caused the councillors, however, to forget that it does not become a public body to be grasping, and resulted in an unanimous vote in favour of immediate application for an Order. We have no doubt that the Board of Trade will see to it that justice is meted out to this plucky pioneer Company.

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Considering that there is often such a great diversity in the tenders for an engineering job, the top one often being twice the price of the bottom one, there is little ground for complaint if, when a single contractor is asked to tender, his tender is somewhat less or more than the estimate of the consulting engineer. The Southampton Harbour Board does not appear to think that this is so. It evinced no little surprise when, after its consulting engineer had estimated the cost at £335, the tender of Messrs. Crompton and Co. (Limited) for erecting electric light plant on the Town Quay was no less than £399. 18s. The consulting engineer had missed the contractor's price by as much as (only) about 16 per cent! When we forget that contractors often, as we said before, miss one another's prices by over 100 per cent., this seems a good deal; but, otherwise, we think it a very fair hit. It is quite possible that both the estimate and the tender were skilful and reasonable; and we confess we cannot understand why the Board should have made the disparity a ground for rejecting the tender.

There is a touch of humour in the course which the Board decided upon taking. Mr. Aldridge, their consulting engineer, having estimated that the work could be done for £335, and the contractors having failed to tender to so low a price, the Board decided to do the job themselves at Mr. Aldridge's price—if they can. We should have thought that the ridiculous results of such a course in the case of the London County Council would have been a sufficient warning, but experience is valued by the price paid for it. A consulting engineer ought not to be expected to give the exact price of a job. So far as it consists of supply of goods, he can get prices and discounts by making preliminary and more or less unofficial inquiries; but he cannot be expected to foretell the exact price which will be tendered, unless he knows. Ought he to know? Nor can he be expected to be able to estimate as well or better than a contractor for the amount of labour required for any works.

Exhibition of Gas and Oil Motors.—An exhibition of gas and oil motors will be held in Paris in the summer of this year, under the auspices of the Société Technique, 65, Rue Provence, Paris.

Electric Working of Warship Turrets.—The new second-class ironclad cruiser for the French navy, the "Latouche-Tréville," is fitted so that all the operations of the guns and the working of the turrets are performed electrically.

Magnetic Fatigue.—We have received a communication from Mr. Albert Campbell on the subject of the alleged magnetic fatigue, or the time change in hysteresis in iron under load. We are unable to find room for this article this week, but we hope to publish it very shortly.

Royal Society.—The following Papers were down for reading yesterday:—Sir John Evans, K.C.B., Treas. R.S., "On the Trust Funds of the Royal Society." E. H. Griffiths, "The Latent Heat of Evaporation." W. M. Mordey, "On Slow Changes in the Magnetic Permeability of Iron."

Street-Boxes.—Having regard to the evidence given at the recent inquiry respecting the Euston-road explosion, the Highways Committee of the London County Council propose that plans for street-boxes should only be approved on the condition that provision is made for their adequate ventilation.

Obituary.—The decease is announced on the 11th instant at Friedrichsdorf, near Homburg, of the widow of Philipp Reis, the inventor of the Reis telephone. For the past twelve years she had enjoyed a small pension from the Imperial German Government in consideration of her husband's scientific work.

Government Telegraph Semi-Jubilee.—The authorities at St. Martin's-le-Grand are making arrangements for celebrating the semi-jubilee of the acquisition of the telegraph system by the Government by a banquet, to be presided over by the Postmaster-General, and to be held about the close of this month.

Northern Society of Electrical Engineers.—At the last meeting of this Society the following gentlemen were elected:—Members: Messrs. J. G. Calvert, S. H. Casson, M. Holroyd-Smith, A. Stahl, P. C. Pope, A. H. Robinson, Wm. Lawrie, G. B. Samuelson, and F. C. Gibbons. Associates: S. Hartford, R. Wood, and A. L. Lind.

Cable Interruptions:—	Date of Interruption.
Latakia-Cyprus	Nov. 27, 1894.
Cadiz-Teneriffe	Dec. 26, 1894.
Hongkong-Macao	Dec. 31, 1894.
Pernambuco-Ceara	Jan. 12, 1895.
Gibraltar-Cadiz	Jan. 14, 1895.
Gibraltar-Tangier	Jan. 14, 1895.

Telephone Communication in Germany.—During the past year or so there has been a most remarkable development in the telephonic system of Germany. At the present time 33 German towns are provided with telephone exchanges, while as regards interurban communication 495 different connections are now available, as against 413 at the end of 1893. The principal new lines are Berlin-Munich, 690 kilometres; Berlin-Cologne, 630 kilometres; Stettin-Stralsund, Berlin-Memel, Berlin-Vienna, Berlin-Bremen and Cologne-Hamburg.

Mechanical Spelling.—"We hope," says the *American Machinist*, of January 3rd, "none of our readers will receive a very serious shock when they note that certain words much used by us and by mechanics generally, are, in this and succeeding numbers, spelled somewhat differently from what we have heretofore spelled them. We can see no use in placing an e in the word hight; we can see no use in an extra m and an e on the end of program; we can see no use in ue on the end of catalog; and, as our new Century Dictionary gives us the authority to adopt the shorter and more sensible spelling of these words, we shall so spell them hereafter."

The Progress of an Idea.—The St. Louis *Chronicle* prints an interview with Dr. Wellington Adams, in which he asserts that "the Chicago and St. Louis Electric Road will most certainly be built, but not until after a revival in business. Already $8,000,000 of the $10,000,000 worth of bonds have been placed," Dr. Adams continues, "and it will not be much trouble to place the remainder. The grading and securing the right of way is going steadily on. The distance between Chicago and St. Louis will be shortened about 35 miles, and the time reduced from 10 and 12 hours to three and four. Fast mails and express will then arrive and depart almost every hour from St. Louis."

An Electrical Letter Box.—An electrical letter box has been invented by a citizen of Chicago. It consists of the ordinary mail box, on the top of which is a device by means of which a signal is sent to the occupant of the building when a letter has been placed in the box. The act of opening the box to insert the letter starts a very simple clock motion and the circuit is closed, or rather the commutator turns with the closing of the box. The commutator revolves continuously in one direction, so that there is nothing to get out of order. It is understood that the post-office authorities favour the device, as it automatically insures the signalling for the delivery of mail, and enables the people to distinguish its ring—three short ones—from the ordinary call. It can be placed in the same circuit with the call bell.

Sir David Salomons.—The Mayor of Tunbridge Wells, Sir David Salomons, celebrated his mayoralty right royally on Saturday evening last by a banquet in the Great Hall at Tunbridge Wells. A special train brought down and took back a party from London. Among the guests were the Lord Mayor of London, the Marquis of Abergavenny, Viscount Cantelupe, Sir George Russell, M.P., Mr. Justice Grantham, Sir Julian Goldsmid, Sir J. Crichton Browne, Mr. Bousfield, Sir Frederick Abel, Prof. Ayrton, and several others interested in electrical science. The Mayor also entertained 600 old people of the Tunbridge Wells district. Great things are expected to accrue to Tunbridge Wells from the public-spirited act of Sir David Salomons in adding the function of Mayor of Tunbridge Wells to his many other duties. Mr. Bousfield, in the course of his speech returning thanks for the "Bar," congratulated Tunbridge Wells on being better off than London, insomuch as its men of standing were ready to come forward and take their proper share of the burden of municipal affairs.

Different Men have Different Opinions.—A new trolley line has been started at Kingston, N.Y. The local *Leader* says: "It was expected that there would be some slight demonstration of popular approval when the car passed through Wall-street, this fact being indicated by the request of a number of Wall-street merchants that they be allowed to place a brass band on board; but nobody for an instant suspected that it would meet with such an ovation as it did. From the starting point on Cedar-street to the end of the line at the corner of Washington and Linderman-avenues, the entire populace all along the line turned out to bid it welcome. There was scarcely a house that was not illuminated from cellar to garret and hundreds of blazing barrels, boxes, and almost anything that would burn, aided in adding brilliancy to the scene, while red fire, torches, Roman candles and other fireworks hissed and sputtered, flashed and glittered."—The Bordeaux Town Council, at its meeting of December 18th, "squarely refused," says *L'Energie Electrique*, to give permission for an electric tramway on the Thomson-Houston overhead-trolley system. In the opinion of the Bordeaux Municipality, the trolley system is quite put out of court, owing to its "*aspect absolument disgracieux.*"

A Strike on a Trolley Line.—Nearly 8,000 men, employed as motormen and conductors of the street cars belonging to the various trolley lines in Brooklyn, went on strike on Monday morning, the men demanding a full ten hours' work a day and an increase in pay. They are now required to be on duty for ten hours, but often lose several hours of this time through being compelled to wait to be appointed to a car. About noon a trolley car, flying the flag denoting that it was carrying mail bags, attempted to leave the Post Office for its destination. The strikers at once attacked it, throwing boards, staves of broken barrels, and other articles at the driver and conductor. The police, who were drawn up in readiness, were ordered to charge the mob, and succeeded in dispersing it. Notice has been issued to the strikers that another interference with the despatch of the mails will result in the calling out of the United States troops, as was done at the time of the strike in Chicago. The threat made by the strikers that they would destroy any street car which attempted to start was carried out on Tuesday afternoon. A crowd numbering 10,000 persons gathering around the sheds, and when the first car was run out it was attacked and wrecked. A troop of mounted police at once charged the mob and kept it at bay long enough to enable one car to start. The strikers are considered to be losing ground.

Carbon Batteries and the Cost of Supply.—Commenting on the production of electrical energy in carbon batteries, our contemporary, the *Electrical World* of New York, says that, "Assuming that the problem were really solved, it does not follow, as often asserted, that a revolution in the electrical industry would result. Supposing that the cost of the apparatus and labour were the same as with the steam and electrical machinery displaced, the saving would merely be in fuel, and this item at present, on the basis of four pounds of coal per horse-power per hour, amounts to less than one cent, with coal at $4.00 per ton, per horse-power per hour of electrical energy delivered, the total cost of which quantity of energy is rarely below 8 cents, and is usually sold for electric lighting at 12 cents. If, therefore, the fuel were supplied under these conditions for nothing, and used at an efficiency of 100 per cent., the reduction on the cost of electrical energy to the consumer would not be 10 per cent. In the production of electrical energy it should be borne in mind that the fuel is but one item of cost in many, the total including fixed charges, management, superintendence, labour, depreciation, insurance and repairs. The error of regarding only the item of fuel has also led to the popular misconception as to the possibilities of water power as a source of very cheap electrical power. In this case it may easily happen that the saving effected in fuel, labour and machinery is balanced by the charges on the investment for improving the water power, though in most instances, particularly where the water power is an extensive one, favourably situated and not requiring too large an outlay for development, there will be a sufficient saving to justify its use, though it may not result in any notable cheapening of the cost of electrical energy to the consumer."

Copper during 1894.—According to Messrs. Stedman, Crowther and Co.'s metal report for 1894 production was curtailed, presumably under the stress of low prices, and will be further reduced if the arrangement between the big American and European producers can be again brought into force. In the open market warrants were sold at £42. 17s. 6d. in January, and this proved to be the highest value throughout 1894. There was an almost continuous fall throughout the first half of the year. By June it had dropped to £37. 17s. 6d., the lowest recorded price, excepting during the time following the collapse of the Copper Syndicate in March, 1889. Some improvement followed, but £38 was again accepted in July. The market then turned round on rumours of proposals for a renewal of the agreement for the restriction of output, and 50s. per ton was soon gained. There was a gradual improvement throughout August and September, until £41. 15s. was reached. In October and November some realisations took place, doubtless influenced by the disappointment following the passing of the American Tariff Bill, and little by little the market drooped, until £39. 15s. was touched early in December, when there was a rebound to £41, and this was the value on the last day of the year. The deliveries of copper out of stock in England and France for the past eight years are as follows:—

Imports.

1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
111,493	63,906	118,352	145,641	122,441	106,272	129,741	97,699

Transformer Chambers under Public Streets.—The following communication has been addressed by the Board of Trade to the London County Council, the Wandsworth District Local Board of Works, and other local bodies and companies concerned in the recently raised objections to the proposals of the electric lighting companies to place transformer chambers below the surface of the public thoroughfares:—

Sir: With reference to the hearing which recently took place at this office of objections raised to the various systems of supply proposed to be adopted by the Undertakers under the above-mentioned Orders, which involve the use of transforming chambers placed underground in the public streets, I am directed by the Board of Trade to inform you that, as arranged at the hearing, they have consulted their legal adviser, who is of opinion that the expression "regulating or controlling the supply of energy" means or includes the transforming of energy, and, accordingly, that there is sufficient authority in Section 12 of the County of London (North) Electric Lighting Order, 1892, and in the corresponding sections of the other Orders mentioned above, for the construction of such boxes as may be necessary for that purpose; and, further, that, so far as the section itself is concerned, there is no limitation with respect to the size of the boxes. In view of this opinion, and after a careful consideration of the representations made at the hearing, the Board of Trade are not prepared to hold that sufficient reasons have been advanced, either on the ground of public safety or of want of parliamentary sanction, to justify them in refusing to approve of a system of supply which involves the use of transforming chambers under the public streets. The Board of Trade, however, consider that the use of the public streets for such a purpose should be as much as possible limited, and that the chambers should be placed where they do not unreasonably interfere with existing underground works of any kind. In these circumstances, the Board of Trade will be prepared to approve the systems submitted by the undertakers under the above-mentioned Orders with certain alterations which will be communicated to the Council shortly. The Board of Trade hope that their decision on the general question will render unnecessary any further action with regard to the appeals which have been lodged by the undertakers under Section 13 of the County of London (North) Electric Lighting Order, 1892, and of the Wandsworth Electric Lighting Order, 1892. Should, however, any difficulty arise in connection with any particular chamber, it would, of course, be open to the London County Council, the Local Authority, and the undertakers to avail themselves of the provisions of the sections of the Orders relating to the construction of works.—I am, &c.,

(Signed) COURTENAY BOYLE.

The Clerk to the London County Council, Spring-gardens, S.W.

Technical Education.—A special feature of the New Year's number of the *Polytechnic Magazine* is a collection of New Year greetings from all the members of the governing body of the institution, including Lord Playfair, Lord Reay, Sir Philip Magnus, and the Hon. T. H. W. Pelham. Lord Playfair wrote:—"In the year 1895 the Polytechnic Institution alone will have between 14,000 and 15,000 students and members. This is an astonishing result to a veteran educationalist like myself, who remembers the time when there was not a single student throughout the entire kingdom who could obtain a technical education. After the Great Exhibition of 1851, of which I am the sole survivor of its Royal Commission of Management, when we learned by comparison with other nations that industrial competition was resolving itself into a competition of educated intelligence, instead of, as formerly, one of local advantages or cheap raw materials, I associated myself with a few active men and began the crusade for technical education. At that date (1851) there was only one institution in Glasgow, and none in all the rest of the kingdom that could be considered technical in any sense. Very slowly, but surely, the want was admitted, and technical schools and colleges were founded, and now there is not a single large town without schools or colleges devoted to technical education. What has compelled this country to make such marvellous advances? Formerly the possession of iron, the source of strength, and of coal, the source of power, gave to England its character as an industrial nation. But gradually iron and coal were found as cheap in other countries, or they could be acquired cheaply by other nations through improvements in means of transport by sea and land. Industrial competition then became converted into a competition of intellect. The nation which becomes the most educated nation will become the greatest nation—if not to-day, certainly to-morrow. . . . An ignorant workman is still called by his employers a 'hand.' Future employers must count their workmen by 'heads' as well as by hands. Our Polytechnic is taking part in permeating the people with general as well as technical intelligence, and so is helping to lay the foundation for the continued properity of this nation in the ever increasing competition of the world."

The Paris Metropolitan Railway.—The antagonism that has long existed between the Municipal Council of Paris and the Government, says the *Engineer*, is responsible in some measure for the rejection of the project that was recently presented to the Council by M. Barthou, the Minister of Public Works, for the construction of two transverse lines across the city in connection with the Ceinture and all the main lines having their termini in Paris. The scheme had been so carefully prepared, and seemed to fulfil all the conditions of a "Metropolitan" in such a satisfactory manner, that its rejection has come as a surprise to everyone. The Council states that it will have nothing to do with the scheme on the following grounds. It places too much power in the hands of the railway companies, who would have authority to construct that part of the system in which they would be immediately interested, and the Council contends that the whole of the "Metropolitan," being an essentially local work, should be carried out by private enterprise. This is a point upon which the Council and the Government have been in conflict on many previous occasions. It is also asserted that the project does not sufficiently serve the interests of the central quarters of Paris, and notably the Rue Reaumur, upon which the Council has already spent a large sum of money, and it is further urged that the benefits accruing to the Council from the carrying out of the scheme would not compensate it for the loss, amounting, it is estimated, to £1,200,000, that would result from the proposed free admission of the material to be used in the construction of the railway. Some other points of minor importance are also raised against the project, and it has, consequently, been definitely rejected. It is not now believed possible that the "Metropolitan" will be completed in time for the Exhibition of 1900, in which event it is difficult to see how the vast amount of traffic that will take place during that period can be dealt with. The only hope of the "Metropolitan" now lies in the possibility of the Government being able to rapidly draw up and pass another project that will receive the approval of the Municipal Council in time for the work to be put in hand during next year; but it is the general impression that the Council is entirely opposed to a scheme of any sort that will facilitate a displacement of population from the centre of Paris to the suburbs, and that the Government will be too busily occupied next year with the preliminary works in connection with the Exhibition to be able to pay any more attention to the underground railway.

The Storage Battery Industry.—As we look back on the development of the electrical industries during the past fourteen years—a commercial development unparalleled in the history of the world—we find, writes the *Electrical World* of New York, "one singular circumstance connected with it, which is that, aside from some promotors and inventors, but few have profited from a business that from its vastness should have been an incomparable source of wealth. When we come to examine into the causes we find that perhaps the principal one has been the stupendous litigation, which will render the period almost as memorable from a legal as from an electrical standpoint. No branch of the industry has suffered more in this respect than that relating to storage batteries, in which not only have millions of money been lost, but the industry itself throttled for years. Owing to the legal impediments encountered at every step, the slight commercial progress made by this branch in comparison with other electrical ones, became a matter of reproach, and even led to the storage battery itself falling into an undeserved repute. It is, therefore, with satisfaction that the new era will be regarded which has been just inaugurated by the consolidation of warring storage-battery interests [see *The Electrician*, December 21st, p. 224], and which we trust will result in the fulfilment of the sanguine hopes of those who have so long looked for the storage battery to take its merited place among the electrical industries. While it is much to be regretted that the peace between the hostile interests was not sooner established, the present is yet an opportune moment, for the field of usefulness is now well prepared in many respects. For central and power station work the opening is already a wide one, and it is not at all improbable that the future may see the storage battery an essential part of every station equipment. The same, in a somewhat less degree, is true of its use with isolated plants, and he would be rash indeed who would maintain that storage-battery traction contains no possibilities, notwithstanding its lack of success in the past. Developments in other directions can now also be attempted without the fear of an untimely halt being called. Not the least benefit of the industry being placed on an assured basis is that its success will result in again attracting inventors to the field, and perhaps some of the theoretical considerations recently put forth by German electro-chemists may thereby be worked into practical realisations."

The Perpetual Motion Man.—There is reason for believing, says the *Engineer*, that justice may at last be done to certain members of that somewhat limited class of inventors known as "perpetual motion men." These individuals may be classed under various heads. We have the unmitigated fraud, for example, now nearly extinct, and we have the man who, beginning honestly, and losing his money, endeavours to retrieve his position at the cost of somebody else—also rare. Then we have the ignoramus, full of conceit and dogmatism, but perfectly honest; and, lastly, we have the mistaken worker who has learned a great deal, possibly much more than he understands. Now, until quite recently all these men were classed together under two heads as either rogues or fools; and they were all alike supposed to be identified with machines which, once started, could run for ever. Whether it is that the better type of perpetual motion man is much superior in mental capacity to his predecessors, or that critics and other advanced persons have taken the trouble to understand what it is the perpetual motion man wants to do, we cannot tell. The fact, whatever the cause, is that no one ever fancies now that anyone out of a lunatic asylum dreams of producing a machine that will run for ever; and it is admitted that, although the schemes of the perpetual motion man are unsound, it is often so difficult to show wherein this unsoundness lies that it would be unadvisable to hold the inventors of them to be fools, or frauds, or even transcendentally ignorant. . . . Finally, continues our contemporary, we may say that to us it seems as though the perpetual motion man of the proper type plays a useful part in the world's economy. He tries experiments with Nature which the plodding, possibly over-trained, scientist would not think of attempting. His imagination carries him everywhere. He does not believe in the existence of natural walls until he has knocked his head against them. If one road is stopped he tries another; when there is no road he will cut a way for himself through the jungle. Everyone wrestling with the forces of Nature is, in a sense, a perpetual motion man. We cannot think that all this means so much waste of mental energy. No man trained to think will say that he knows what is and is not impossible in the future; at the best, he can but believe. Half-a-dozen names hang on our pen, names of men who have proved that the belief of a past generation had no more substantial foundation than a cloud. The perpetual motion man lacks but one thing to make him respected, and that is worldly sense. But, possibly, if he had worldly sense he would not be a perpetual motion man.

MR. CROMPTON'S PRESIDENTIAL ADDRESS TO THE INSTITUTION OF ELECTRICAL ENGINEERS.

I think that I shall interest you most if I address you on electrical engineering from my own standpoint. I believe that I am the first of your Presidents who received his early training in mechanical and structural work entirely unconnected with electrical engineering, which at that time meant telegraph engineering. You must, therefore, not be disappointed if I deal with electrical engineering chiefly from the mechanical engineer's point of view, believing as I do that its great development dates from the time when the mechanical engineer first took in hand the design and construction of dynamo electric machinery. This date is that of the Paris Exhibition of 1878, so that we have had 16 years in which to develop the dynamo, the alternator, the transformer, and the storage battery into their present form. During these 16 years the dynamo, in mere size, has increased 500-fold, its efficiency has increased from 60 to 97 per cent.; from an instrument maker's model it has become a machine which, whether as regards solid mechanical construction or smooth efficient working, will compete favourably with any form of engine or machine tool that has ever left the hands of the mechanical constructor. The modern alternator has been slowly evolved from the original Alliance magneto electric machine, the transformer from the induction coil, the storage battery from the original Planté cell. When I say that the vast development which has taken place during these 16 years has been mainly due to the labours of the mechanical engineer, I do not in the least undervalue the immense labour of the physicists and of the telegraph engineers who preceded us; on the contrary, it is abundantly evident that this rapid development was only rendered possible by the splendid work which the physicists had already done, laying down so clearly the laws and the co-relation of electromotive forces, electric currents, resistance and induction, and to the admirable system of units which, through the British Association Committee, the telegraph engineers had worked out to such completeness that they now form, with very slight changes, the complete system of modern units that are universally adopted; and I cannot omit to mention the great impulse which was given to the progress of electrical engineering by the invention of the incandescent lamp by Swan, Stearn, and others. For it is quite certain that, although the development of dynamo plant for arc lighting and for transmission of power would have attained considerable proportions without the assistance which it has derived from the demand for incandescent lighting, yet it would have taken a vastly longer period to have reached its present stage of development.

I am one of those who, when I use the word "electricity," have before me a mental picture of an agency which we use for producing action at a distance, an infinitely flexible connecting rod by which we can transmit energy and reproduce it at a distance in any desired form. Perhaps the reason why I have formed this mental picture is that I entered on the study of electrical engineering through a very correct process of evolution. Having been previously engaged on a practical application of hydraulic transmission plant, I was, from the time that I first commenced on electrical work, struck by the general resemblance which the flow of electric currents through conductors bears to that of water or other fluids through a system of pipes. It is almost a pity that the actual demand for electrical energy for light-giving purposes preceded that for mechanical power purposes, as the part which electricity plays as a connecting-rod only is not so immediately evident when it is reproduced as heat for electric lighting as when it is reproduced as mechanical energy in a motor. At a very early stage in the mechanical development of electrical machinery the mechanical engineer found himself confronted with an entirely new set of problems; he found that the laws which govern the flow of the electric current, and the formulæ he had to use, were simplicity itself compared with those he had been compelled to master before he could deal with the design of any form of thermal engine, or even deal with the flow of fluids or liquids through pipes, the chief reason being that the electric current is so easily confined—"canalised," as the French call it—in its conductor by its insulation that the losses due to electrical leakage may in most cases be neglected, whereas the losses in thermal engines through the walls of the passages or confining chambers are so great, and form such a large percentage of the whole of the energy, and vary through such very wide limits according to their form and to the materials of which they are constructed, that the calculations involved in any new design are extremely complex. On the other hand, the mechanical engineer found that the necessity for so frequently interposing insulating materials between the various parts of electrical machinery greatly increased the difficulties of mechanical construction. Nearly all insulating materials are deficient in mechanical strength; in most cases they do not maintain their form through any considerable range of temperature, are readily damaged by oil or grease, and do not readily lend themselves to being cut or shaped by ordinary tools. Constructors of electric apparatus have to deal chiefly with iron, copper, and insulating materials.

The improvement in the electric qualities of the first two have been very marked, and we have probably arrived at finality, but we have made but little advance in the improvement of our insulating materials. Probably, of all the materials that are available for insulating or isolating the parts of generating machinery, transformers, and distribution appliances, mica is the only one that at all approaches our requirements, and mica is only satisfactory when it can be applied in thin sheets to insulate adjacent surfaces of considerable area. Slate, porcelain, and enamel, when used as insulators, although they can stand considerable changes of temperature without alteration of their insulating qualities, are deficient in mechanical strength, and cannot be readily shaped or cut. Wood, hard rubber, and the various patent materials—such as woodite, vulcanised fibre—although they are more satisfactory as regards mechanical strength, are considerably affected by heat, moisture, and oil or grease. The various slates and marbles are mechanically weak, and unless protected by enamel, are absorbent, and partially lose their insulating qualities in a damp atmosphere. Attempts that have been made to mould or cast insulating materials out of mica waste or similar substances, cemented together by shellac, resin, or other adhesive materials, have only obtained partial success. In no case has the double requirement of mechanical strength been combined with that of resisting change of temperature or the absorption of moisture. This difficulty in obtaining satisfactory insulating materials has been the chief stumbling-block which makes the work of the designer of electrical machinery so much more difficult than that of the designer of ordinary metal work, where the necessity for insulating the parts does not come in. The improvement of the material that must be used for insulating the distribution system of conductors has been an equally difficult matter. The study of this question was forced upon us as soon as it became evident that electrical energy could be commercially supplied and distributed throughout our streets. The problem has been attacked in various ways. The various systems of insulation that have been tried can only be tested by time; it will be many years before we shall be able to predict with any certainty as to which systems are likely to survive. It is impossible for me to devote more than a few lines to this interesting question. As you know, the systems of conductors that have been hitherto laid divide themselves roughly into built-in systems, drawn-in systems, and those which use bare conductors insulated by glass or porcelain. Quite recently the attention, not only of ourselves, but of the public, has been directed by several accidents to the dangers attached to electrical conductors laid in the streets. In many cases these dangers are not properly attributable to the electric conductors themselves, but to the presence of gas in the soil through which these conductors pass. Wherever any space exists into which this gas can infiltrate, an explosive mixture may be formed, which may be fired either by an electric spark from the conductors themselves or by contact with a match dropped by a smoker. I think, however, that there is no reason for the public to unnecessarily alarm themselves. In the vast majority of cases where the system of conductors is continuously inspected for traces of gas no accidents of any kind have occurred.

Although I have already stated that electrical engineering is greatly indebted to the mechanical engineer for much of the development that has taken place in recent years, yet in some respects the reverse is the case. The alliance between us has not been wholly productive of benefit to us. An electrical engineer nowadays has to grasp the whole subject of the production and distribution of electrical energy, from the energy contained in the coal to the point at which it is delivered to the consumer. As regards a very large portion of the plant he has to use, the electrical engineer has had to adopt the appliances already sanctioned by the mechanical engineer: I allude to the boilers, steam engines, and to the motive power generally. When the electrical engineer called for a motive power on a large scale, he found ready to his hand the experience of those who had equipped the great factories of the manufacturing districts of England; and these gentlemen have had a considerable hand in the design and application of the motive power we use, and I am afraid that in many cases the combination has not been altogether a paying one. Previously to the introduction of power houses for the generation of electrical energy, the large mill-owners were the principal users of power in England, and it is to their requirements we owe the developments of the Lancashire boiler and the refinements of the large slow-moving engines that are always found in such factories. These gentlemen are perpetually reminding us that in order to obtain the maximum of economical success we have only to copy their practice, and that anything that differs from their practice is wrong, and I am afraid a very considerable number of electrical engineers, particularly the younger members of our profession, have been considerably swayed by these utterances. I feel very strongly, however, that it is time to speak on these matters with no uncertain voice. The conditions under which we work our engines, boilers, and other motive-power plant for electrical supply purposes differ so widely from the conditions of motive power for driving factories that their experience is of little or no value to us—in fact, it is in many respects misleading; and I take it, to the credit of electrical engineers, that it is we who have been mainly instrumental in developing the newer type of engines and boiler plant which are now largely used in our supply stations. I think that few will doubt it was the exigencies of electrical engineering that led the late Mr. Willans to carry out his extensive series of experiments on the economical use of steam which has so revolutionised our ideas on the subject. If it had not been for the conveniences for accurate measurements which the dynamo and electric measuring instruments offered, Mr. Willans' experiments could never have been carried out to the convincing degree of accuracy which he attained. I think, from this and from other causes, that we electrical engineers are already beginning to return to the mechanical engineers some of the benefits that we received from them. I am sure that the considerations of load factor and all similar matters, which have been found of great importance to electric supply engineers, will be found to have almost equal importance in the matter of waterworks, gasworks, and many other industries. In a word, I believe that the studies which we have been compelled to pursue in order to investigate and deal with our electrical difficulties will prove to be of considerable service to the engineering world in general, and that the engineering world in general will gradually become more and more intimately connected, so that eventually some part of the training of every engineer who deals with constructive works, or supply works of any form, will be an electrical one.

Not the lightest of the duties of the modern electrical engineer is that of educating the public in the use of electrical energy. This process, which we in this room call the improvement of the load factor, is a matter of such importance to you all that I need not apologise for dealing with it at some length. We not only desire to have the output of our generating station more evenly distributed throughout the 24-hour day, so as to fill up the valleys and reduce the peaks of our daily diagram; but we also wish to improve the summer diagram, as compared with the winter one. The problem of satisfactorily and economically working the daily diagram may be, to some extent, dealt with by improvements in the storage of electrical energy; but, even if we were in possession of as satisfactory a system of electrical storage as the gas companies possess in their gasometers, it would only help us to this point. The great disparity between our winter and summer loads is due to our geographical position, and will always exist so long as the major part of the energy we supply is for lighting purposes, and the obvious remedy is to encourage its use for motive power, and for heating and cooking; and to me at the present time it appears a far easier matter to educate the public to the advantages of using electricity for heating than to induce them to use motive power to any considerable extent. For this reason I have persistently advocated the perfecting of electric heating and cooking appliances. This matter has not been much understood even amongst electrical engineers themselves. For a long time the opinion was very generally held that the energy required for electric heating is so great that its cost would be prohibitive. At first it was not seen how effectively electrically heated appliances could be used for cooking purposes, how large a proportion of the heat units would be usefully employed in cooking food, and how small a percentage would be wasted in heating surrounding air. Now that this result has been obtained, and that cooking operations on a considerable scale can be carried on in an ordinary sitting room without perceptibly raising the temperature of the air of the room, it will be seen that electric cooking is certain to obtain popularity in hot climates, or in summer, or in small tenements at such time when the lighting of fires and the waste heat from these fires is not only unnecessary but actually objectionable, and this even if the cost of the electrical cooking be considerably in excess of that by other means. At any rate, we may assume, if these expectations are only partially realised, that there will always be some sale of electricity for these purposes, and that the addition to our load diagram from such use will take the form of adding to it a parallel strip commencing from seven o'clock in the morning and ending at eleven o'clock at night, as I do not think there is anything in the condition of electric cooking to warrant anyone in thinking that the demand for energy for this purpose will be confined to the period immediately preceding each meal-time. The use of electricity for heating will be probably confined to the partial heating of rooms or parts of rooms which are required to be occupied for short periods or for the airing or warming of clothes or linen, and such use is also likely to be confined to the same hours as I have given for cooking.

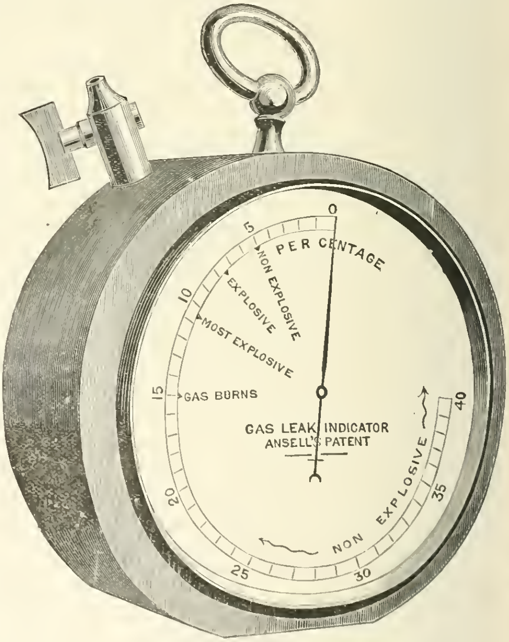
Turning now to the possible extension of the load from the use of motive power, we know how large a portion of the income of the American supply companies has been during the past two years obtained from its motor load, and that up to the present our motor load in England, at all events in London, has been insignificant. I have attempted to find out, by putting questions to the managers of the most important American electrical supply works, whether the habits of the American people, or the construction of the dwellings in which they live or of their business premises, was such as to cause a special demand for motive power which would never arise on this side. In putting these questions, I fully expected to hear that their large motor load would be chiefly attributed to the driving of elevators, to the ventilating of their rooms during their exceptionally hot summers, and to the working of special machinery necessitated by their lofty buildings; but I am told that this is not so, that many of the large hotels and larger blocks of buildings possess their own separate plant for working their elevators and other machinery, and that the bulk of the motor load of the electric supply stations is obtained from the buildings of a moderate size, and that in these the motors are used for small industries and for domestic work, both of which uses are likely to exist to an equal extent in London or in any large English towns. If this is the case, we may feel sure that the commercial enterprise of those amongst you who make and sell electric motors and the engineers of our supply companies who are so desirous of increasing their motor load will be sufficient to make it gradually approximate to the American one. In this connection it is curious to note that, although we, in our central stations, are so anxious to increase the output of our plant, and hence our load factor, by encouraging the use of electric motors, the main argument we must use to an intending user is that of all sources of motive power none can be worked with so little waste of power during long periods of idleness as the electric motor. In other words, the electric motor is the cheapest of all systems of driving machinery when the load factor is at its lowest. To mention a very ordinary case. Throughout all residential districts there exist a considerable number of small shops for repairing, and in some cases making domestic furniture on a small scale. In many cases it would be an advantage in such a small shop if one or two machine tools, such as a saw and a moulding machine, could be occasionally used for preparing the material. Such a machine would require from 3 to 5 H.P. to drive it when doing useful work. In most cases these machines would be only used for a few minutes at a time, several times a day, the total use probably not extending to more than seven hours per week. If the user obtained his power from a central source of supply, and paid 4d. per unit for it, the total cost of working these two machines would only be about 7s. per week, although the above time would be made up of many short periods of use. If we add on an ample sum for the interest on the cost of the machines and motors and for their maintenance, the total cost need not exceed £1 per week, so that it is evident that, in many cases, it would pay well to employ such tools and motors, rather than send work out to be executed at a saw-mill. It is evident that if the same intermittent employment of power had to be obtained from a steam engine or even a gas engine, the total cost of full attendance and upkeep would be from £3 to £2 per week, quite apart from the many inconveniences and dangers attending the use of steam-power in small premises. It is evident, however, that as you increase the hours during which these machines are worked, the electric motor will lose its advantages, and a point will be reached at which, first, the gas engine, and eventually the steam engine, will be found to compete favourably as regards cost.

This argument of the cheapness and convenience of the electric motor for very intermittent supply of power is one which cannot be impressed too strongly on likely future users of power; but, apart from what we can do in supplying power to such small industries, there is much to be done in this country in familiarising the minds of the inhabitants of Mayfair and Kensington—to take these diistrcts only as typical of many others—that the use of motive power in private houses need not be limited to working lifts, driving sewing machines, knife-cleaners, grinding coffee, or even, as has been stated in another presidential address, "brushing their boots, washing their faces, and serving their meals." With great deference to the gentleman whose words I have just quoted, I must submit that there has hitherto been a certain want of imagination shown whenever the question of the possible extended use of motors has been discussed. No one can help noticing that amongst English women and English men, at any rate, the desire to work at home, to make something useful or artistic, or to decorate or to beautify our homes, is very widely spread. The number of those who employ their otherwise idle fingers during their leisure time in some kind of work is very great; but hitherto this work has been confined to sewing, embroidery, etching, painting, light carving—at any rate, to work where the muscular exertion required is small. This practically excludes any constructive or decorative work which requires to be made out of materials of a hard and enduring nature; but if once the electric motor is pressed into our service, if the electrically-driven shaper or graver needs only to be intelligently directed by the user, the most delicate-handed lady could cut and carve out designs in the hardest materials with the same ease and same certainty that she now uses the embroiderer's needle or the etching pen. There is one use to which electrical energy can be applied in very considerable quantities in residential districts. I allude to the production of artificial cold by means of electric motors. You all understand that this is at present done by arranging them to drive an air compressor, and afterwards expanding the compressed and already cooled air into any properly-constructed cold room in which it is desired to maintain a temperature sufficiently reduced to store perishable eatables—such as meat, fish, game, and vegetables, or fruit—for long periods. Such cold storage would enable each consumer to deal far more directly with the producer than has hitherto been the case; the cost of several daily deliveries of food articles would be practically abolished, and the extravagances and waste of housekeeping would be reduced to the lowest possible limit; in fact, the advantages of such cold storage are so obvious that it is unnecessary to further insist upon them.

(To be continued.)

A GAS LEAK INDICATOR.

In the course of the recent Board of Trade inquiry on the explosion in St. Pancras, allusion was made more than once to an instrument for detecting the presence of gas. Several different kinds of detector or indicator have been suggested, and the one which we illustrate has been used for a long time by gas companies, and is found to be very useful in subways, cellars, and gasworks, and has been employed successfully in tracing out and discovering a leak in a main. It is, of course, too late to introduce one into a conduit after an explosion has occurred, nor, indeed, could this be done without raising the cover, and then, probably, effectually ventilating the manhole or junction box. The instrument consists of a simple aneroid barometer in which the vacuum box is replaced by a box of which one side is made of red porous earthenware, and the other of the usual corrugated plate. The diffusion of hydrogen being so much greater than that of atmospheric air, the gas passes into the box faster than the air passes out. The flexible side is thus distended, and by the usual mechanism the hand is moved on the dial. The dial is graduated in percentages, and opposite the proper points the words "non-explosive," "explosive," "most explosive," "gas burns," and again "non-explosive" are to be found. Such an instrument is useful for showing whether the atmosphere in which gas evidently is present is near the explosive point; but there are two other important uses. The smell of coal gas may be largely reduced by filtration under certain circumstances; and, conversely, the smell of gas, which is probably due to some messy hydrocarbons which have not been removed in the process of manufacture, may give a false



alarm. In both of these cases, which may occur in connection with electric conduits, a gas detector should prove useful. In coal mines, and places in which carbonic acid is present, erroneous indications might be given; under any circumstances such an instrument must not be regarded as giving very accurate measurements. The instrument, which is illustrated herewith, is supplied by Messrs. Wright and Co., of Old Queen-street.

ON THE RETARDATION OF POLARISATION IN DIELECTRICS.[*]

BY RICCARDO ARNÒ.

Ewing and Miss Klaassen have shown[†] (1) that the energy w consumed by magnetic hysteresis in iron may be represented, in terms of the magnetic induction B, by an equation of the form

$$w = k\,\mathrm{B}^{\epsilon}$$

where ϵ and k have values differing according to the limits of B. (2) That the variations of the exponent ϵ correspond to the passage from one to the other of the successive stages in the process of magnetisation, and that the relatively high values of ϵ correspond to the initial and final stages, where the permeability is small. whereas the values of ϵ corresponding to intermediate stages, where the magnetic permeability is greater, diminish considerably.

I have, on the other hand, from a series of experiments described in previous Notes been led to maintain :—(1) That in a dielectric cylinder, placed in a rotating electric field, a dissipation of energy takes place, since the cylinder is subjected to a couple which tends to make it rotate in the direction of the field itself. (2) That the relation between the energy W dissipated in the dielectric cylinder and the electrostatic induction B, at any point of the rotating field, is of the form

$$\mathrm{W} = \mathrm{K}\,\mathrm{B}^{x}$$

where x and k have values which vary as the limits of B are changed. (3) That for paraffined cardboard the exponent of B is 1·83, 1·65, and 1·90 respectively, when the values of B employed are comprised between 0·06 and 0·17, 0·95 and 2·65, or 9·90 and 14·58 C.G.S. electrostatic units.

These results, confronted with those of Ewing's and Miss Klaassen's experiments on the magnetic properties of iron, bring out the analogy which appears to exist between the law of magnetic hysteresis in magnetic bodies and the law of the phenomenon I am studying in dielectric bodies, and suggest the predictions : (1) That the phenomenon of the rotation of a dielectric cylinder in a rotating electric field is due to a lagging with which the polarisation of the dielectric follows the rotation of the electric field, precisely as in a rotating magnetic field an iron cylinder, laminated in such a manner that Foucault currents cannot be produced in it, rotates in consequence of the lag with which the magnetisation of the iron follows the rotation of the magnetic field. (2) That the values of the exponent x will correspond to different stages in the process of polarisation, and that, by analogy with what happens in the magnetisation of magnetic bodies, the relatively greater values of x will correspond to the initial and final states, and the smaller ones to intermediate states.

A series of fresh experiments, the results of which are given in this note confirms these predictions. The apparatus used, and the dielectric cylinder experimented upon, are those used for the researches described in my last note on the subject.[‡] The frequency of the alternating current was 40. The distance between the rods enclosing the space in which the rotating electric field was generated, was 4·4cm., and the distance of the mirror from the scale was 2,660mm. The dielectric cylinder was of paraffined cardboard, with a height of 26mm., external diameter 30mm., thickness 1mm., and weight 2·011 grammes.

Under such conditions, and with seventy different values for the electrostatic induction B, comprised between 0·030 and 5·30 electrostatic units,[§] I performed a number of experiments, which are grouped in seven sets of 10 each, each set corresponding to a definite sensitiveness of the apparatus. In order to be able to attach the same weight to all the measurements, I arranged things in such a manner, by means of suitable transformers, that the value of the electrostatic induction was deduced for each experiment from a measurement (with a Cardew voltmeter) of a difference of potential always comprised between the same limits—40 and 112 volts.

If in a system of rectangular co-ordinates are plotted the values of log B as abscissæ, and those of log W as ordinates, taken from one of each of the seven groups of experiments in the table, we obtain points the locus of which is, with sufficient approximation, a straight line. This shows that the mean values satisfy a relation of the form

$$\mathrm{W} = \mathrm{K}\,\mathrm{B}^{x}$$

where K and x are, for each series of experiments, constants which were determined by the method of least squares.

[The following table gives the data for one of each set of ten experiments.]

No. of experiment.	V in volts.	B in electrostatic units.	d observed.	x.	k_1
1	40	0·30	11·7	1·843	327·593
12	48	0·072	23·4	1·830	287·240
23	56	0·168	31·6	1·905	385·782
34	64	0·432	50	1·743	352·513
45	72	0·98	79	1·747	445·096
56	80	1·89	89	1·663	509·251
70	112	5·30	172	1·681	518·240

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[*] *Rendi conti dei Lincei*, November 18, 1894.

[†] *The Electrician*, April 13, 1894, p. 668.

[‡] *The Electrician*, March 3rd, Vol. XXX., p. 516; June 23rd, Vol. XXXI., p. 201; December 29th, Vol. XXXII., p. 222; June 22nd, Vol. XXXIII., p. 210.

[§] In order to obtain values for the electrostatic induction differing much amongst each other, I used transformers with ratios of transformation of 1 to 2, 1 to 4, 1 to 18, and 1 to 250.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, January 18th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read : "Electrical Transmission of Power (with special reference to mining operations)," by H. T. Haws.

ROYAL INSTITUTION.

9 p.m. Evening Discourse : "Phosphorescence and Photographic Action at the Temperature of Boiling Liquid Air," by Prof. Dewar, F.R.S.

SATURDAY, January 19th.

ASSOCIATION FOR THE IMPROVEMENT OF GEOMETRICAL TEACHING.

11 a.m. General Meeting at University College, Gower-street, W.C. Report of Council. The following Paper will be read :—"Algebra in Schools," by G. Heppel.

2 p.m. The following Papers will be read :—(1) "The A.I.G.T. Syllabus of Geometrical Conics," by Dr. C. Taylor; (2) "The Conics of Apollonius," by the Rev. J. J. Milne; (3) "Notes on Mensuration," by Prof. A. Lodge.

MONDAY, January 21st.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture II. : "The Arc Light," by Prof. S. P. Thompson, F.R.S.

TUESDAY, January 22nd.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. The Papers read by Messrs. Berg, Collett and Pownall will be further discussed. The following Paper will be read (time permitting):—"Boiler Explosions," by W. H. Fowler.

THURSDAY, January 24th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper will be read : "The Origin and Development of the Telephone Switchboard," by J. E. Kingsbury.

FRIDAY, January 25th.

PHYSICAL SOCIETY.

5 p.m. The following Papers will be read :—(1) "Tests of Glow Lamps," by Prof. W. E. Ayrton and Mr. Medley; (2) "The Temperature of Water and its Maximum Density," by Prof. Anderson and Mr. McClelland

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. The following Paper will be read :—"The Strength of Large Graving-Docks," by F. E. Wentworth-Sheilds.

ROYAL INSTITUTION.

9 p.m. Evening Discourse :—"The Nile," by Sir Colin Scott-Moncrieff, K.C.M.G., C.S.T.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

Telegraphs in Spain.—Much has been heard recently of the wretched condition of the telegraphic system in Spain. The Government has evidently been brought to understand the matter, as in the budget for the present year provision is made for a sum of £20,000 for new telegraph material.

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SPECIAL NOTICES.

With this week's number of "THE ELECTRICIAN" is issued (Gratis to Subscribers) a COLOURED MAP, showing the Streets in the Metropolis in which Mains for Private Lighting are actually laid, up to January, 1895, together with the areas allotted to the different Supply Companies.

Complaints of non-receipt should be at once sent to the Publisher.

With next week's Number of "THE ELECTRICIAN" will be published (Gratis to Subscribers) a fine **STEEL-PLATE PORTRAIT** of Mr. R. E. CROMPTON, President of the Institution of Electrical Engineers, 1895.

MR. CROMPTON'S PRESIDENTIAL ADDRESS.

The address of Mr. Crompton, as President of the Institution of Electrical Engineers, is, as might have been expected, a thoroughly practical one, and worthy of a man who is first a mechanical engineer and afterwards an electrical engineer. It is sufficient for him to regard electricity as an action at a distance and to picture it to his mind as an infinitely flexible connecting rod; considerations such as those which Prof. Rowland has recently discussed, and on which Prof. Oliver Lodge comments in another column, such as the transfer of energy by the ether, do not concern the daily practice of an electrical engineer. But there is more of the scientific man in Mr. Crompton in his leisure moments than the present address would suggest. The remarks on the mechanical difficulties of insulation and the electrical view of motive power, and the use of steam, deserve careful reading: they do not pretend to give any novel information, there is little in them which anyone will care to contradict; but they present the general position of important matters from a practical point of view.

Coming to the load factor, Mr. Crompton, of course, enlarges upon a favourite topic. His discussion of the needs of a small workshop deserves wide publication, and the question which a carpenter or jobbing ironmonger ought to put to himself is not "how large must my shop be to warrant the use of a motor?" but, having put in a motor or two, and having considerably increased his business, "ought I to drop these very useful appliances, and go in for a gas engine or steam engine?" The speed-torque question is a very important matter, to which pure electricians have paid but little attention. We have long recognised the importance of variable gears, and have given our readers from time to time all the information about them that has been accessible. In the latter part of Mr. Crompton's address, which we shall print next week, he describes the very ingenious invention of

Mr. H. Ward Leonard. This was described by the inventor in a Paper read at Chicago in June, 1892, and was reprinted in the course of the next month in *The Electrician*, Vol. XXIX., p. 200. We heard from Mr. Ward Leonard himself not long ago that the practical use of the device has fully realised his expectations.

Part of the second portion of this Presidential Address is concerned with electrical measuring instruments. The author is well qualified to speak on this subject, since he is the only example of a leading manufacturing or contracting engineer who has turned his personal attention to it. In doing so, he has specialised; he took up the potentiometer where Dr. Fleming had left it, and first elaborated the instrument, and then searched for a galvanometer to use with it. Finding none, he began to make one, and still specialising and aiming only at an instrument which should be most sensitive under the particular conditions of the work, he has made with his own hands galvanometers for which he makes high claims. We only hope that the challenge which he makes for the potentiometer method will be taken up by his rivals. There is an extraordinary diversity, and not only diversity but antagonism, of opinion among instrument makers as to principles of measurement and as to the ideal instruments for making measurements. Whatever criticisms may be made on the potentiometer, such a system, which, of course, as a system, is nobody's property, ought to be very valuable for inspection work and other cases in which instruments must be carried from place to place. In alluding to the progress made with electric storage, Mr. Crompton regretted the sneers with which accumulators are met when they are mentioned at the Institution of Electrical Engineers. Mr. Crompton was not in a fighting mood when he wrote this address, and he was careful to attack no person or system; but nobody could have blamed him if he had hinted that a peculiarity of the electric lighting carried out by his firm is that it neither bobs nor goes out; but this is not entirely due to the storage batteries which he generally uses.

We thoroughly agree with the warning given about the placing of the responsibility for designs of systems of electrical supply in the hands of young and inexperienced men. During the last few years dozens of "consulting engineers" have sprung up, who, if they spent as much time in carefully studying the present types of electrical engineering practice as they do in stirring up local authorities and in nursing electric lighting committees, would really serve the true interests of the industry. It is really a pity that some other name cannot be found for them, since their procedure differs so widely from that important branch of the engineering profession to which they are supposed to belong. There are still, however, more consulting engineers who have never designed a supply station, and who do not wish to do so, than those who have never had any other consultative practice than advising local authorities as to electric lighting. The youthful contractor and the youthful engineer-in-charge are the result of the rush into the electrical profession, of keen competition, and of the fact that men must live. They might perhaps be excused for some of their shortcomings if only they were not so "cocksure," and would condescend to learn from older men. Mr. Crompton's remarks about the importance of visiting supply works, and the few inquiries addressed to engineers-in-charge, may be taken as a hint to those who can give the information as well as to those who seek it. It is by no means easy to get into all stations, and the snubs sometimes administered to visitors are not pleasant. There is not usually any competition between one company and another which could be an obstacle to freely giving information. There are only three conceivable excuses for refusing admission: first, the use of half-patented apparatus, or apparatus about which there is possible patent litigation; second, the use of experimental or, perhaps, ineffectual apparatus, about which the manager or responsible engineer is reticent or ashamed; and thirdly, mere laziness or bad manners. We could name specimens of all three; but, on the other hand, we could name others at which visitors are not only received with courtesy, but their questions are most freely answered, and the engineers seem ready to take a large amount of trouble in explaining the system under their charge.

We hope that the new President will be strongly supported in his proposals for spending the time of this session. The punctual closing of the debate at half-past nine and a firm hand with discussions are not difficult to achieve; but to secure good Papers is a task which must be a serious burden to a President if he really seeks to take it upon his shoulders. Will he be able to induce any practical supply station engineer to give a Paper? There is but one such man on the Council, and he is the only one of his class who has ever read a Paper on electric supply, and that before another society; cannot Mr. Dobson be induced to imitate Mr. Bailey, cannot Prof. Kennedy encourage one of his energetic men to contribute something? We are tired of hearing contractors and dynamo-makers talking about their goods; it is time that the men who use them should have their turn.

MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 240.)

Steam Engine Details.

In the present article brief descriptions and, where possible, illustrations of the steam engine details mentioned in the previous articles will be given. The examples will be taken from the most recent practice in electrical engineering in America and Europe as well as in this country.

Condensers.

The importance of suitable condensing plant in electric power stations driven by steam is so great that an exhaustive treatment of this plant, from a descriptive point of view, will be undertaken. This is all the more necessary as there is such a great variety in the arrangements for condensing which can be made, and from the fact that the suitability of any given arrangement largely depends on local conditions. There are few, if any cases, where *some* form of condensing plant would not be more economical than none at all; and it is, perhaps, greatly to be deplored that so many electric power stations are run with non-condensing engines, even where there are great facilities for working condensers. The erroneous impression that condensers necessarily involve the use of large quantities of water has largely to do with the adverse prejudice which some engineers have towards them. As a matter of fact, though it is true that most condensers require a copious stream of water to be passed through them, it is rarely necessary to draw this stream continuously from an outside source. With the use of cooling ponds or tanks, and other arrangements for quickly getting rid of the heat of the condenser water, it is possible to keep a good vacuum in a large condenser without drawing upon the outside source to any greater extent than is done with non-condensing engines. In fact, the total quantity of supply water required, both for feed make-up and for the various leakages, &c., at the condenser ponds, is often less than the amount required by the boilers where non-condensing engines are used. The objection is often raised that using the same water over and over again involves the use of very extensive cooling ponds, which, in populous districts, means a high rental. It will be shown presently that there are appliances for cooling large volumes of water quickly which take up little space, cost little to construct and work, and which reduce the necessary reservoir space to so small a size that it may be put on the roof of the engine house.

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Some engineers object to the use of condensed steam for feed water on the score that it is oily, and on that account bad for the boilers. There are simple and cheap separators, which can be used for extracting the oil, and which cost little to work. Where surface condensers are used, the use of these separators is advisable; but they are not so necessary where the condensed steam is mixed with the cooling water, unless the make-up is at a very small rate.

Steam engine condensers may be classified as follows:—

1. Jet condensers.
2. Ejector condensers.
3. Surface condensers.
4. Evaporative condensers.
5. Dry air condensers.

Jet Condensers.—In the jet condenser the condensed steam is mixed with the stream of condensing water, which is introduced as a spray or jet, in an enclosed vacuum chamber communicating with the exhaust pipe of the engine. This form may be used where the condensing water is of sufficiently good quality to allow of its being returned to the boiler, or where the supply of clean feed water is copious and cheap enough to allow of the whole of the water from the condenser being rejected into the drain.

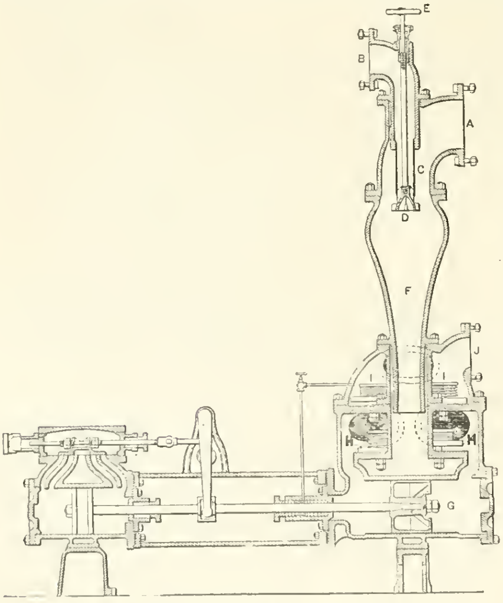

Fig. 42.—Worthington Condenser. Longitudinal section.

The theoretical weight of condensing water required to condense each pound of exhaust steam can be calculated from the temperature data, by equating the heat lost by the steam to the heat gained by the water; but this weight is always far below the actual weight of water required, as such a calculation takes no account of the effect of the air carried over with the steam or leaked into the condenser chamber from other sources, nor does it take into account several other influences which tend to diminish the condenser "vacuum." The actual weight of water required by a good jet condenser, per pound of steam condensed, depends on the following quantities: the release pressure of the steam, the degree of vacuum to be maintained in the condenser, the temperature of the in-flowing cold water, and the temperature of ejection of the mixed water and condensed steam. The usual weight may be taken at from 20lb. to 25lb. of water, at 60°F., per pound of steam condensed. The flow of injection water is usually adjusted by hand until the right "vacuum" is indicated on the vacuum gauge which is placed on the condenser.

A well-designed jet condenser, the Worthington condenser, is shown in section in Fig. 42 and in perspective in Fig. 43. It consists of the following principal parts: the exhaust inlet, A (Fig. 42), leading to the vacuum chamber, F; the cold water inlet, B, leading to the spray pipe, C, and to the spray cone, D, which is adjusted by the injection handle, E; the pump chamber, G, communicating with the vacuum chamber, F, by means of the lift valves, H H, and with the discharge chamber, I, and discharge pipe, J, by means of the lift valves, I I, and the air-pump, actuated by the direct-acting steam engine, as in the Worthington pumps. There are two of these steam engines and two pumps in each set, forming the "duplex" arrangement, which is one of the features of the Worthington plant; and the steam valves are worked in the same way as in the feed pumps, *i.e.*, the right valve is acted on by the left pump rod, cross-wise. There is a periodic pause in the movement of the pump, the purpose of which is to allow time for the lift valves of the condenser to settle on their seats. The action of the condenser is very simple: the cone, D, spreads the jet of cold water so as to cause it to intercept and condense the in-rushing exhaust steam; and the momentum of the stream of water causes the vacuum in the upper part of the chamber F to exceed that in the lower part and in the pump chamber, thereby giving a good vacuum with diminished work being put on the air-pump. The admixed air and water are discharged through the lift valves into the ejection chamber I, and through the outlet pipe J, by the successive strokes of the air pump, the pump being double acting.

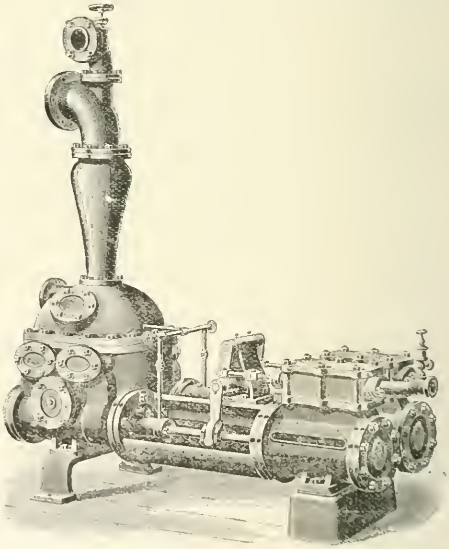

Fig. 43.—Worthington Condenser.

Ejector Condensers.—In many jet condensers the momentum of the in-flowing water and steam is wasted in useless, not to say objectionable, heat; in the Worthington condenser we have seen that it is partially used to assist the air-pump; but in the ejector condenser this momentum is taken advantage of to get rid of the ejection water without the aid of any mechanical pump whatever. The principle of the ejector condensor resembles that of the Sprengel or mercury pump, and its action takes place without the aid of any moving machinery. There are two classes: (1) ejector condensers which are supplied with water under pressure, usually from some overhead tank or from supply mains; and (2) ejector condensers in which the water receives its momentum, not from the pressure due to any head, but wholly from the inrushing exhaust steam. The second class will work wholly immersed in water, the cooling steam being drawn into it at one end through a strainer, and ejected at the other end with the condensed steam, as shown in Fig. 44. The vacuum obtainable by means of a submerged condenser is not so high as the maximum obtainable with water forced into the apparatus under pressure, but a vacuum of from 22in. to 24in. of mercury can be obtained with a copious supply of cold water.

The overhead ejector condenser, as the first class is usually called, does not as a rule require a greater head than about 15ft. for the cold stream. Its efficiency is higher than that of the submerged type, and owing to its complete independence of the exhaust steam it can be relied on to supply the proper vacuum. Under favourable conditions a vacuum of nearly 27in. of mercury can be obtained when using about 100lb. weight of water, at 50° F., under a head of 15ft., per pound weight of exhaust steam. It must also be noticed that with an overhead condenser the vacuum can obtained before the engine starts; while with an immersed condenser it can only be developed after exhaust has commenced. Fig. 45 shows a vertical section of Ledward's overhead ejector condenser. This apparatus consists of an inner jet or stream of cold water, surrounded by a large number of inclined passages leading to the jet from the exhaust pipe. The vacuum caused by the passage of the jet past the orifices causes an induction of the steam into the jet, and the momentum of the inflowing steam, which is immediately condensed, assists the outflow of the water. The discharge passage, which is seen immediately below the induction passages, is funnel shaped, expanding outward in such a way as to slow down the stream of water, and to convert its energy of velocity into energy of pressure. By means of this augmented pressure the back pressure of the air is overcome without the aid of an air pump. A non-return or check valve at the end of the exhaust pipe prevents water from getting into this pipe. At the Manchester Electric Supply Station there are six of Ledward's ejector condensers, and the vacuum obtained in these is about 25in. to 27½in. of mercury.

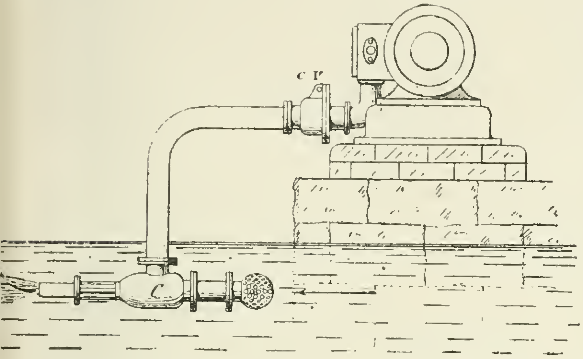

Fig. 44.—Submerged Ejector Condenser. C = Condenser C.V. = Check Valve.

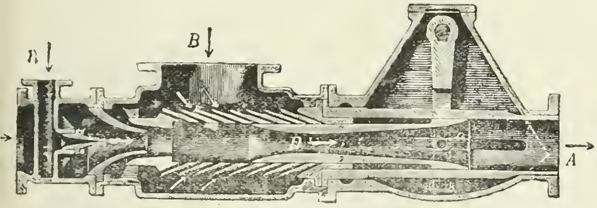

Fig. 46.—Körting Adjustable Capacity Ejector Condenser. Vertical Section.

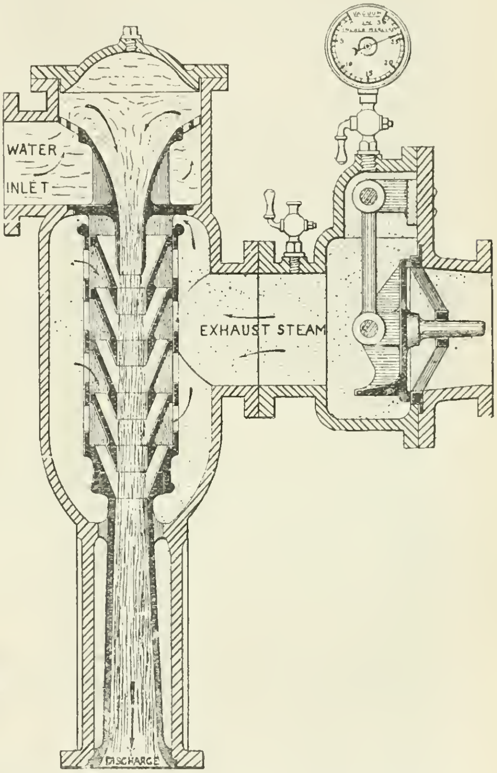

Fig. 45.—Ledward Overhead Ejector Condenser. Vertical Section.

Where the steam plant is liable to work during lengthy periods at low loads it is often desirable to be able to adjust the capacity of the ejector condenser to suit the output of exhaust steam. The only objection to be raised against this practice is that the adjustments have to be made by hand and involve extra labour; but this is very trifling as a rule. Messrs. Körting Bros. make a form of adjustable capacity condenser, which is shown in section in Fig. 46. The exhaust connection is made at B, and the inlet water connection at E, the ejection passing through A. By giving the expanding tube D a sliding movement any number of the nine annular passages may be covered or exposed, and the capacity of the condenser thereby adjusted. This condenser is fitted with a live steam jet for starting the flow of water when there is not an outside head; *i.e.*, when the water is not supplied under pressure. When the lever is full open this condenser works up to a proportion of 1lb. of exhaust steam to 15lb. of cold water, giving a vacuum of from 20in. to 24in. of mercury. Above this proportion, *i.e.*, with less cold water, the vacuum falls rapidly and the condenser fails. With 50lb. weight of water per pound of exhaust steam, and with all the passages open, a vacuum of 28½in. can be obtained.

(To be continued.)

PROF. ROWLAND ON MODERN THEORIES OF ELECTRICITY.

BY PROF. OLIVER LODGE, F.R.S.

A popular exposition should not be judged by too high a standard of rigorous criticism, nor need it always be instructive to specialists in the department of which it treats; but when a man like Henry A. Rowland, of Baltimore, endeavours to expound modern theories in ordinary language to untechnically instructed readers, the effort is always of interest and seldom fails to yield some modicum of instruction.

In the *Engineering Magazine* of New York for the current month, there is an article by Prof. Rowland bearing the title "Modern Theories as to Electricity." He begins by saying that electricity no longer exists; and that nothing is more certain than that electricity is not a fluid; he also speaks of that unfortunate term "electric current," and says that "even the definition of electrical units, as adopted by all scientists, suggests a fluid theory."

For our part we should not like to have expressed ourselves quite so unreservedly as this. To say that electricity no longer exists, though of course it only means that it is the ether which is now claiming the lion's share of attention, is hardly a helpful statement; and we fail to see how the orthodox electrical units are clever enough to suggest a fluid or any other theory.

As a specimen of exposition, the following can hardly be considered extremely luminous:—

> "But the question now arises as to how the lines of electric force can be produced in the ether; or, in other words, how bodies can be charged. In the first place, we know that equal quantities of plus and minus electricity are always produced. As an illustration, suppose it is required to charge two balls with electricity. Pass a conducting wire between them, with a galvanic battery in its circuit. The galvanic battery generates the lines of force; these crowd together around it and push each other sideways until their ends are pushed down the wire, and many of them are pushed out upon the balls."

But the following attempt to explain electrification by friction is rather better:—

> "We can consider, for instance, in chloride of silver that the atoms of silver are joined to the atoms of chlorine by lines of electrostatic force, which hold them to each other. If, by rubbing the chloride of silver, we could remove the chlorine on the rubber while leaving the silver, we could stretch them asunder, and so fill space with the lines of electrostatic force. According to this theory, then, each atom has a number of lines of force attached to it, and it is only by stretching the atoms apart that we can fill an appreciable space with them, and so cause electrostatic action at a distance. We come to the conclusion, then, that all electrification is originally produced by separating the atoms of bodies from one another . . . by friction . . . or some other manner."

He speaks of an electric current as the sliding of the ends of these electrostatic lines on matter, and on matter always, and he continues, "but as they cannot end in a vacuum they cannot pass through it. Thus we conclude that a vacuum is a perfect non-conductor of electricity."

Here the phrase "pass through it" must be interpreted "*move* through it," or it will mislead a reader into thinking that a vacuum has no dielectric properties; and thus a novel discovery might be worked up by the newspapers, quite as good as the memorable and much puffed "discovery" of Prof. Dewar, that radiant heat was stopped by a vacuum.

Leaving these more or less verbal criticisms, we arrive at a bold and uncompromising statement, several times repeated, regarding the earth's magnetism.

> "To account for the earth's magnetism, we must suppose the ether to have such properties that the rotation of ordinary matter in it produces magnetism."

And, again,

> "The ether must also account for the earth's magnetism. If we assume that magnetic lines of force are simply vortex filaments in the ether, we have only to suppose that the ether is carried around by the rotation of the earth, and we have the explanation needed. The magnetism of the earth would then be simply a whirlpool in the ether."

Now these statements are full of more than doubtful hypotheses. First, that magnetism is certainly due to rotation of something, which, although Thomsonian and Maxwellian, has never been proved; next, that rotating ether is the necessary and sufficient whirling material, whereas all that is known is that rotating electrification is sufficient; and, lastly, that the spinning of matter on its axis magnetises it, against which may be adduced a crowd of specially-directed experiments, all of them having had a negative result.

Certain arithmetical calculations as to the strain required in the ether, in order to explain known electric and magnetic forces, may be of interest.

> 1st. It must be able to explain electrostatic attraction. These electrostatic forces are mostly rather feeble as we ordinarily see them. Air breaks down and a spark passes when the tension on the ether amounts to about $\frac{1}{100}$ pound to the square inch. It is the air, however, that causes the breakdown. Take the air entirely away, and we then know no limit to this force. In a suitable liquid it may amount to 500 times that in air or 5lb. to one square inch, and become a very strong force indeed. In a perfect vacuum the limit is unknown; but it cannot be less than in a liquid, and may thus possibly amount to hundreds, if not thousands, of pounds to the square inch.
>
> 2nd. It must explain magnetic action. These actions are apparently stronger than electrostatic actions, but in reality they are not necessarily so. A tension on the ether of only a few hundred pounds on the square inch will account for all magnetic attraction that we know of, although we are able to fix no limit to the force the ether will sustain. No signs have ever been discovered of the ether breaking down.

It might be added that to explain gravitation—after a Maxwellian fashion—the stress that must be borne by the ether amounts to hundreds of thousands of atmospheres, in the neighbourhood of very large lumps of matter such as the sun.

The most instructive statement here is the emphatic perception that it is the air which causes disruptive discharge. It is the residues of air which are responsible for the breakdown of condensers, as Tesla found; and in absolute vacuum there can be little doubt that all modes of conveyance of electricity, whether conductive or disruptive, must cease. And this is best expressed, as Prof. Rowland himself has done in an above-quoted paragraph, by saying that the very phrase electric charge ceases to be applicable to vacuum; *charge* is absolutely limited to the surface of material atoms, and accordingly where they are absent there cannot possibly be any conveyance of electric charges, such as is involved in a current of any kind.

Another useful remark concerns the velocity of ethereal rotation in a magnetic field, supposing always, as Prof. Rowland evidently does, that such rotation is a certain physical fact. He points out that the speed of rotation can be estimated from the known value of the Verdet constant; in other words, by the amount of the Faraday rotation of the plane of polarisation of light in magnetised transparent substances. He says:—

> "The velocity of rotation is immense, the plane of polarisation rotating in some cases 300,000,000 times per second."

It is a perception of facts of this kind which has deterred the writer, and doubtless other experimenters, from a serious attempt to rotate the plane of polarisation by rotating a transparent substance.

With respect to an explanation of gravitation, he shows how far away we still are from any approach to it. One of the difficulties connected with this subject is the necessity for infinite speed of transmission. Nothing less than a practically infinite speed suffices to account for astronomical facts.

The natural conclusion is that the ether must be incompressible, and must transmit this action by some sort of thrust or tension; and certain facts suggest that the ether really is incompressible, or else is insusceptible itself to gravitational forces; viz., the fact that

> "light passes in a straight line through space even when near one of the larger planets, unless the latter possesses an atmosphere. This could hardly happen unless the ether was entirely incompressible or else possessed no weight."

Lastly, Prof. Rowland deals with the ether as a conveyer of energy; he does not consider it in its function of a great storehouse or reservoir of energy on which the whole activity of the material universe depends; but he points out that it is remarkably competent to convey, and convey rapidly, much more energy than any known form of matter is.

> "The amount of energy which can be transmitted by the ether in this manner is enormous, far exceeding that which can be carried by anything composed of ordinary matter. Thus take the case of sunlight: on the earth's surface illuminated by strong sunlight a horse-power of energy falls on every seven square feet. At the surface of the sun the ethereal waves carry energy outward at the rate of nearly 8,000 H.P. per square foot.
>
> "Again, an electric wire as large as a knitting needle, surrounded with a tube half an inch in diameter, in which a perfect vacuum has been made, to prevent the escape of electricity, may convey to a distance 1,000 H.P.: indeed, even 10,000 or more horse power, there being apparently no limit to the amount the ether can carry

> "Compare this with the steam-engine, where only a few hundred horse-power requires an enormous and clumsy steam pipe. Or, again, the amount carried by a steel shaft, which, at ordinary rate of speed, would require to be about a foot in diameter to transmit 10,000 H.P."

He concludes by emphasising once more his belief that magnetism is due to ethereal rotation, and says definitely that "a magnetic line of force is a vortex filament in the ether." The alternative view, championed by Dr. Larmor, that magnetism may be due to flow, and electric current to spin, has evidently not yet impressed him as possessing any force or validity. It may be assumed as probable that he has strong reasons for this orthodox Maxwellian belief, and it would be interesting to know them.

He considers magnetism more simple and easy to comprehend than electrostatics; which, again, must be considered as a thoroughly Maxwellian position; and it is interesting to see how the great foreign philosophers of the world are all slowly coming to recognise the magnitude of this great teacher. Prof. Rowland, indeed, has long recognised it, and it is hard to speak of members of the Anglo-Saxon race as foreigners; but their aloofness from insular prejudice and the bonds of the mother country render their adhesion to the English, instead of to one of the many forms of continental theory, of special interest.

The domain of electrostatics is evidently regarded by Rowland, as it is also by Poincaré, as the least edifying and satisfactory parts of the present theoretical treatment of the subject, regarded from an ethereal point of view, and almost the concluding words of the article now under notice are the following :—

> "Electrostatic action is more difficult to explain, and we have hardly got further than the vague idea that it is due to some sort of elastic yielding in the ether.
>
> "Light and radiation in general are explained when we understand clearly magnetic and electrostatic actions as the two are linked together with certainty by Maxwell's theory."

MODERN THEORIES AS TO ELECTRICITY.*

BY PROF. HENRY A. ROWLAND.

It is not uncommon for electricians to be asked whether modern science has yet determined the nature of electricity, and we often find difficulty in answering the question. When the latter comes from a person of small knowledge which we know to be of a vague and general nature, we naturally answer it in an equally vague and general manner; but when it comes from a student of science anxious and able to bear the truth, we can now answer with certainty that electricity no longer exists. Electrical phenomena, electrostatic actions, electromagnetic actions, electrical waves—these still exist, and require explanation; but electricity, which, according to the old theory, is a viscous fluid throwing out little amœba-like arms that stick to neighbouring light substances, and contracting, draw them to the electrified body, electricity as a self-repellant fluid, or as two kinds of fluid, positive and negative, attracting each other, and repelling themselves—this electricity no longer exists. For the name electricity, as used up to the present time, signifies at once that a substance is meant, and there is nothing more certain to-day than that electricity is not a fluid.

This makes the task of one who attempts to explain modern electrical theory a very difficult one, for the idea of electricity as a fluid pervades the whole language of electrical science, and even the definitions of electrical units as adopted by all scientists suggest a fluid theory. No wonder, then, that some practical men have given up in despair, and finally concluded that the easiest way to understand a telegraph line is to consider that the earth is a vast reservoir of electrical fluid, which is pumped up to the line wire by the battery, and finally descends to its proper level at the distant end. Is not this the proper conclusion to draw from that unfortunate term "electric current ?" Remembering this fact—that we cannot yet free ourselves from these old theories, and exactly suit our words to our meaning—we shall now try to understand the modern progress in electrical theory.

This whole progress is based upon something in the human mind which warns us against the possibility of attraction at a distance through vacant space: Newton felt this impossibility in the case of gravitation, but it is to Faraday that we must look principally for the idea that electrical and magnetic actions must be carried on by means of a medium filling all space and usually called the ether. The development of this idea leads to the modern theory of electrical phenomena.

Take an ordinary steel magnet and, like Faraday, cover it with a sheet of paper, and upon this sprinkle iron filings. Mapped before us we see Faraday's lines of magnetic force extending from pole to pole. We can calculate the form of these lines on the supposition that a magnetic fluid is either distributed over the poles of the magnet or on its molecules, assuming that attraction takes place through space without an intervening medium. But at this idea the mind of Faraday revolted, and he conceived that these lines, drawn for us by the iron filings, actually exist in the ether surrounding the magnet; he even conceived of them as having a tension along their length and a repulsion for one another perpendicular to their length. Two magnets, then, near each other, become connected by these lines, which, like little elastic bands always pulling along their length, strive to bring the magnets together. These so-called lines of force (now called tubes of force) were, by his theory, conducted better by iron and worse by bismuth than by the ether of space, and so gave the explanation of magnetic attraction and diamagnetic repulsion.

The same theory of lines of force was also applied by Faraday to electrified bodies, and thus all electrostatic attractions were explained. By this idea of lines of force it will be seen that Faraday did away with all action at a distance, and with all magnetic and electrical fluids, and substituted, instead, a system in which the ether surrounding the magnet or the electrified body became the all-important factor, and the magnet or electrified body became simply the place where the lines of force ended; where a line of magnetic force ended there was a portion of *imaginary* magnetic fluid; where a line of electric force ended thete was a portion of *imaginary* electric fluid. As the quantities of so-called plus and minus electricity in any system are equal, we can thus imagine every charged electrical system to be composed of a group of tubes of electrical force (more strictly electric induction) which unite the plus and minus electrified bodies, each unit tube having one unit of plus electricity on one end and one unit of minus electricity on the other. The tension along the tube explains the reason why such an arrangement acts as if there were real plus and minus electrical fluids on the ends of the tube, attracting one another at a distance. Consider a plus electrified sphere far away from other bodies. The lines of force radiate from it in all directions, and, being symmetrical around the sphere, they pull it equally in all directions. Now bring near it a minus electrified body, and the lines of force turn toward it and become concentrated on the side of the sphere toward such a body. Hence the lines pull more strongly in the direction of the negative body, and the sphere tends to approach it.

In the case of a conducting body, the lines of force always pass outwards perpendicularly to the surface, and hence, if we know the distribution of the lines over the surface, or the so-called surface density of the electricity, we can always tell in which direction the body tends to move. It is not necessary to know whether there are any attracting bodies near the conductor, but only the distribution of the lines. These lines then do away with all necessity for considering action at a distance, for we only have to imagine a kind of ether in which lines of force with given properties can exist, and we have the explanation of electric attraction.

But the question now arises as to how the lines of electric force can be produced in the ether, or, in other words, how bodies can be charged. In the first place we know that equal quantities of plus and minus electricity are always produced. As an illustration, suppose it is required to charge two balls with electricity. Pass a conducting wire between them with a galvanic battery in its circuit. The galvanic battery generates the lines of force; these crowd together around it and push each other sideways until their ends are pushed down the wire, and many of them are pushed out upon the balls. When the tension backwards along the lines of force just balances the forward push of the electromotive force of the battery, equilibrium is established. If the wire is a good conductor, there may be electrical oscillations before the lines come to rest in a given position, and this I shall consider below. The motion of the ends of the lines of force over and in the wire constitutes what is called an electric current in the wire, which is accompanied by magnetic action around it and also by waves of electromagnetic disturbance which pass outward into space. If, after equilibrium is established, we remove the wire, we have simply two charged spheres connected by lines of electrostatic force and thereby attracted to each other. If we replace the battery by a dynamo or by an electric machine the effect is the same.

But there is another way by which bodies are often charged, and that is by *friction*. In this case we can suppose the glass to take hold of one end of the lines of force and the rubber the other end, and it is then only necessary to pull the bodies asunder to fill the space with lines. The friction is merely needed to bring the two bodies into intimate contact and remove them gently from each other.

The following considerations may guide us in understanding the details of the process. It is well known from Faraday's researches that a given quantity of electricity has a fixed relation to the chemical equivalents of substances. Thus, it requires 10,000 absolute electromagnetic units of electricity to deposit 114 grammes of silver, 68 grammes of copper, 34 grammes of zinc, &c. Hence we can consider, for instance, in chloride of silver that the atoms of silver are joined to the atoms of chlorine by lines of electrostatic force which hold them to each other. If, by rubbing the chloride of silver, we could remove the chlorine on the rubber, while leaving the silver, we could stretch them asunder and so fill space with the lines of electrostatic force. According to this theory, then, each atom has a number of lines of force attached to it, and it is only by stretching the atoms apart that we can fill an appreciable space with them and so cause electrostatic action at a distance.

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We come to the conclusion, then, that all electrification is originally produced by separating the atoms of bodies from one another, which can be done by breaking contact, by friction, or by direct chemical action of one substance on another, or in some other manner not so common. The lines of electrostatic force in a case of electricity at rest must always begin and end on matter, and they can never have their ends in space free from matter. The ends can be carried along with the matter, constituting electric convection, or they can slide through a metallic conductor or an electrolyte or rarefied gas, making what we call an electric current; but, as they cannot end in a vacuum, they cannot pass through it. Thus, we conclude that a vacuum is a perfect nonconductor of electricity.

The exact process by which the ends of the lines of force pass through and along a conductor can at present be only dimly imagined, and no existing theory can be considered as entirely satisfactory. In the case of an electrolyte, however, we can form a fairly perfect picture of what takes place as the decomposition goes on. Thus, in the case of zinc and copper in hydrochloric acid, we can imagine the zinc plate attracting the chlorine of the acid, thus stretching out the natural line of electric force connecting the chlorine atom and the first hydrogen atom; we can imagine the atoms of chlorine and hydrogen in the body of the liquid recombining with each other, and their lines of force uniting until they form a complete line long enough to stretch from the zinc to the copper plate; and all without once making a line of force without its end upon matter. We can further imagine the ends of this line sliding along the copper and zinc plates to the conducting wires and down their length, thus making an electric current and carrying the energy of chemical action to a great distance.

If the ends of the lines should slide along the wire without any resistance, the wire would be a perfect conductor; but all substances present some resistance, and in this case heat is generated. This we always find where an electric current passes along a wire: as to the exact nature of this resistance or the nature of metallic conduction in general we know little; but I believe we are approaching the time when we can at least imagine what happens in this most interesting case.

Besides the heating due to the electric current, steadily flowing, we must now account for the magnetic lines of force surrounding the current and the magnetic induction of one current on the other. If the current is produced by the ends of the tubes of electrostatic force moving along the wire then we may imagine that the movement of the lines of electrostatic force in space produces the lines of magnetic force in a direction at right angles to the motion and to the direction of the lines of electrostatic force. At the same time we must be careful not to assume too readily that one is the cause and the other the effect: for we well know that a moving line of magnetic force (more properly induction) produces, as Faraday and Maxwell have shown, an electric force perpendicular to the magnetic line and to the direction of motion. Neither line can move without being accompanied by the other, and we can, for the moment, imagine either one as the cause of the other. However, for steady currents, it is simpler to take the moving lines of electrostatic force as the cause, and the magnetic lines as the effect.

We have now to consider what happens when we have to deal with variable currents rather than steady ones. In this case we know from the calculations of the great Maxwell and the demonstrations of Hertz that waves of electromagnetic disturbance are given out. To produce these waves, however, very violent disturbances are necessary. A fan waved gently in the air scarcely produces the mildest sort of waves, while a bee, with comparatively small wings moved quickly and vigorously, emits a loud sound. So with electricity, we must have a very violent electrical vibration before waves carrying much energy are given out. Such a vibration we find when a spark passes from one conductor to another. The electrical system may be small in size, but the immensely rapid vibrations of millions of times per second, like the quick vibration of a bee's wing, sends out a volume of waves that a slowly-moving current is not capable of producing. The velocity of these waves is now known to be very nearly 300,000 kilometres per second. This is exactly the velocity of waves of light, or other radiation in general, and there is no doubt at present in the minds of physicists that these waves of radiation are electromagnetic waves.

By this great discovery, which almost equals in importance that of gravitation, Maxwell has connected the theories of electricity and of light, and no theory of one can be complete without the other. Indeed, they must both rest upon the properties of the same medium which fills all space—the ether. Not only must this ether account for all ordinary electrical and magnetic actions, and for light and other radiation, but it must also account for the earth's magnetism and for gravitation.

To account for the earth's magnetism we must suppose the ether to have such properties that the rotation of ordinary matter in it produces magnetism. To account for gravitation it must have such properties that two masses of matter in it tend to move toward each other with the known law of force, and without any loss of time in the action of the force. We know that moving electrical or magnetic bodies require a time represented by the velocity of light before they can attract each other in the line joining them; but, for gravitation, no time is allowable for the propagation of the attraction. But the problem is not so hopeless as it at first appears. Have we not in two hundred and fifty years ascended from the idea of a viscous fluid surrounding the electrified body and protruding arms outward to draw in the light surrounding bodies to the grand idea of a universal medium which shall account for electricity, magnetism, light, and gravitation? The theory of electricity and magnetism reduces itself, then, to the theory of the ether and its connection with ordinary matter, which we imagine to be always immersed in it. The ether is the medium by which alone one portion of matter can act upon another portion at a distance through apparently vacant space.

Let us then attempt to see in greater detail what the ether must explain, in order that we may. if possible, imagine its nature.

1st. It must be able to explain electrostatic attraction. These electrostatic forces are mostly rather feeble, as we ordinarily see them. Air breaks down, and a spark passes when the tension on the ether amounts to about $\frac{1}{100}$th pound to the square inch. It is the air, however, that causes the breakdown. Take the air entirely away, and we then know no limit to this force. In a suitable liquid it may amount to 500 times that in air, or 5lb. to 1 sq. in., and become a very strong force indeed. In a perfect vacuum the limit is unknown; but it cannot be less than in a liquid, and may thus possibly amount to hundreds, if not thousands, of pounds to the square inch.

2nd. It must explain magnetic action. These actions are apparently stronger than electrostatic actions, but in reality they are not necessarily so. A tension on the ether of only a few hundred pounds on the square inch will account for all magnetic attraction that we know of, although we are able to fix no limit to the force the ether will sustain. No signs have ever been discovered of the ether breaking down.

Again, we must be able to account for the magnetic rotation of polarised light as it passes through the magnetic field; and it can only be accounted for by assuming a rotation around the lines of magnetic force. This action, however, takes place only while the lines of magnetic force pass through matter, and it has never been observed in the ether itself. The velocity of rotation, however, is immense, the plane of polarisation rotating in some cases 300,000,000 times per second.

The ether must also account for the earth's magnetism. If we assume that magnetic lines of force are simply vortex filaments in the ether, we have only to suppose that the ether is carried round by the rotation of the earth, and we have the explanation needed. The magnetism of the earth would then be simply a whirpool in the ether.

3rd. The ether must be able to transmit to a distance an immense amount of energy, either by means of electromagnetic waves as in light or by the similar action which takes place in the ether surrounding a wire carrying an electric current.

The amount of energy which can be transmitted by the ether in this manner is enormous, far exceeding that which can be carried by anything composed of ordinary matter. Thus take the case of sunlight; on the earth's surface illuminated by strong sunlight a horse-power of energy falls on every seven square feet. At the surface of the sun the ethereal waves carry energy outward at the rate of nearly 8,000 H.P. per square foot! Again, an electric wire as large as a knitting-needle, surrounded with a tube half an inch in diameter, in which a perfect vacuum has been made, to prevent the escape of electricity, may convey to a distance 1,000 H.P.; indeed, even 10,000 or more horse-power, there been apparently no limit to the amount the ether can carry. Compare this with the steam-engine, where only a few hundred horse-power requires an enormous and clumsy steam pipe. Or, again, the amount carried by a steel shaft, which, at ordinary rate of speed, would require to be about a foot in diameter to transmit 10,000 H.P. When we compare the energy transmitted through a square foot of ether in waves, as in the case of the sun, with the amount that can be conveyed by means of sound waves in air or even sound waves in steel, the comparison becomes simply ridiculous, the ether being so immensely superior. As quick as light, the ether sends its wave energy to the distance of a million miles while the sluggard air carries it one. Thus, with equal strain on each, the ether carries away a million times the energy that the air could do.

4th. The ether must account for gravitation. For this purpose we are allowed no time whatever to transmit the attraction. As soon as the position of two bodies is altered, just so soon must the line of action from one to the other be in the straight line between them.

If this were not so, the motion of the planets around the sun would be greatly altered. Toward the invention of such an ether, capable of carrying on all these actions at once, the minds of many scientific men are bent. Now and then we are able to give the ether such properties as to explain one or two of the phenomena; but we always come into conflict with other phenomena that equally demand explanation.

There is one trouble about the ether which is rather difficult to explain, and that is the fact that it does not seem to concentrate itself about the heavenly bodies. As far as we are able to test the point, light passes in a straight line through space even when near one of the larger planets, unless the latter possesses an atmosphere. This could hardly happen unless the ether was entirely incompressible or else possessed no weight. If the ether is the *cause* of gravitation, however, it is placed outside the category of ordinary matter, and it may thus have no weight although still having inertia—a thing impossible for ordinary matter, where the weight is always exactly proportional to inertia. Ether, then, is not matter, but something on which many of the properties of matter depend.

It is curious to note that Newton conceived of a theory of gravitation based on the ether, which he supposed to be more rare around ordinary matter than in free space. But the above considerations would cause the rejection of such a theory. We have absolutely no adequate theory of gravitation as produced by the ether.

To explain magnetism, physicists usually look to some rotation in the ether. The magnetic rotation of the plane of polarisation of light, together with the fact of the mere rotation of ordinary matter, as exemplified by the earth's magnetism, both point to rotation in the ether as the cause of magnetism. A smoke ring gives, to some extent, the modern idea of a magnetic line of force. It is a vortex filament in the ether.

Electrostatic action is more difficult to explain, and we have hardly got further than the vague idea that it is due to some sort of elastic yielding in the ether. Light and radiation in general are explained when we understand clearly magnetic and electrostatic actions, as the two are linked together with certainty by Maxwell's theory.

Where is the genius who will give us an ether that will reconcile all these phenomena with one another and show that they all come from the properties of one simple fluid filling all space, the life-blood of the universe—the ether?

THE ELECTRIC ARC.

BY HERTHA AYRTON.

At the Electrical Congress held in Chicago in August, 1893, Prof. Ayrton read a long Paper on this subject, which gave the results of experiments which he had been carrying out with his students during the three preceding years. Neither the Paper, however, nor even any abstract of it has been hitherto published, since, while it was in the hands of the secretary of Section B of the Congress, it was unfortunately burnt five months after it had been read.

Prof. Ayrton, having no rough copy, had neither the courage nor the inclination to rewrite the Paper, which had already cost him so much trouble; but, as my own interest in electric arcs was roused while I was helping him in some of the later experiments, and as the investigations which I am at present carrying on are a continuation of those which he made, it will be well, before dealing with the results which I have since obtained, to give a very short abstract of the most important points which he noticed and the deductions made from them. This, fortunately, I am able to do, by using the curves which, having escaped the sad fate of the Paper itself, have been returned to him from America, and by examining the laboratory note-books.

The experiments to which Prof. Ayrton specially directed his attention were briefly:—

1. Obtaining curves connecting the steady final values of the potential difference between the carbons with the current for different currents, lengths of arc, and sizes of carbons, cored and uncored.

2. Obtaining the time variations of the potential difference between the carbons with various constant currents, various constant lengths of arc, and with the ends of the carbons variously shaped.

3. Obtaining the time variation of the potential difference between the carbons when the current was suddenly changed, and the length of the arc was kept constant.

4. The distribution of potential throughout the arc.

5. The influence of varying the current and the length of the arc on the depth and width of the crater.

6. The candle-power and efficiency of the arc, with various currents, potential differences, and lengths of arc.

The lamp (Fig. 1), was hand-regulated the adjustments being effected by turning pinion P_1 to alter the height of the positive carbon, P_2 the height of the negative carbon, and P_3 to raise both carbons together. By turning the nut N_1 the positive carbon could be turned about a horizontal axis in the plane of the figure, and by turning the nut N_2 the positive carbon was moved round a horizontal axis at right angles to the plane of the figure. To measure the potential difference between the tips of the carbons, the voltmeter was attached to two thin carbon rods *k*, *k*, sliding in tubes in a block of asbestos, A, and pushed against the main carbon rods C C by spiral springs S, S. Had the potential difference been measured between the lamp terminals, a variable error would have been introduced, from the drop of pressure in the carbons themselves, which would have been serious with large currents and long carbons. And, since the voltmeter had a resistance of about 80,000 ohms in circuit with it, the resistance between the ends of these auxiliary voltmeter carbons *k k* and the main carbons C C introduced no practical error.

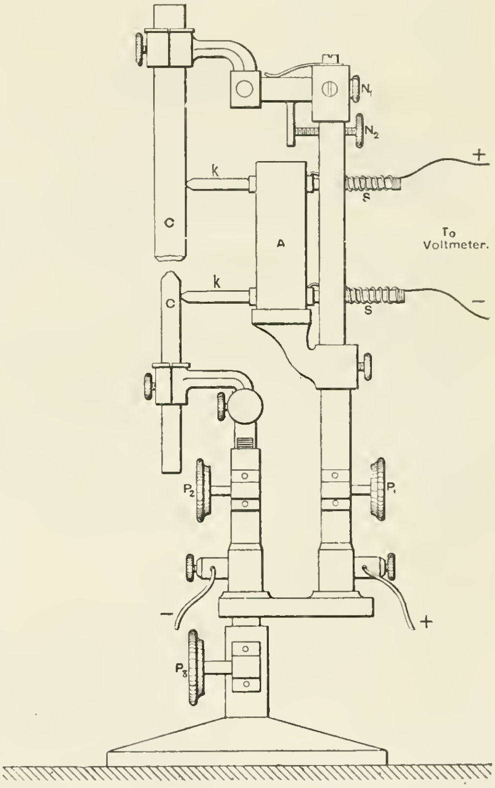


Fig. 1.—"Hand-fed" Arc Lamp.

The length of the arc means throughout the vertical distance between the point of the negative carbon and the horizontal plane drawn through the edge of the crater of the positive, this distance being measured on an image formed on the diagram screen at the upper left-hand corner of Fig. 2 by the lens L and the plane mirror M. This image of the arc was exactly ten times full size. Length of arc "0 millimetres" does not, therefore, mean that the carbons were in contact, but that the point of the negative carbon was just entering the crater at the end of the positive carbon.

Figs. 2 and 3 indicate the general optical arrangements that were employed for measuring the light given out by the arc under different circumstances, to be described later on. In each of these two figures, A, B, C are three plane mirrors so placed as to reflect on to the screen that portion of the light which would otherwise have passed under the screen.

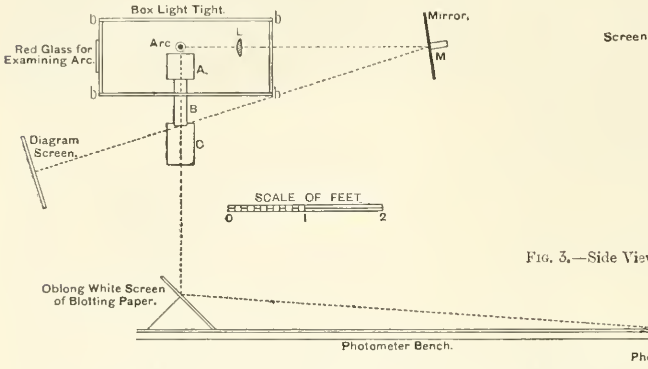

Box Light Tight.
b
b
b
b
Mirror.
Red Glass for Examining Arc.
Arc
L
M
A.
B
C
Diagram Screen.
SCALE OF FEET
0
1
2
Oblong White Screen of Blotting Paper.
Photometer Bench.
Photometer Fixed.
2-c.p. Methven Standard Adjustable in Position.
2000
1000
600
400
200
75
60
Scale Graduated Direct in Mean Spherical Candles.

FIG. 2.—General Plan of Apparatus for taking Mean Spherical Candle-power of Arc. A B C, three mirrors at different angles (*see* Fig. 3); L, projecting lens; M, mirror; Photometer bar about 12 feet long.

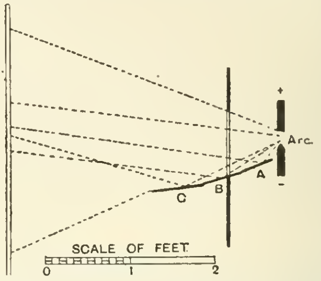


FIG. 3.—Side View of Three Mirrors, A, B, and C, throwing the Light of the Arc through a Slit on the Screen.

In Figs. 4, 5, and 6, the curves connect potential difference between the carbons with the current flowing for various constant lengths of arc, and with various sizes of carbons. Each point on each curve represents the potential difference between the carbons *after* the current has been kept flowing at its specified value for a considerable time, and the length of the arc kept at its specified value during the *whole* of this time. The carbons have thus acquired their normal shape for the particular current and length of arc. The time required for this varies from about 10 minutes to over one hour under different circumstances, and want of appreciation of the very long time that it is necessary in certain cases to keep the current and length of arc constant before the carbons acquire their final shape led to much labour being wasted at the commencement of the investigation in obtaining looped curves for ascending and descending current, like hysteresis curves for iron.

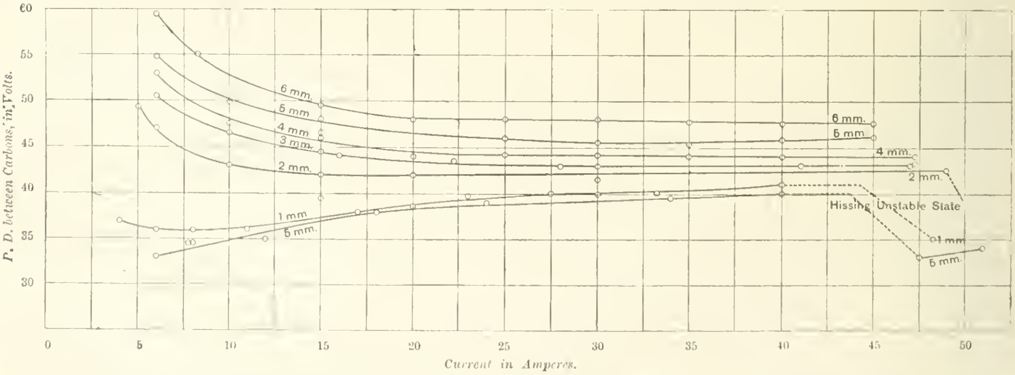


FIG. 4.—P. D. and Current for Different Lengths of Arc. Carbons:—Positive, 18mm., cored; negative, 15mm., solid.

In 1879 the late Mr. Schwendler published the then new fact that the potential difference between the carbons for a fixed length of arc was independent of the current. This result was confirmed by Profs. Ayrton and Perry, for currents that were fairly large for the carbons employed and for the length of arc (*Proc.* Phy. Soc., 1882, Vol. V. p. 197). More recent experiments, however, carried out with a greater range of current, have shown that the potential difference generally falls with increase of current for a constant length of arc. The curves on Figs. 4, 5, and 6 show that when the positive carbon is cored it is only for *long* arcs that this latter result is true, but that for short silent arcs the potential difference actually rises with increase of current—a fact not previously published. Between these descending curves for long silent arcs and ascending curves for very short silent arcs there is a region in which the potential difference is practically independent of the current after the current has reached a certain minimum value; that is to say, it is for arcs of about this one length for each particular pair of carbons that Mr. Schwendler's result is true.

The particular length of a silent arc for which the potential difference is practically independent of the current is best seen from the point of intersection of the curves on Figs. 7, 8, and 9, which connect potential difference with length of arc for various constant currents, and with various sizes of carbons. This length is evidently a little under two millimetres. When *both* the positive and negative carbons are *cored* the point at which the curves connecting potential difference and length of arc for different currents cut one another becomes very marked (*see* Fig. 10), and the length of arc corresponding with this intersecting point diminishes to three-quarters of a millimetre. On the other hand, when *both* carbons are *solid* there is *no* length of silent arc, for which the potential difference is independent of the current, as may be seen from the curves that will be published later on, when the experiments on solid carbons are discussed.

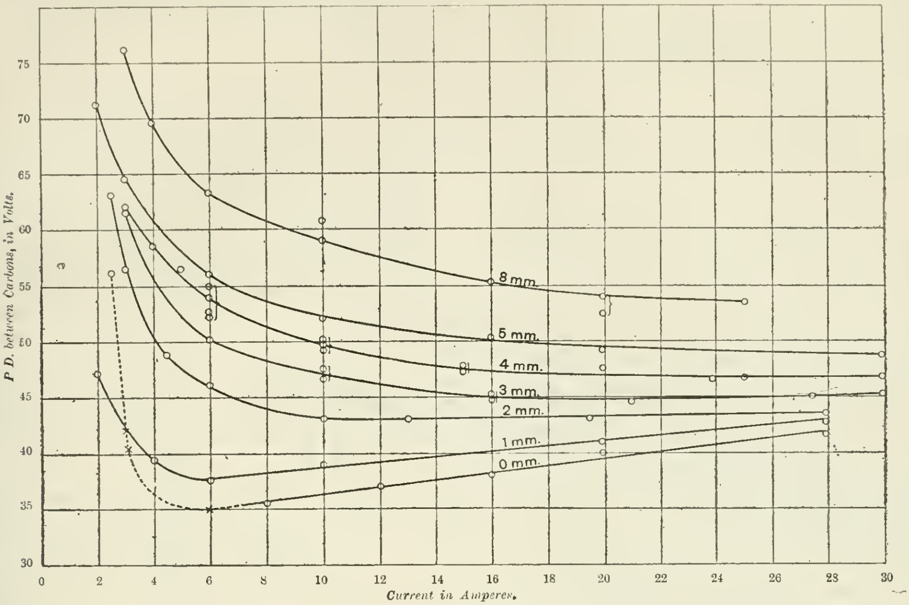


Fig. 5.—P. D. and Current for Different Lengths o Arc. Carbons :—Positive, 13mm., cored ; negative, 11mm., solid.

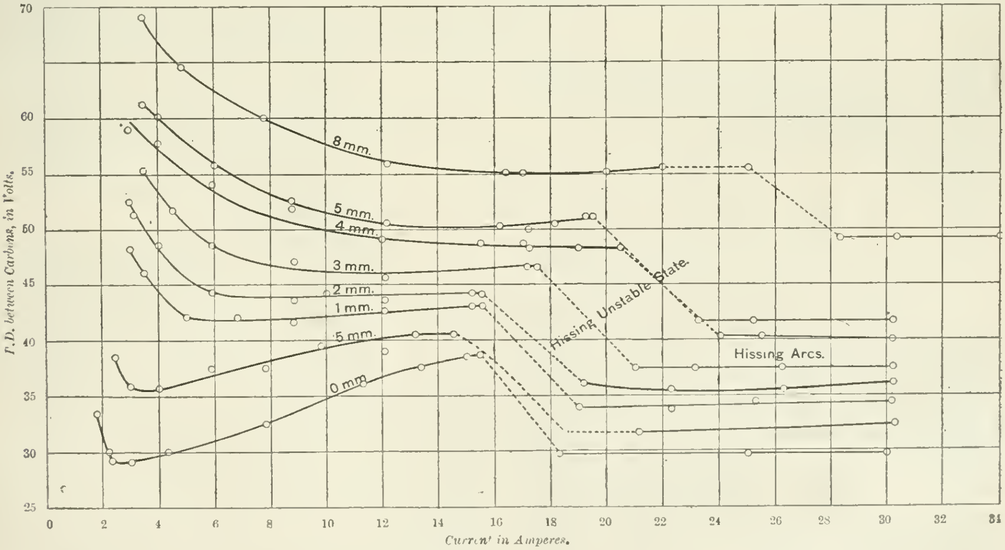


Fig. 6.—P. D. and Current for Different Lengths of Arc. Carbons :—Positive, 9mm., cored ; negative, 8mm., solid.

For very small currents, however, whether one, or both, or neither of the carbons be cored, the potential difference falls rapidly with increase of current, probably on account of a small current arc presenting a large cooling surface in proportion to its cross-section.

On examining the curves on Figs. 4, 5, and 6 another very curious fact may be noticed, viz., *if the potential difference between the carbons be kept constant, and the arc be lengthened, and maintained at the greater length, the current is larger and not smaller than it was for the shorter length of arc.* For example, a given potential difference, say 50 volts, sends a current of 4·1 amperes through an arc two millimetres long (Fig. 5), 6·2 amperes through an arc three millimetres long, 9·6 through one of four millimetres, and 16·4 amperes through one of five millimetres, all the arcs being silent. Or, dividing this potential difference of 50 volts by these currents, it follows

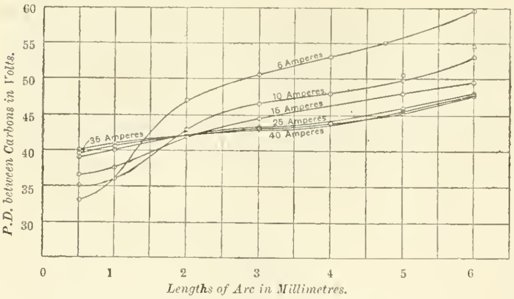


FIG. 7.—P.D. and Length of Arc for Various Constant Currents. Carbons:—Positive, 18mm., cored; negative, 15mm., solid.

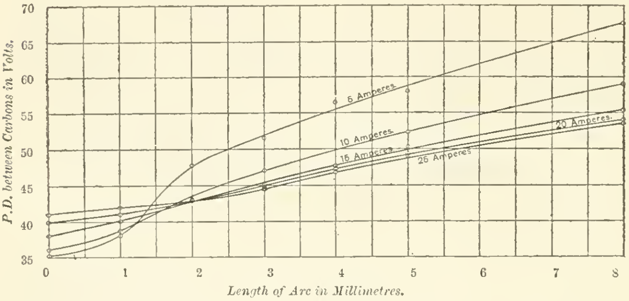


FIG. 8.—P.D. and Length of Arc for Various Constant Currents. Carbons:—Positive, 13mm., cored; negative, 11mm., solid.

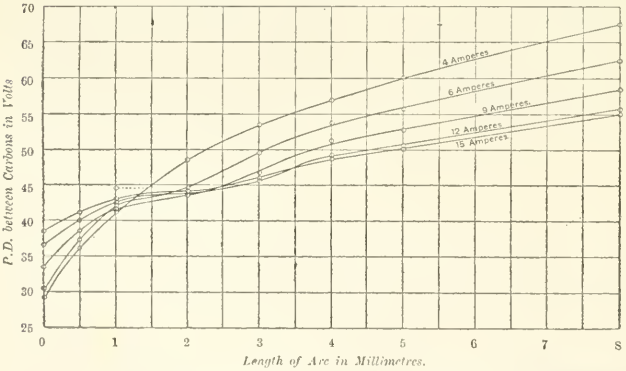


FIG. 9.—P.D. and Length of Arc for Various Constant Currents. Carbons:—Positive, 9mm., cored; negative, 8mm., solid.

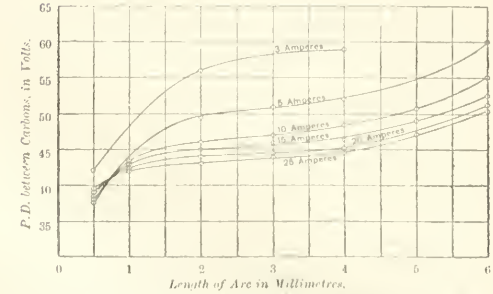


FIG. 10.—P.D. and Length of Arc for Various Constant Currents. Carbons:—Positive, 18mm., cored; negative, 15mm., cored

that the apparent resistances of the 2, 3, 4, and 5-millimetre arcs for this potential difference are 12·2, 8·1, 5·2 and three ohms respectively. Hence for a *constant potential difference, the apparent resistance of the silent arc, when in the normal condition, diminishes rapidly as the arc is lengthened.* I shall have to refer to this result again when describing my own experiments.

Another interesting point that is seen from the curves on Figs. 5 and 6 is that for very short silent arcs any given potential difference will send two distinct currents through the arc. For example, a potential difference of 41 volts (Fig. 5) will send either a current of 3 or of 21 amperes through a 1 millimetre arc. This points to the complete equation connecting potential difference, current, and length of arc for silent arcs, produced with a cored positive and a solid negative carbon, being a quadratic in terms of C, the current flowing, and not a linear equation such as has been published. To this I shall refer again, but I may mention that I do not find that such an equation as

$$v = a + b\,\frac{l}{C},$$

where v is the potential difference between the carbons, a and b constants, l the length of the arc and C the current (Prof. Silvanus Thompson, *The Electrician*, August 26, 1892) satisfies the curves on Figs. 4, 5, and 6, even for the longer arcs.

The part in the curves marked "Hissing Unstable State" really indicates a condition of the arc such that no current between the highest for the silent arc and the lowest for the hissing can be sent through the arc at all. For instance, on Fig. 6, consider the curve for a 3 millimetre arc. It is there indicated that no current between 17·5 and 21 amperes will pass through the arc. If, when a current of 17·5 amperes is flowing, you lower the resistance in the circuit by ever so little, the current immediately leaps up to 21 amperes or thereabout, and the potential difference falls from about 46 volts to about 37·5 volts, and, however cautiously and slowly you diminish or increase the resistance, the same result will follow, you will have either a silent arc with about 17½ amperes, or a hissing arc with about 21 amperes.

The potential difference for hissing arcs increases with length of arc, but appears to be fairly constant for a given length of arc (Fig. 6); in other words, the total apparent resistance of the hissing arc varies nearly inversely as the current for a given length of arc.

One talks of hissing, however, as if there were only one sort of hissing, whereas really there are at least two, with very different significations:—(1) The sort of sound like a kettle just about to boil, which belongs to a long arc with a small current, but which is *not* accompanied by a drop in the potential difference. (2) The sharp hiss of an arc of any length when the current sent through it is too great for a silent arc to be maintained; this is the hissing usually referred to. There is a third sound, rather like the wind blowing through a crack, which comes just before the hissing with big currents begins. It is a sound very difficult to maintain, for the arc has a great tendency at that particular stage to become either hissing or silent; it is accompanied by a beautiful intense pale green light along the edge of the positive carbon, or, rather, probably coming from the crater itself, but seen just above the edge of the crater in the image on the screen. There are also several other sounds given out by the arc, generally of a temporary character, and very difficult to classify.

There seems to be some idea that a "hissing arc" proper is necessarily a short arc, an idea which the curves on Fig. 6 will immediately dispel. Hissing may occur with any length of arc, if the current be increased beyond what the arc can bear silently. The hissing obtained with an 8 millimetre arc and a current of 29 amperes, for instance, is of exactly the same character as that obtained with a current of some 5 or 6 amperes when the carbons are first separated to form the arc. In both cases it simply means that the current is too big for the arc to burn silently.

(To be continued.)

SECONDARY BATTERY PATENTS EXPIRING THIS YEAR.

In our last issue we published a list of the secondary battery patents expiring during the present year, and gave an abstract of the Faure patent No. 129 of 1881, which expired on Thursday last. This week we give abstracts of the five remaining secondary battery patents, the legal existence of all of which will have terminated before this time next year.

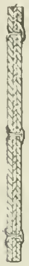


Fig. 1.
Faure's Patent.

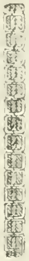


Fig. 3.
Faure's Patent.

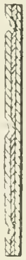


Fig. 4.
Faure's Patent.

Taking them in order of date we come first to Faure's patent No. 1,676 of April 16, 1881. This invention relates briefly to means of securing a porous covering against the face of a secondary battery plate to prevent the active material falling off.

In order to maintain the paste on the surface of a plate "a porous or permeable sheet or covering of any material not liable to be injuriously affected by the action of the battery is applied over the substance or composition, and secured to the plate or element by riveting, stitching, cementing, enveloping, or by the interposition between the plates of open-work material. This porous or permeable covering may consist of felt, cloth, asbestos, paper, cardboard, gauze, or cloth made with lead or other wire or any other similar porous or permeable material."

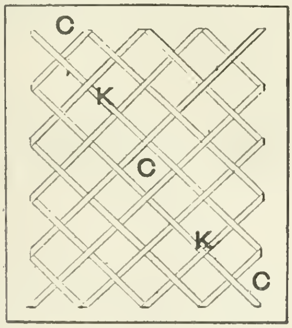


Fig. 6.—Faure's Patent.

The drawings accompanying the text show more clearly the various methods of securing these coverings to the pasted plates.

Figures 1 and 3 of the specification reproduced herewith are sections of a plate with its active material supported against the surface of the plate by a porous covering secured to the plate respectively by rivets and stitching. In Fig. 4 (reproduced) a plate with its covering cemented on to its surface is shown, and in Fig. 6 (reproduced) we have a side elevation of a plate in which a trellis, C K, of wicker work, indiarubber, or other similar material is arranged between it and the next plate so as to retain in position the porous sheets of both. Fig. 8 of the specification shows a cell in which the lead backing of the paste has a further backing of wood, and Fig. 10 a series of cone-shaped cells on this principle.

The claims are :—

1st. The peculiar means of *securing* a porous or permeable covering over the layers of active substance or composition or porous or spongy metallic matter, to the plates or supports of the battery so as to maintain the said layers of active substance or composition or porous or spongy metallic matter against the plates or supports, substantially as hereinbefore described.

2nd. In secondary batteries of the description herein referred to, constructing the elements with partitions or supports of impermeable material to which the plates with the layers of active substance or composition or porous or spongy metallic matter and porous or permeable supporting covering are attached substantially as hereinbefore described and illustrated in Figs. 8, 9, and 10 of the drawings.

From the foregoing it will be evident that this second patent of Faure's is by no means as important a weapon as that which expired last week.

The next formidable secondary-battery patent we come to is that of Mr. J. Wilson Swan, No. 2,272, of May 24, 1881, intituled "Improvements in Secondary Batteries or Apparatus for Storing or Conserving Electricity," and aiming at the production of plates having surfaces more suitable for holding spongy lead than any hitherto devised ; and for this purpose "plates of lead having a cellular, corrugated, or grooved surface, or surfaces of such a character as to be capable of retaining in the cells, grooves, corrugations, or interstices spongy or finely-divided lead" are employed.

The drawings accompanying the text are reproduced herewith in their entirety, and need no further explanation.

Swan's Patent.

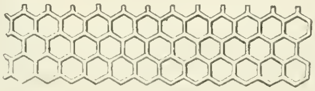


Fig. 1.

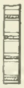


Fig. 2.

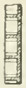


Fig. 2A.

Swan's Patent

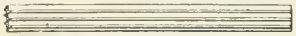


Fig. 3.

Fig. 4.

Fig. 4A.

"It should be understood," says the inventor, "that the form of the cells, corrugations or grooves may be greatly varied without departing from the principle of my said invention, the object being to obtain an interstical construction of plate capable of affording a very large amount of acting surface in a small compass, and to prevent the coating of oxide or spongy lead from falling away from the plate as it would from a plain vertical surface, unless held in position by some material external to the said coating."

The claim runs as follows :—

Constructing the plates of secondary batteries or apparatus for storing or conserving electricity with cells, corrugations, grooves, or interstices substantially as and for the purpose hereinbefore described.

The next patent is No. 3,926, granted to Mr. J. S. Sellon, and dated September 10, 1881. Perhaps the best way to gauge the exact extent and bearings of this patent is to begin at the end of it and work backwards. The patentee expressly disclaims the use of spongy lead, &c., *per se*, and the use of corrugated or grooved lead plates "unperforated for the retention of such substances." His claim is :—

> The use in the construction of secondary batteries of *perforated plates* or sheets, roughened, serrated, or indented, composed of lead, platinum, or carbon, upon, in, or against which plates spongy or finely-divided lead, or oxides or other salts, or compounds of lead, or other suitable substances or compounds are or may be held or retained substantially as and for the purposes hereinbefore described.

Fig. 1 of the specification, reproduced herewith, represents a perspective view of a perforated battery plate with dovetailed corrugations, a form stated as "very suitable." Other figures show perforated plates with angular zigzag corrugations, Fig. 7 (reproduced) representing a compound perforated plate.

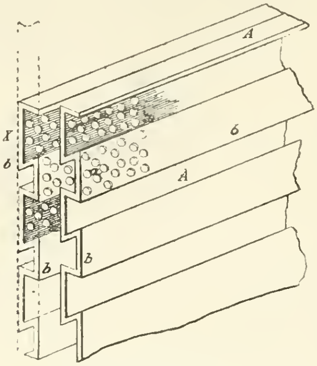


Fig. 1.—Sellon's Patent.
X, conducting strip ; A, perforated plate ; *a*, holes ; *b*, shelves.

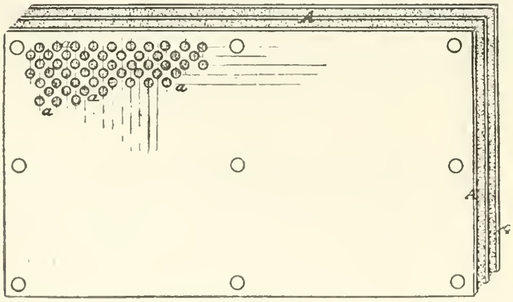


Fig. 7.—Sellon's Patent.
A, perforated plates ; *a*, holes ; *c*, active material.

The Swan patent, No. 5,494, of December 15, 1881, relates to the rapid preparation of secondary battery plates on the Planté plan, the plates being exposed to the combined action of acetic acid, carbonic acid, and atmospheric air, as in the well-known white lead process, the lead carbonate so formed being reduced to metallic lead by the plates being connected up as cathodes. The claim is for

> The preparation of lead plates for use in secondary voltaic cells by the combined action of acetic acid, carbonic acid, and atmospheric air, and the subsequent reduction of the carbonate of lead formed to metallic lead, substantially as hereinbefore described.

The Sellon patent, No. 5,631, of December 23, 1881, claims :—"The construction of terminal plates, supports, retainers, or frames employed in secondary batteries of a material or materials not readily subjected to the destructive influence of oxidation in the manner and for the purposes herein described." Amongst the materials mentioned are carbon, asbestos, wood, papier maché, cellulose, and platinum.

The surviving master secondary battery patents are, it will thus be seen, the Swan "grid" patent, No. 2,272 of 1881, expiring on the 24th of next May, and the Sellon "perforated plate" patent, No. 3,926 of 1881, expiring on the 10th of next September. It must be admitted that these two patents together with that of Faure, No. 129 of 1881, which expired last week, form a tolerably substantial foundation for a monopoly in the pasted-plate storage battery business ; as substantial and sure a foundation, that is to say, as one could expect to obtain from patents. It remains to be seen whether these three patents were in reality the incubus they are said to have been. If the complete freeing of the storage-battery business this year is followed by an outburst, not of feverish competition as in the glow lamp trade, but of inventive activity resulting in genuine advance towards a cheaper, more durable, and more manageable battery, then, and not till then, will it be possible to say without fear of contradiction that these three master patents were, though a boon to their owners, a bane to the electrical industry.

A LANE-FOX GLOW LAMP PATENT.

Fourteen years ago to-day Mr. St. George Lane-Fox took out his patent, No. 225, for "Improvements in Electric Lamps, in the Manufacture of Parts thereof, and Means of Turning on and off Electric Currents for Lighting and Extinguishing Lamps or for other Purposes."

The improvements in glow lamp manufacture referred to are as follows : The ends of what is now known simply as the filament, but which the patentee calls the "luminous bridge or burner," are directed to be inserted into spirals formed at the ends of the platinum leading-in wires, the spirals and said ends being then coated with genuine Indian ink. A particular mode of manufacturing the filament is then clearly described in great detail. The material to be carbonised is to be wound around a horseshoe-shaped block of graphite or gas carbon ; a piece of steel projecting from the block, serving as a knife-edge, to ensure that the filaments, as they shrink during baking, are all broken at the same place. The process of flashing is then described. The "baked threads" after removal from the blocks are to be placed in clips and "immersed in an atmosphere of coal gas or other carbon compound, while an electric current is passed through them so as to raise them to a white heat." The original high resistance is to be broken down by short-circuiting the dynamo, and then breaking the short circuit through the filament ; the process to be repeated until the succession of extra-current rushes has done its work. The text then proceeds to describe a means of thickening the ends of the carbonised threads prior to insertion in the platinum spirals aforesaid. The filament, whilst immersed in a hydro-carbon and traversed by a current, is to be short-circuited near the ends so that the entire deposit of carbon takes place at the ends.

The concluding portion of the patent relates to two electromagnet devices for enabling street lamps to be lighted and extinguished from the central station. One device effects the purpose by reversals in the polarity of the supply current, the other is actuated by sudden increases and decreases of pressure. The following is the pleasant *modus operandi* suggested. "The momentry increase of the electromotive force can be conveniently produced by the momentary introduction between the main and the earth of a powerful secondary battery and the momentary decrease by the sudden short-circuiting of the mains with the earth or by a sudden check of the source of supply of the electromotive force." Light-hearted suggestions such as these give one a vivid idea of the immense advance in practical knowledge of the essential conditions of electric supply which has been made since 1881.

The claims of this interesting and ingenious patent are six in number and relate to (1) the Indian-inked platinum spiral joint, (2) the baking of threads for "luminous bridges" on suitably-shaped blocks, (3) the preliminary incandescing of baked threads by extra currents, (4) the thickening of the filament ends by the short-circuit device, (5 and 6) the devices for lighting and extinguishing street lamps without affecting (?), the lights in the adjoining houses.

UNDERGROUND ELECTRIC LIGHT MAINS.

Messrs. Doulton and Co., of Lambeth, have just introduced the Spence-Doulton system (patented) of bare copper underground electric light mains, for which they claim that an attempt has been, for the first time, successfully made to combine the advantages of a genuine "drawing in" system with those obtainable from bare copper strip mains in culverts. Fig. 1 shows the system in an earthenware culvert; Fig. 2 in a concrete culvert; Fig. 3 a plan of the culvert; and Fig. 4 sections of junction box, and method of making branch connections. The system consists of one or more lines of tubes of vitrified stoneware, supported on insulating bridges of the same material (which serve to hold the tubes in place with an air insulation) in a culvert or trough of earthenware, concrete, or iron. The lengths of tubes are fitted with a patent joint of Doulton's manufacture. This is practically an artificial "bored-and-turned" joint requiring no cement, and the tubes can therefore be rapidly placed in position. Earthenware troughs can be supplied for the culvert, in 2ft. lengths, with socket joints for Portland cement, and provided with internal lugs for supporting the bridge insulators in position. The non-conducting character of the material must be regarded as an advantage, and this culvert can be more rapidly and conveniently constructed than one of concrete. The tubes are composed of vitrified enamelled stoneware, a thoroughly insulating material impervious to moisture, moulded into sections suited to the various requirements, but forming in every case a continuous envelope around the conductor. The separate sections or pipe lengths being united end to end by a water-tight joint, surface leakage is entirely prevented, and the danger of breakdown through flooding of the culvert is thus obviated. In addition to the high insulation given by the tubes, the bridges form a further safeguard in this respect, and as a consequence the insulation resistance, which is high to start with, does not vary, and immunity from surface leakage is secured to a greater degree than in other bare copper systems.

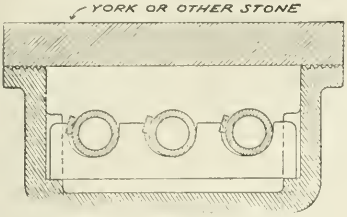


Fig. 1.—The Spence-Doulton System in Earthenware Culvert.

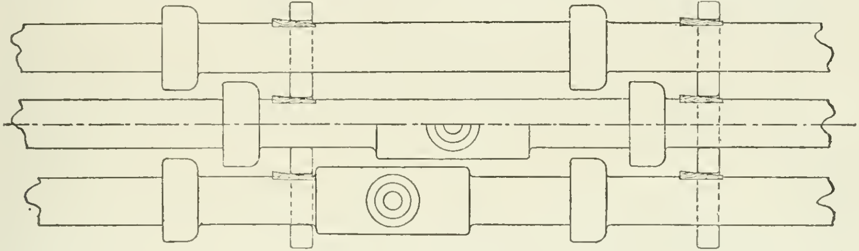


Fig. 3.—Plan of Culvert. A, Straight Pipes. B, Junction Boxes.

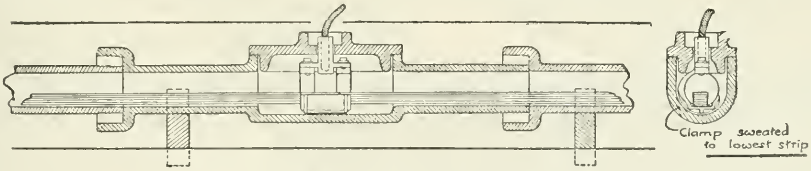


Fig. 4.—Junction Box Sections, showing method of making Branch Connections.

The Spence-Doulton system permits of additional strips being aid down with a facility even greater than that of drawing nsulated cables into cast-iron pipes. Existing conductors do not need to be hauled out before new ones can be drawn in, and, there being no insulation coating to be abraded, or to weight the strip, the surface boxes may be further apart than is the case where insulated cables are used.

Facilities for making service connections are offered by the new system, and the junction boxes, which are simple and inexpensive, can be inserted at small cost opposite every alternate party wall. Should, as sometimes happens, a connection be required where no provision has previously been made, it is only necessary to remove a short length of the pipe and to replace it with a modified one.

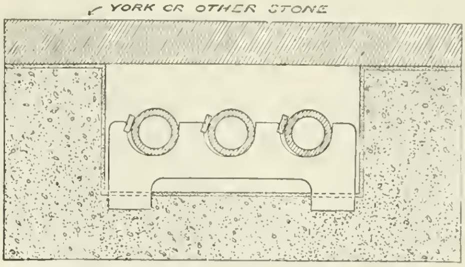


Fig. 2.—Spence-Doulton System in Concrete Culvert.

It is not essential to provide surface boxes for these branch connections, as the clamp or cable terminal does not obstruct the through-way for drawing in more copper, and the weight and strain of the joint is taken by the conduit, and not by the conductor. By thus joining each consumer directly on the network the cost of the sub-main from each surface-box is saved, and each circuit obtains the full pressure of supply. It is further claimed for the Spence-Doulton system that no straining devices are used. Every thing is retained in position by gravity, and no reliance has to be placed on the efficiency of set-screws or other tension apparatus.

With regard to cost of maintenance, practically no depreciation can occur with a conduit composed entirely of imperishable materials. It is not pretended by the makers that it can compete in first cost with the method of laying bare strips directly on notched bridge insulators; but it is claimed that this first extra cost is very small in comparison with the solid advantages secured.

BOOKS RECEIVED.

"Hilfsbuch für die Elektrotechnik." By C. Grawinkel and K. Strecker. (Berlin: Julius Springer. 1895.)

"Text-Book of Mechanical Engineering." By W. I. Lineham. Price 10s. 6d. (London: Chapman and Hall, Limited. 1894.)

CORRESPONDENCE.

"LABOUR-SAVING" APPARATUS AS AN INSTRUMENT OF EDUCATION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : I cannot do justice to my views on this subject in the time at my command; but your urgent appeal to me to say something in defence of them cannot be disregarded.

It is curious that such views as I hold should be so much opposed, and opposed by the very men who in their practice, generally, seem to me to act rightly. The criticism of a particular piece of apparatus, which is only one of hundreds in Prof. Ayrton's laboratory, seems as if it were going to be applied to Prof. Ayrton's whole method of teaching, and this means that it is going to be applied to the teaching which Prof. Ayrton has caused to be a very general kind of teaching all over the world. It seems to be forgotten that Prof. Ayrton's students have a very extensive course of laboratory instruction, in which the correction of all sorts of errors, allowances for all sorts of heat losses and electrical leakages, and graduation of ammeters and voltmeters, come in over and over again. His critics seem to think that in measuring the mechanical equivalent of heat, his students should not go straight at the actual problem, but should take up every problem that any previous investigator found in his way. Is it a lack or a superabundance *of humour*? Cæsar had to make roads in Gaul, so it is unscientific for a modern military man to use the railways, and he mustn't do it. Have Prof. Ayrton's critics ever read the adventures of Huck Finn? The two boys, Tom and Huck, are contriving the escape of a negro prisoner. Huck suggests digging him out with picks and shovels. "Huck Finn, did you ever hear of a prisoner having picks and shovels . . . ?" "Well, then," I says, "if we don't want the picks and shovels, what do we want?" "A couple of case-knives." "To dig the foundations out from under that cabin with?" "Yes." "Confound it, it's foolish, Tom." "It don't make no difference how foolish it is; it's the *right* way, and it's the regular way."

What a jolly and true story it is, and how the boys spoil their hands, and make no progress with the case knives, and how high-principled and theoretical is Tom, and how admiring and low-down and or'nary and practical is Huck! "Well, then, what are we going to do, Tom?" "I'll tell you. It ain't right, and it ain't moral, and I wouldn't like it to get out—but there ain't only just the one way; we got to dig him out with picks, and *let on* [pretend] it's case-knives." "*Now* you're *talking!*" I says: "Your head gets leveller and leveller all the time, Tom Sawyer," I says. "Picks is the thing, moral or no moral; and as for me, I don't care shucks for the morality of it, nohow. When I start in to steal a nigger, or a water-melon, or a Sunday-school book, I ain't in no ways particular how it's done, so it's done. What I want is my nigger . . . and I don't care a dead rat what the authorities thinks about it, nuther."

The fact is, too many teachers just now have uneasy consciences. They believe that as the great chemists of a hundred years ago had only tumblers and water buckets for apparatus, it is making the road to the chemist's heaven too irreligiously easy for him to give him the beautiful apparatus now at his command; but, like Tom Sawyer, who asked for a clasp-knife and pretended that the spade given him was a clasp-knife, they are continually using the good apparatus and pretending that it is primitive.

When I was at school, in the early sixties, I listened to lectures on chemistry and physics, and never made an experiment except at home. When I was at college, towards the end of the sixties, I listened to lectures on physics and never made an experiment. I listened to one of the most famous chemical physicists on chemistry, and I attended his chemical laboratory, where there was an attempt to teach some 30 men at a time, and what we did was a qualitative analysis of some 40 numbered bottles, whose contents were known to us through the kindness of last year's students. This bottle method was a failure, but it was the first attempt to give laboratory work to numerous students, and deserves recognition. For three years at Clifton I tried to do for physics what had been done for chemistry. I cannot call my system a failure—at all events, I gave my students an interest in laboratory work in spite of the small amount of time they had, and I was learning. I had gradually convinced myself of this—that there is no teaching power whatever in mere lectures on physics and mechanics; that laboratory instruction must be given to every individual student, and that without this laboratory instruction you may enable students to pass examinations; but you are causing deterioration of their mental powers all the time.

It was Sir R. Ball's book on mechanics which, in 1873 or 1874, first gave me a clear idea of the sort of work that might be done in a mechanical laboratory. He, however, used Willis's apparatus, which served for all sorts of experiments, and had to be taken to pieces and put together again. I wrote out descriptions of special pieces of apparatus for many investigations, and, indeed, made an attempt to get a book published at that time, the ruling ideas being these: A batch of three or four students should find a piece of apparatus ready; this apparatus, and the nature of the experiments, should have been described to them already in the lecture room. Definite written instructions should be before them as to the measurements to be made and as to the reduction of their observations, and the apparatus was to be left as it had been found. Also, that all apparatus used by first-year students should be as simple as possible, for I had found that complicated contrivances needing all sorts of corrections only produced confusion of mind in a beginner.

This system was never properly carried out, until, in 1881, Prof. Ayrton (whom I found to have the same notions as myself) and I arranged to give laboratory work in electricity and magnetism, mechanics, and heat to all the day and evening students at Finsbury. There is no space in a letter like this to adequately describe the system. I believe that everybody who has seen it in actual use has approved of it; it certainly has been enthusiastically copied, and is in active use in the great majority of teaching institutions all over the world. I do not see how in any other way we can give to *every* student some laboratory instruction. It is just possible, however, that a person who has not seen it in use will think that too much is done for the student and also for the demonstrator. I might illustrate the fallacy of this by almost any of the pieces of apparatus at Finsbury. To take a mechanical experiment; I have a small fly-wheel which is set in motion by a falling weight. At the instant when the weight ceases to act, the speed of the wheel must be measured. It seems to me impossible for a student to employ our method of measuring that speed, without refreshing his mind concerning the laws of motion. He is to measure also the energy given to the wheel. He first assumed that all the energy of the lifted weight was given. One correction is for the kinetic energy of the weight when it ceases to act. Then for the friction of a pulley and the stiffness of the cord which causes motion; then for the friction of the journals of the wheel and so on; if time permits, and if a student is interested, there are smaller and smaller corrections which are nearly endless. This is an experiment which refreshes a student's memory of all parts of mechanics. But perhaps the very next piece of apparatus which the student takes up will involve no such corrections. He will know beforehand that the apparatus has been constructed in such a way that all sorts of errors are nearly eliminated; and in using this apparatus, instead of his attention ranging through all the principles of physics, it is kept upon some one important principle. Prof. Ayrton, at the Central College of the City Guilds Institute, works on the same principle on which he worked at Finsbury. Students have apparatus arranged for them, and have very definite instructions as to what they must observe. The experience of 13 years has confirmed my opinion that it is only in this way that laboratory instruction can be given to every student who attends one's lectures. On any other system the mental fatigue of the demonstrators must be appalling, if the whole thing is not a farce. But there are some other students. These men are really doing original work. They have already passed through the general course. These men design apparatus, and either make it themselves or see that it is made. They make all their arrangements themselves, and no other student interferes with their apparatus

They try to get possession of the very best labour-saving instruments. In their general course they, no doubt, had to calibrate a voltmeter or an ammeter; but if they can get possession of a voltmeter or ammeter which needs no calibration, of course they will use it. Now, how many such students can there be under one professor? It depends on the professor. The professor is consulted in their greater difficulties. I know of some professors who have the power to detach their minds from other work and enter into the troubles even of four different investigations; but I am unable to do this myself. It is, however, to be observed that the general system sketched above has produced advanced students who are fit by themselves to meet all minor difficulties.

In 1874 I put myself as a student under the command of the greatest physicist of our time. He had hundreds of students who only listened to lectures; but they had no time to devote to laboratory work. They could not obtain degrees unless they attended his course. But, except the two or three men who did nothing but laboratory work, I am quite certain that not one of those numerous students got any benefit from the teaching of this great genius. I speak of what I know, and I am really overstating the number of men who benefited. I benefited because I did nothing else except attend these lectures and work in the laboratory. I had already had students and a laboratory of my own. I could consult my chief several times a day. I could get any apparatus constructed that I designed, and I had only to say that I wished for a particular galvanometer or electrometer, and I had it at once. Yes, I benefited and gained more insight into scientific work in that one year than I ever gained before or since. But what of the seven or ten other men who were supposed to be doing laboratory work. I say that it was merely the crackling of thorns under a pot, in nearly every case. They were discontented, soon lost any interest that they had had at the beginning, and they became very mischievous. I have seen a reflecting galvanometer thrown about like a cricket ball, and much worse doings than that.

The system of giving, not to every student, but to a certain selected number of students, laboratory instruction, with apparatus arranged ready, is sometimes carried out in another than the Ayrton-Perry manner. The guiding idea is that the *mind of a student is to be trained*. My life has brought me in contact with no end of faddists on mind training. It seems to me that in every case it is not the system which a man invents which has to do with the great success which I acknowledge to have observed, it is the man himself. Whether he induces his disciples to break up roads like labourers, or makes them practise vegetarianism, or impresses them with the beauties of pure mathematics, or esoteric Buddhism, or any other faddism that looks to outsiders nonsensical, they are enthusiastic, for his soul has kindled theirs, and so long as they live they may thank him for waking them up and bringing them out of the land of the Philistine.

But let such a man take himself away and leave his system behind; let him do what is much more mischievous—put his system in a book for woodenheaded men to carry out, and what mind training is there possible in the system?

It seems to me that if we are to have a crystallised system of laboratory instruction at all, and I am convinced that we must have one for the average student if the average student is to study physics, it must be one of which the object is the gain of *knowledge*, of insight into phenomena, because such knowledge is in itself valuable. As I said many years ago, we must allow a boy to use a watch, even if he cannot make one, and even if he does not understand its construction. What sort of presumptuous insects are we to say that a boy cannot through experiments know the truth of the 47th proposition of the first book of Euclid as exactly as he knows the truth of any of Euclid's axioms? How are we to arrange things into things that are complex and things that are simple? The sixth book of Euclid is more complex to me than the first, because I began at the first and worked on to the sixth.

A direct reading ammeter is complex because I know the steps by which it has been evolved, and it was not common in my youth. A 2ft. rule is not complex because I have always had one. The word ammeter has an uncivilised sound to some men, because in their province the provincials have been always used to call it an ampere-meter; they have never spoken of a balance as a gramme-meter or a pound-meter or a ton-meter, and so the word balance is not uncivilised to them. Who was it in Silas Marner who said, "It is not proper to say *hoss*, we say *'orse*?"

The whole point is in this: Can we give to every student physical knowledge unless we give him laboratory instruction? Can we give to many students laboratory instruction unless on the system which I have described? If not, that system must be adopted, and we may be quite sure that wherever there is an ingenious demonstrator who wants to train the minds of his students he will find sufficient ways of escaping from the system. He will find enough elasticity in the system for what is practically perfect freedom. A man who breaks stones on the road will find enough materials for mind-training in the work that he does, and a man like Plato found such materials in the absurd ideas of a universe created by his imagination.—Yours, &c.,

J. PERRY.

EXPLOSIONS IN ELECTRIC CULVERTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The numerous explosions which have occurred in electric culverts lead me to draw attention to the necessity of accurate and delicate testing for inflammable gas in the air of these culverts and street boxes. After a recent explosion of this kind in the metropolis careful tests were carried out by Mr. Boverton Redwood's apparatus, which involves the application of the hydrogen flame to gas testing. I have shown that this flame surpasses all others for accurate and delicate gas testing, and I was therefore quite prepared to hear that the presence of 1 per cent. of gas was easily detected by means of this apparatus when other detectors had failed to find any gas at all.

It does not seem to be generally considered that coal-gas is more or less completely deodorised by passing through soil, as is shown by the strong smell which it imparts to the soil through which it has passed. It has been stated on good authority that this loss of smell is in some cases complete. Hence, the statements freely made that coal-gas must be absent from the culverts, if this gas is not smelt, cannot be held to be conclusive; and it becomes necessary to apply an accurate detector, such as Mr. Redwood's apparatus, to establish the fact whether gas is present or not.

It may be added that this hydrogen-flame detector, when applied either in a safety lamp or in the apparatus already mentioned, also easily shows the presence in the air of a proportion of carbonic oxide or of water-gas, which, according to the report of the Prussian Firedamp Commission, is below the quantity poisonous to man when inhaled.—Yours, &c.,

University College, Nottingham, FRANK CLOWES.
January 15, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There is a point in connection with the recent explosions in electric light conduits of which I have not seen any notice taken, and that is the possibility of the explosions being due to other than the two generally suspected gases; namely, electrolytic and coal gas.

I refer to the hydrogen gas resulting from the oxidation of iron, of which so great a quantity is now buried beneath our pavements. Iron does not oxidise at ordinary temperatures in dry air or oxygen, but requires moisture, such as is furnished by dew or rain in the atmosphere or the moisture in the ground. The carbon in the iron probably facilitates the electrolysis of the water, the oxygen combines with the iron, and the hydrogen is given off. Wrought-iron pipes buried without any protection oxidise very rapidly, and must produce a great quantity of hydrogen gas, which, owing to its being inodorous, is not to be detected by smell, but requires a special detector.

In the case of the explosion in some large gas mains in the Tottenham-court-road some years ago, evidence was given by the gas company's man that there was no smell of gas before he applied the light test; and, further, the pipes were afterwards found to be very rusty inside.—Yours, &c.,

J. HIGGINS.

AN EXAMPLE OF VISCOUS HYSTERESIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In course of some experiments with Thompson's permeameter, a definite magnetic lag was noticed. To test the value of this lag, the time effect was observed for three values of H by measuring the pull exerted immediately after closing the circuit and also after different intervals of time, with the following results:—

H.	Time required for maximum pull.	Increase over initial pull.
192	5 seconds	1·2%
48	10 ,,	1·6%
24	20 ,,	0·9%

The second value is at the bend of the μ curve of a particular specimen tested. Being unaware whether this effect has been observed before, with this apparatus, we venture to call your attention to it.—Yours, &c.,

H. P. GAZE,
E. E. JOHNSTON.

University College, Liverpool,
January 15, 1895.

BORCHERS' BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Shortly after reading the account of Dr. W. Borchers' cell, which appeared in your issue of November 30th, I made a trial of the same, using carbon electrodes, one of which was placed in cupric chloride, the other in a solution of cuprous chloride in hydrochloric acid, a porous partition being interposed.

Cupric chloride was used, as the prolonged action of an air jet would convert cuprous chloride into cupric chloride. The E.M.F. between the electrodes was found to be about 0·2 volts in the above arrangement, and when coal gas was led into the cuprous chloride the E.M.F. rose to 0·36 volts. A similar result was obtained by churning the cuprous chloride with petroleum oil.

In this arrangement cupric chloride is used as an oxidising agent, and, as it requires a considerable amount of energy to deoxidise a cupric solution, a loss of E.M.F. results. By employing chromic acid as an oxidising agent, instead of cupric chloride, an E.M.F. of 0·79 volts is observed. As the theoretical voltage for the oxidation of either hydrogen or carbon monoxide is nearly 1·5 volts, a large balance remains to be accounted for, and this loss may arise from the formation of partially oxidised compounds, from the energy of combination of the fuel material with the carbon monoxide, or from the correction for the temperature coefficient of the cell, the E.M.F. of which rises with the temperature.

Hoping the above may interest some of your readers.—Yours, &c.

WILLIAM TATLOW.

Belgrave-square, Monkstown, Dublin.

Night Navigation in Indian Waters.—Some interesting experiments have been lately carried out, says the *Indian Engineer*, on the s.s. "Scinde" with regard to the possibility of night running in the Sunderbunds by the aid of the electric search light. On the 19th ultimo a large party assembled on board to witness the trial run of the plant (which consisted of a 25,000-c.p. projector worked by a Marshall's vertical engine and dynamo placed on the upper deck) off Koila Ghat. The search light was shown on different vessels down the river with the long-distance lens on, and then put on the bank with the diverging lens. The trial proved in every way satisfactory, and she left Calcutta the next morning, making a most successful run to Naraingunge, on the Brahmaputra, and back in 12 days. Although detained frequently at night on account of tides and fogs, Capt. Ainsley reported most favourably on the light as an aid to navigation at night; and as the "Scinde" has made a second trip to Naraingunge in even shorter time with the light, under the command of Capt. Elder, there is no doubt that in the near future boats will be running through the Sunderbunds both by night and day, which will be a great advantage to the tea and jute traders.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

IMMEDIATE. The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is in active preparation, and will shortly be ready. Subscription and advertisement orders should be sent in immediately. In addition to the old well-known features of the book, which will be brought up to date, a quantity of new and useful matter will be added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Alterations to existing entries and New Names must be sent in forthwith, and the Publisher requests that those who have received the circulars relating to the new edition will return them corrected at once.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices:—*

THE LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, presented with our issue of January 4th, can be obtained mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 2s.—each post free. The Map showing positions of Supply Stations is mounted on the back of the Table. The Coloured Map issued with the present Number is also mounted on some copies, and the price of these, complete, post free, is 4s. 6d.

LABORATORY NOTES AND FORMS.—With the above title, we have in the press a set of Elementary (now ready) and Advanced Exercises (ready shortly) for use in Electrical Engineering classes. These have been prepared in Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is just out, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. net., is now ready.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"ELECTROMAGNETIC THEORY" (Vol. I., second issue), by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application. Vol. II. is in preparation.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"DRUM ARMATURES AND COMMUTATORS."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

TENDERS INVITED.—The Metropolitan Asylums Board require tenders for the supply and running of mains, and the wiring of the buildings and grounds of the North-Western Fever Hospital, Haverstock Hill, London, N.W. Some further particulars are given elsewhere, and sealed tenders must be sent in by eleven o'clock on Thursday next, January 24th. Mr. T. Duncombe Mann is clerk to the Board, Norfolk House, Norfolk-street, London, W.C.

——— The Moss Side School Board invite tenders for the installation of the electric light in their schools in Prince's-road, Moss Side, Lancs. Particulars may be obtained from Mr. S. V. Clirehugh, Temple-chambers, Brazennose-street, Manchester, on and after the 28th inst., and tenders must reach Mr. W. E. Rowcliffe, the clerk of the Board, 30, Cross-street, Manchester, not later than 12 noon on Wednesday, February 6th. Some further particulars appear in our advertisement columns

——— In the Vosges Department of France the Saint-Die Municipality invite tenders for the concession of a central electric lighting station for the town. Tenders to be sent in by February 1st.

——— Tenders for the complete electric lighting of the Museum and Art Gallery, Dock-street, Newport, are invited. Particulars can be obtained of Messrs. Swash and Bain, architects, Friars-chambers, Newport.

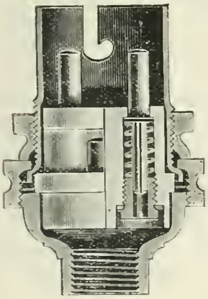
TENDERS ACCEPTED.—The tender sent in to the Electric Lighting Committee of the Coventry City Council by Messrs. Chamberlain and Hookham, of Birmingham, for the supply of sixty electricity meters, has been accepted, at £270. 10s. and £20. 14s. for testing the meters. Each meter is, we understand, to be certified as efficient by the Electrical Standardising and Testing Institution, the specification for the meters having been prepared by Mr. Robert Hammond, consulting electrical engineer to the Corporation.

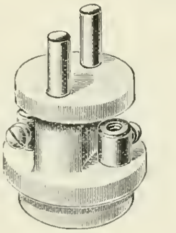
Vacant Appointment.—The Sunderland Town Council invite applications for the appointment of an assistant electrical engineer at a salary of £120 per annum. Some particulars are given in our advertisement columns, and applications must be sent in not later than 5 p.m. on Wednesday next, the 23rd inst., to Mr. F. M. Bowey, Town Clerk, Town Hall, Sunderland.

Sale by Auction.—Messrs. Wheatley Kirk, Price and Goulty announce the sale on Wednesday, February 6th, at 10 for 11 o'clock prompt, under sanction of the High Court of Justice, in the action Hammond *v.* the Brighton and Hove Electric Light Company (Limited), of the entire contents of the central lighting station, 49, Gloucester-road, Brighton. The sale includes a large quantity of heavy plant by the best makers, about 20 miles of cable, a quantity of electrical instruments, 19 arc lamps, E.P.S. and E.C.C. accumulators, &c., &c. Some further particulars are given in our advertisement columns, and all information can be obtained of Mr. G. Sneath, 44, Gresham-street, E.C. ; Messrs. Slaughter and May, 18, Austin-friars, E.C. ; or of the Auctioneers, 49, Queen Victoria street, E.C., London, and Albert-square, Manchester.

Turbine for Sale.—Messrs. H. R. Lewis and Co., of Draper's-gardens, E.C., offer for sale in our advertisement columns a 146-H.P. turbine of the improved Jonval pattern.

Messrs. Verity and Sons' Lampholder.—We illustrate herewith a new form of lampholder just patented by Messrs. B. Verity and Sons, of London and Birmingham. A glance at the illustrations will show the principal deviations from the standard type. The china insulator is made of one piece, and the holes in which the plungers work themselves form the cylinders, so that the insulation is most perfect. Nothing is visible when the lampholder is put together but the two contact plungers. The method of wiring is simple and safe, the connection having the popular bleck terminal. A good feature of the lamp is that the current is not carried through the springs, but by the contact of the plungers, which are split to make a tight fit in the metal parts on the lower face of the insulator. We think that this latest pattern will compare favourably with any other lampholder that we have seen.





Liquidations.—At a meeting of shareholders of the British Volta Electric Glow Lamp Company (Limited), held at 49, Queen Victoria-street, E.C., on Dec. 29th, it was resolved to wind up the Company voluntarily. Mr. A. Hunt, of Chesham and Great Missenden, is the liquidator.

——— The shareholders of the Wray Electrical Engineering Company (Limited) resolved, at meetings held on November 30th and December 17th, to wind up the Company voluntarily. Mr. J. F. Dyson, C.A., of Huddersfield, has been elected liquidator.

Bankruptcy.—At the London Bankruptcy Court on Monday, the affairs of Mr. Whitehall Mulloney, commission agent, were mentioned. Amongst the causes of failure the debtor refers to a loss of £2,000 on accommodation bills in connection with the purchase of the English patent rights of an electrical storage battery. The creditors have accepted a proposal for the payment of 7s. 6d. in the pound in cash.

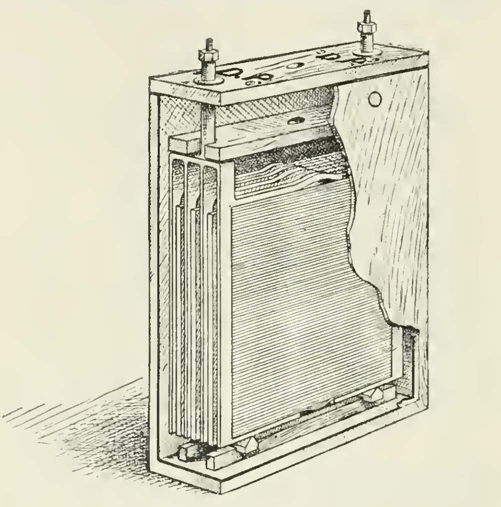
New Branch.—Messrs. Avon Gray and Co., general wood turners, of Ladypool-street, Birmingham, have opened a branch office at 28, Gray's Inn-road, W.C., where Mr. Archibald Campbell represents them as agent.

The Pneumatic Type Writer.—In the Pneumatic Type Writer (Limited) prospectus, issued a short time back, considerable prominence was given to the fact that heads of agreement had been entered into between the Pneumatic Type Writer (Limited) and the Consolidated Telephone Construction and Maintenance Company (Limited) respecting the manufacture by the latter of the pneumatic type writers. We are asked to state that these headings of agreement have now been cancelled.

Apparatus Catalogue.—Messrs. Elliott Brothers announce that their new complete catalogue of electrical apparatus for 1895 is now ready. Copies can be obtained on application to the firm at 101 and 102, St. Martin's-lane, London, W.C.

Casings and Covers.—Messrs. McGaw and Co., of York-road, Lambeth, S.E., send us their new list of electric light cable casings and covers. The list is illustrated, and shows a variety of sizes. The firm make casings and cleats to any design in any wood. A special feature are the "Appendo" mouldings, which are much used as covers for electric light casings. Copies of the list can be obtained, post free, on application.

Storage Batteries.—The illustration herewith shows a modification of the well-known "D.P." battery, made by Messrs. Johnson and Phillips, specially adapting the battery for train-lighting. Special advantages are claimed, the principal being the small space occupied, reduced weight, large space between the plates (preventing short-circuiting and collapse of cells), great mechanical strength, and high efficiency. The cell shown above is the B size, of 220 ampere-hours capacity, the outside dimensions being $6\frac{1}{2}$in. by $10\frac{3}{4}$in. by $17\frac{3}{4}$in., weight 92lb. The cells are produced by a special electrolytic process, which is claimed to be entirely free from any patent held by other makers. The "D.P." batteries are well known to the trade, and Messrs. Johnson and Phillips anticipate a brisk business in the new type.



The New "D.P." Train-Lighting Cell.

Electric Construction Company (Limited).—The past year has been a very busy one with this Company. The reconstruction of the Company took place during the latter part of 1893, and during 1894 the staff of the Company and the business generally has been completely re-organised. In April last Mr. Parker left the Company, and Mr. Blackburn was appointed chief engineer. Since then the re-establishment of the business has proceeded satisfactorily and successfully. Mr. Garcke, who joined the Company for a fixed period, retired from the position of Managing Director at the end of the year. During the period of his connection with the Company the reconstruction and reorganisation above referred to have been carried out, and the Company is now in smooth waters. The Company's business, we are pleased to learn, has steadily increased, and we are informed that the orders executed during the past half-year have been of an equal amount if not greater than that of any previous half-year in the Company's history. The central-station work on hand during the year has included complete electrical equipments for Wolverhampton Corporation and for the united Parish of St. James and St. John, Clerkenwell ; dynamos and accessories for the lighting stations of Halifax, Crystal Palace District, Chelsea, Liverpool, Stafford, Aberdeen, Nottingham, &c. ; and a large number of motor generators, both continuous and alternating, for various stations, including Brighton Corporation, Oxford, &c., &c. Traction work orders have included the extensions of the Liverpool Overhead Railway, complete electrical equipment of the Madras Electric Tramways, and electric locomotives for South Africa. In general dynamo, motor and switch work the Company has been exceedingly busy, an unprecedented number of machines for private firms having been delivered during the autumn. Several large orders for power transmission, mining and pumping plant have also been executed. Orders already in hand for 1895 are sufficient to keep the shops fully employed for several months, and include the equipment for Clerkenwell; alternators and transformers for St. Pancras Vestry; six 65 kilowatt transformers for Birmingham; plant for South Africa; dynamos for the War Office; motor transformers for Manchester and Birmingham; Lighting plant for China, &c.; in addition to a large number of general orders.

Electric Heating.—During the recent severe weather the lessees of the Vaudeville Theatre, London, found it necessary to provide some system of warming for frequenters of the theatre. After consideration, Mr. Henderson, the manager, decided to adopt electric heating. Messrs. Crompton and Co.'s Brompton-road establishment was speedily requisitioned to supply suitable electric heating apparatus. The order was received at 11 o'clock on Tuesday morning, and by six in the evening the theatre was being warmed electrically. Although no mention had been made of any system of heating having been adopted, many persons remarked on the increased warmth and comfort. The large radiators employed were portable, and it was found possible to place them in the stalls during the day and remove them to the sides of the theatre in the evening. Messrs. Crompton have now received an order for the permanent warming of the theatre, and in a short time the new system of warming will be completed. The cost is not expected to exceed that of other systems, and, being free from danger, and allowing for perfect regulation, the electric system of heating should shortly become very popular for theatres and other places of amusement.

Loud-Speaking Telephones.—The use of loud-speaking telephones on cable steamers when engaged in cable-laying or repairing work has proved eminently successful. The Eastern Telegraph Company's c.s. "Chiltern" has recently tested the instruments of the Single Wire Multiple Telephone Signal Company's manufacture, and the report is to the effect that "standing on the bow baulks, with the receiver 20ft. away, it was possible under ordinary conditions of cable work to hear quite distinctly." The instruments were also found to be very useful between the testing room, cable tanks, and the picking-up and paying-out gear at the bows and stern of the vessel, while for use in the engine room they serve to supplement the ordinary engine room telegraph, and allow of orders being given which are not otherwise provided for—such as "one turn ahead," &c. There is no doubt that a cable steamers' equipment will in future include a complete telephonic installation.

Trade in 1894.—Mr. A. P. Lundberg reports a very satisfactory year's work. The "Unique" switch and other specialities of the firm have had a full share of support during the year, and continue in large demand. Trade with the Continent and the Colonies has, during the past year, largely increased, and those firms who have decided to have nothing but the best work in all apparatus used have naturally not allowed Mr. Lundberg's specialities to be overlooked. In this connection it is satisfactory to find that the experience of firms in this country who are best known for the excellence of their manufactures all report a steady and increasing recognition of their efforts to improve the apparatus and accessories used in electric light and power work. Mr. Lundberg has not reached the length of his tether in new patterns. He hopes during 1895 to introduce to the trade a number of new designs of switches and other fittings. The current year opens with satisfactory orders.

Tests.—Mr. Thomas Barton informs us that the result of a recent test of feeders and ring main and pilot wires at Blackburn. The total length of cable being 6·75 miles was an insulation resistance, including pilot wires, of 190 megohms. The result is, therefore, highly satisfactory, being nearly double the guarantee. The cables are of Messrs. Siemens Bros. and Co.'s manufacture.

New Year's Greetings.—The Commercial Cable Company forward us a New Year's greeting in the shape of a useful pad hanging calendar, which, in addition, gives the various offices at which telegrams can be forwarded *viâ* the Commercial system, rules regarding registered addresses, counting words in messages, tariff rates, business holidays, standard time, and other information.

"Commudine."—We have received the following from the London Electrical Goods Agency, of 53, Victoria-street, S.W.: "Your notice in the last issue, for which we thank you, was hardly correct in one particular. The material was sent you as from the Electrical Goods Agency, and not as from Messrs. Mavor and Coulson. If you will kindly make this right in your next issue you will kindly oblige. We are also agents for Messrs. Mavor and Coulson, and it is probable from this fact that the mistake has arisen." Messrs. Mavor and Coulson also write as follows:—"We were very much surprised to see in this week's issue of *The Electrician* a reference to Commudine in connection with our name. This note was sent without our authority, and we have been quite unable to trace its source. The material in question is Commutine, and belongs to Messrs. Henry Lea and Thornbery, consulting engineers, of 38, Bennet's-hill, Birmingham. We have used Commutine to a considerable extent, and know of nothing to equal it for keeping commutators in good order. We strongly recommend it to all who wish to see their commutators run bright and without wear. We have no manner of claim to Commutine. We do not even know of what the mixture exists. Thanking you in anticipation for inserting the above." We regret that the mistake should have been made, but at the head of the letter which accompanied the sample, Messrs. Mavor and Coulson's name appears in letters more than twice as large, and more than twice as conspicuous, as that of the London Electrical Goods Agency. The name of the latter firm on the bottle was accidentally hidden by a piece of tape, and the most conspicuous words are "Mavor and Coulson, of Glasgow, manufacturers of Sayer's patent dynamos and motors, C. C. system of concentric wiring and Commu*d*ine," (*not* Commu*t*ine), the last being in writing.

New Catalogue.—Messrs. Laing, Wharton and Down send us their latest catalogue of dynamos, motors, coupled plants and accessories. The catalogue is embellished with a number of excellent illustrations, the frontispiece showing a factory driven by a large "L.W.D." electromotor. Other illustrations include two-, four-, and six-pole machines, arc lamps, and several views of machines installed for power transmission work, air compressors, &c. The firm are sole agents for "Okonite" specialities, and for Messrs. Bolling and Lowe for light portable railways, machine tools, &c.

Electro Harmonic Society.—A smoking concert is announced for Friday, the 25th inst., at the St. James's Hall Restaurant, Regent-street, W., at eight o'clock. An excellent programme is provided.

Smoking Concert.—A well-attended gathering of the members of the City Electric Athletic Club (in connection with the *employées* of the City of London Electric Lighting Company) took place at a smoking concert, held at the Falstaff, Eastcheap, E.C., on Friday last week, and an excellent entertainment was provided. The club announce their third annual Bohemian concert to take place in March.

Ashton-under-Lyne.—The general discussion on the electric lighting question took place at the last meeting of the Town Council. Mr. Councillor Kelsall inquired if there was any prospect of the electric lighting scheme being proceeded with. Many applications had been made for improved lighting in the principal streets of the town, and these applications were becoming more frequent day by day. The Mayor, in reply, said that the Lighting Committee were fully aware that something would shortly have to be done in the matter of electric lighting, but no provision had been made in the estimates for the current year. The surveyor had been instructed to obtain information on the subject, and this would be communicated very shortly to the Council.

The African Transcontinental Telegraph.—In a very voluminous and interesting report just published by the British South Africa Company the following reference is made to the African Transcontinental Telegraph Company's operations:—

> "Since the date of the last report good progress has been made with the work of construction by the African Transcontinental Telegraph Company (Limited) of that section of the line to Uganda which is to connect Salisbury in Mashonaland with the Company's possessions north of the Zambesi, bringing Nyassaland, British Central Africa, and ultimately Lake Tanganyika in direct communication with the Cape, and thereby Great Britain. The survey of the section from Salisbury to Zomba (400 miles) has long since been made; the material for the sub-divisions north and south of the Zambesi has been sent forward, and about 313 miles of line have been completed. This includes the section of 180 miles from Blantyre to Tete, and that northward from Salisbury as far as the Mazoe River, where telegraph offices have already been opened. An arrangement has been arrived at by the British South Africa Company, on behalf of the African Transcontinental Telegraph Company, with the Portuguese Government for the construction by them, with the Telegraph Company's material, of that part of the line, covering 120 miles, which crosses Portuguese territory."

Bedford.—Messrs. Kilpin and Billson have secured the contract for wiring the Town and County Club, Bedford, and the work is being carried out under the supervision of Mr. J. Hardie McLean, consulting engineer.

Bradford.—The Gas and Electricity Committee of the Corporation are seriously considering the question of an extension of the supply station, as the demand for electric current is every day increasing.

Bowness.—The Lighting Committee of the District Council have decided to make no opposition to the application by the Windermere Company for an electric lighting Order. The Committee consider the interests of the public are protected by the terms of the Order.

Cardiff.—An attempt made to appoint a special committee to inquire into what is termed the delay in completing the electric lighting of the town was defeated at the last meeting of the Council by 15 votes to 5.

Chelsea (London, S.W.).—At the next meeting of the Vestry a proposal submitted by the Chelsea Company for lighting a number of the principal thoroughfares of the district by electricity will be considered. The Company offer to enter into a seven years' contract for lighting the public lamps during ordinary lighting hours at £28 per lamp per annum, a minimum of 50 lamps being stipulated. The Vestry are to provide the lamps, and the Company will connect the lamps with their system of mains and cables, and maintain them at the price quoted.

Cheltenham. Complaints having been made of the quality of the gas supplied by the local gas company, it is proposed to establish a gas testing station at the electric light testing station in Manchester-street. Complaint is also made of the inefficient gas lighting of the upper part of the High-street; but the principal consumers have expressed a wish to wait until the electric light cables are put down, in order that they may have the benefits of the improved illumination. Up to the present the electric mains go no further than Cambray. The Surveyor was instructed to obtain tenders for the electric lighting of the Municipal Offices, and to ascertain whether Messrs. Brydges, Mellersh, and Brydges would join in the expense of wiring the premises throughout.

Church Lighting.—The church of St. Mary, Redcliffe, Bristol, has now been fitted for the electric light, and the effect is pronounced most satisfactory. The church has some magnificent carving; but, owing to the general construction, pendants were not available. Twenty 16-c.p. incandescents are used for encircling each of the four arches, current being obtained from the Corporation mains.

Fareham.—The special notice required in order to rescind the previous resolution of the District Council to purchase the local electric lighting company's undertaking has been given, and is to be discussed at a future meeting.

Glasgow. At a meeting of the Tramway Committee of the Town Council on Wednesday, an offer was submitted by a private firm offering to work several of the lines by electricity. It was decided, however, to decline the offer.

Hackney (London, N.).—There was to have been a discussion on the electric lighting question at the last meeting of the Vestry, but it was decided to adjourn its consideration till the next meeting.

Kendal.—At the last Town Council meeting, in moving the adoption of the Committee's recommendation to oppose the application of the Windermere Company for a Provisional Order, Mr. Councillor Jefferys said the Committee did not wish it to be understood that they were against the introduction of the electric light; but, unless more favourable terms could be obtained from the Company, the Committee were desirous that the Council should themselves take up the question of supplying electric current. The Committee's recommendation was agreed to.

Killarney.—Last week the action brought by the Killarney Electric Lighting Company against the Killarney Town Commissioners, in which the Commissioners were sued for the amount of the Company's account for electric lighting, came before Judge Shaw in the County Court. It will be remembered that the question at issue is the validity of a contract given by one section of the Town Commissioners contrary to the opinions of another section. The quarrel is a very pretty one, and, after the action is concluded, the Gas Company propose to bring their action against the Commissioners for their bill. After a lengthened discussion the judge said that the question was a very important and a very difficult one, and raised points as to the various statutes; he would, therefore, reserve his decision for another occasion. As may be easily realised, the action was not devoid of humorous incident.

Lambeth.—On a proposal to reconstitute the Electric Lighting Committee, with the object of information being obtained to be subsequently reported to the Vestry, it was pointed out that the Vestry had obtained a Provisional Order nearly two years ago, but nothing had yet been done; unless the Vestry was prepared to proceed with the subject it should allow a private company to come in. It was ultimately decided that the clerk should prepare a report upon the precise position of the parish in regard to the Electric Lighting Order, and that Mr. Preece's report, which was circulated amongst the members some time back, should be again printed and circulated

Liverpool.—At Monday's meeting of the Lighting Committee of the Corporation, a proposal was adopted that an application should be made to the Board of Trade for a licence to enable the Corporation to light the streets of the city by electricity, and to supply electric current in the manner now adopted by the Liverpool Electric Supply Company (Limited). The proposal was carried by four votes to three. Notwithstanding this singular proceeding, we understand the Corporation are still negotiating with the local company for the transfer of their undertaking to the Corporation. Under these circumstances it is surely unlikely that the Board of Trade would agree to grant any such licence, at any rate until the negotiations have failed. The success of the local company is well known, and any attempt to compel the Company unduly to hasten the negotiations at a possible loss to its shareholders is not likely to be countenanced by the Board of Trade. Under all the circumstances, the action of the Electric Lighting Committee is more likely to complicate matters than to lead to a speedy settlement. It is possible, however, that the full Council will decline to sanction the Committee's action.

Leeds.—Some months ago the National Company asked leave from the Leeds Highways Committee to lay a considerable number of its wires underground instead of overhead, and the committee agreed on condition that the Company would undertake to pay an "acknowledgment" of 5s. in respect of every subscriber using their wires. The Company, however, protested against this impost, and pleaded that the postal authorities paid nothing, or only a nominal sum, for a similar right. The committee, however, declined to give way, and so additional wires by which the Company is enlarging and improving the facilities of its patrons are being erected in the air.

Lighting of Turkish Baths.—Gas has always proved a serious drawback to the full enjoyment of a Turkish bath. In the superheated air of the hot rooms gas is particularly objectionable, and it is, therefore, satisfactory to learn that in the extensive range of Turkish baths in Camden-road, London, N.W., the electric light is now superseding gas. The installation is being carried out by Messrs. Pickup and Co., of Queen Victoria-street, E.C.

Montrose.—At a meeting of the Town Council a previous resolution to support the Scottish House-to-House Company in its application for a Provisional Order for lighting the district by electricity was confirmed.

New Graving Dock.—The Wallsend Slipway and Engineering Company have just completed a new graving dock at Wallsend, on the Tyne. On Saturday last the ceremony of opening the dock was performed by the Mayor of Newcastle. This is the second slipway owned by the Company, both being 1,000ft. in length and capable of accommodating vessels of 2,000 tons. Illumination is provided by four powerful arcs and a large number of incandescent lamps are placed along each side of the dock, by which means work can be carried on by night, and facilities are offered for the repairing of oil vessels, in the tanks of which no naked lights are allowed.

Newington (London, S.E.).—The County of London Company have notified the Vestry of their intention to apply for a Provisional Order, and the Vestry will oppose the application, apparently awaiting the decision of the Committee appointed in the adjoining parish of Lambeth to discuss the electric lighting question generally.

Oswestry.—The action taken by the Local Board in connection with the application of the gas company for an increase in the price for lighting the public lamps has led to the receipt of a plausible letter from the gas company deprecating any tension between the Local Board and the company. It is, however, the opinion of many members of the Board that the gas supplied to the public lamps would be dear at any price. Further complaints have been addressed to the gas company, and it is possible that an attempt will be made to resuscitate the local electric lighting scheme.

Plymouth.—A Sub-Committee has been appointed to consider and report as to the exercise by the Corporation of its powers under their Electric Lighting Provisional Order.

Presentation.—Mr. K. Lowdon, of Messrs. Lowdon Bros., Dundee, is about to depart for Calcutta, where he is to instal the electric light in two extensive jute mills. The event was made the occasion of a supper and presentation by the employés on the evening of the 11th inst.

Queenstown.—A proposal is before the Town's Commissioners to appoint a competent electrical engineer to report to the Board upon the practicability of lighting Queenstown by electricity, by utilising the present machinery at the pumping station, and upon the probable cost of the undertaking.

Reductions.—The City of London Company notify the following allowances to consumers and reduction of meter rentals:—5 per cent. off a bill amounting (at 8d. per Board of Trade unit, the Company's standard rate) to £100 per annum, 7½ per cent. off £200, 10 per cent. off £400, 12½ per cent. off £550, 15 per cent. off £700, 17½ per cent. off £850, 20 per cent. off £1,000. The discounts will be allowed in the accounts rendered for the last quarter of the year, and after the consumer has been supplied for a complete year from January 1st to December 31st. Each tenancy in a building to be treated as a separate consumer. The rate for current for lighting at night (between the hours of 10 p.m. and 6 a.m.) and for motive, heating and cooking purposes remains at 4d. per unit, and is not subject to discount. The meter rents are altered as follows:—Up to 50 lamps of 8 c.p., from 5s. to 2s. 6d. per quarter: above 50 and for every additional 50 or part of 50 8-c.p. lamps 2s. 6d. per quarter. These alterations take effect from January 1st instant.

Richmond, Surrey.—The offer of Messrs. Drake and Gorham to inspect the Local Board's electric lighting undertaking periodically for the sum of £3. 3s. per annum and travelling expenses was discussed at the last meeting, and if the firm are prepared to accept £4. 4s. per annum the offer will be accepted.

Taunton.—At the last meeting of the Town Council one of the members complained of the increase of the cost of lighting the public streets, and stated that, "by using the electric light, the Council had turned night into day"—apparently much to the speaker's regret.

The Electric Light in New Zealand.—In a note from Wellington, New Zealand, we are informed that several errors have crept into the Trade Notes dealing with the electric lighting question in New Zealand. The statement on page 706 of our last volume that the Brush Company was supplying the plant for the *Herald* offices at Auckland and the General Electric Company the fittings is an error. This work has been carried out by Mr. A. I. Suckling-Baron, Managing Director of the New Zealand Electrical Syndicate (Limited), as consulting engineer to Messrs. Wilson and Horton, and the plant was supplied by the General Electric Company. From time to time statements have appeared which would, it seems, give the impression that the plant at Wellington was not running satisfactorily. We are assured that no trouble has ever been experienced with this plant, and the contracts made with the Corporation have been carried out to its satisfaction. What would appear to have given rise to the complaints that have been made is the fact that the lamps used for the public lighting are not large enough. Only 20-c.p. lamps are used, and these are placed very far apart. The New Zealand Syndicate are also completely dependent upon the City Corporation for their water supply, and when pressure is low the speed of the turbines is decreased accordingly, and the lights are dulled. We are pleased to make this explanation, but our correspondent will appreciate the difficulty we experience in verifying items of news which reach us from such a distance.

Telegraph Wire and Apparatus Exports.—Although the exports of telegraph wire and apparatus during December are not so large as in November, they are fairly satisfactory, showing an increase of £7,210 over the exports of December, 1893. This will be seen from the following figures:—November, 1894, £49,438; December, 1894, £41,152; December, 1893, £33,492; December, 1892, £38,439. It is, however, when we turn to the figures relating to the exports during the whole of the year, which are now available, that evidence is found of the improvement in this trade during 1894. In 1892 export values only reached £909,917. In 1893, they advanced to £1,062,887, while last year they show the large increase of £354,259, having amounted to a total of £1,417,446.

Telephonic Extension.—Arrangements have been completed at the General Post Office, Buxton, by which direct communication is established between Buxton, Manchester, Leeds, Newcastle-on-Tyne, Bristol, Exeter, and Plymouth.

The Trades' Union Dispute at Olympia.—The officials of the Electrical Trades' Union sends us a cutting from the *Daily Chronicle* of the 15th inst. which bears reference to our remarks on this subject in our last issue. A denial is given to the statement of the secretary of Olympia (Limited) that all unionist workmen were not discharged. It is also denied that any restraint was placed upon union men from going back to their work. On the contrary, it is stated that all union men who applied for work have been refused. With regard to the original point of dispute, it is stated that the two men who were originally accused of creating a disturbance had been dismissed for the day at the usual hour, and, instead of leaving the building, visited the staff bar and became unruly. It is pointed out that so trifling a matter scarcely justified the locking out of 40 wiremen whose character up to that time had been unimpeachable. With regard to the extra pay alleged to have been so liberally bestowed by the Directors, it is stated that this extra money was paid to only 15 out of the total number of men engaged on the work, and this for performing work of an exceptionally dangerous character. The excess pay is stated to have been one halfpenny per hour, and even this was not granted until the whole of the men threatened to stop work in order to obtain the Union rate. With regard to the "offer" of £1 to 13 of the men provided their portion of the work was finished at a stipulated time, it is pointed out that these men were set an impossible task at a quite inadequate rate of pay, and as proof of this it is stated that for the same work the same men each earned £4 after the offer of £1 by the Directors had been declined. Certainly the statements at present before us are, to say the least, at variance, and as, so far as we remember, this is the first time in which the men in the union have been at serious difference with their employers, it would be interesting to learn to which side the truth really belongs.

Tiverton.—In connection with a proposal to purchase their undertaking from Messrs. J. Heathcote and Co., the proprietors of the local gas company, a somewhat heated discussion took place at the last meeting of the Town Council. The proposal was opposed in the interests of electric lighting, and was ultimately deferred for further consideration to a date not fixed.

Toxteth.—It is stated to be the intention of the District Council to apply for a licence to supply electric current within their district.

Transvaal.—It will be remembered that in 1891 those responsible for the management of Moodie's Gold Mining and Exploration Company decided to put down plant for the generation and distribution of power on their property. In November of that year, Mr. Lewis Cousens prepared plans and quantities for the work. Little progress was made with the scheme until June, 1893, when it was officially announced that electric power would be available by January, 1894. In May, 1894, it was announced that the current would be ready for supply in August, and now dissatisfaction is expressed that the completion of the installation seems as far off as ever. It was proposed to supply this power at £20 per horse-power per annum. This arrangement was again modified; but the latest report is that a much higher figure will have to be paid. The whole business appears to be badly managed by the Moodie's Company, if the *Barberton Herald* is to be believed.

Ulverston.—The first work after the election of Chairman of the new Rural District Council was to undo what had been done by the Council's predecessors in the electric lighting matter. The Council have rejected the report presented on the subject.

Valuation of Machinery.—Those interested in the subject of the quinquennial re-valuation of machinery which takes place in 1895 are recommended to apply to the Machinery Users' Association, 8, Laurence Pountney-hill, Cannon-street, E.C., and 16, Deansgate, Manchester, for information.

Wakefield.—The City Council have received a notification from the Cathedral authorities intimating their intention of lighting the Cathedral by electricity, and asking for particulars concerning the electric lighting scheme for the city. Mr. Robert Hammond has discussed with the Electric Lighting Committee his report on the subject, and it has been decided that the Committee shall visit and inspect several of the principal electricity works in operation in England.

Walsall.—As mentioned in our last issue, at Monday's meeting the Town Council discussed the tenders sent in by Messrs. Thomas Parker (Limited), the Callender Company, and Mr. H. Gough, for work in connection with the electric lighting scheme. The Town Clerk read correspondence from the Electric Construction Company, in which the Company complain that they have been unfairly passed over by the Council, who had not given them an opportunity of sending in an amended tender. The Chairman of the Company pointed out that in restarting the electric trams the Company had been largely influenced by the understanding that the Corporation were favourably considering their tender for the electric lighting works. After some discussion the tenders above referred to were accepted. It was further decided to raise £15,000 on account of the loan of £19,000 sanctioned by the Local Government Board for electric lighting purposes.

Windermere.—The District Council have agreed to give their consent to the application of the Windermere Company for a Provisional Order.

Wolverhampton.—In reply to a request for information regarding the supply of electric current, the Mayor said that it had been considered unwise to commence the supply until everything was quite ready, but regretted to say that a short time ago when they were about to make tests of the work, Mr. Lewis, their electrical engineer, met with an accident which would lay him up for several weeks, but they had engaged another engineer to make the tests, and these were now being made.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The revenue return of this Company for the quarter ended December 31, 1894, is as follows:—Sale of current for public lighting, £3,181. 3s. 2d., against £3,105. 4s. 9d. in the corresponding period of 1893; private lighting, &c., £26,052. 5s. 3d., against £13,091. 9s. 11d.; other sources, £404, against £450: total, £29,637. 8s. 5d., against £16,646. 14s. 8d.—an increase of £12,990. 13s. 9d. The equivalent of 8-c.p. lamps connected on December 26, 1894, was 135,460, against 65,541 on December 26, 1893.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Company (Limited).

The following is the report of the Directors for the half-year ended September 30, 1894, to be presented to the forty-fifth half-yearly ordinary general meeting, to be held at Winchester House, 50, Old Broad-street, London, on Thursday next, the 24th inst., at one o'clock :—

The revenue for the six months ended September 30, 1894, amounted to £362,557. 2s. 5d., from which are deducted £97,533. 0s. 9d. for the ordinary expenses and £43,709. 12s. 5d. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £4,815. 0s. 9d. for depreciation of spare cable, £1,138. 19s. 4d. due to revaluation of currency assets, and £5,458. 7s. 9d. for income tax, there remains a balance of £209,902. 1s. 5d., to which is added £2,001. 8s. 2d. brought from the preceding half-year, making a total available balance of £211,903. 9s. 7d. From this balance there have been paid —

Interest on debentures and debenture stock	£27,571	0	7
Dividend on Preference shares	20,296	7	0
Two interim dividends of 2s. 6d. per share each on the Ordinary shares..............................	100,000	0	0
	£147,867	7	7

After carrying £4,860. 5s. 6d. to the reserve fund for maintenance ships, there remains a balance of £59,175. 16s. 6d., which is carried forward to the next account.

The revenue includes £22,687. 8s. 6d. dividends for the half-year upon the Company's shares in the Eastern and South African, the Black Sea, the Direct Spanish, and the African Direct Telegraph Companies.

Two of the Directors, the Most Hon. the Marquis of Tweeddale, and Sir Albert J. Leppoc Cappel, K.C.I.E., retire by rotation at this meeting, and, being eligible, offer themselves for re-election. The auditors, Messrs Deloitte, Dever, Griffiths and Co., and Messrs. Welton, Jones and Co. retire and offer themselves for re-election.

Anglo-American Telegraph Company (Limited).

The following is the report of the Directors to the ordinary general half-yearly meeting of the proprietors, to be held at Winchester House, 50, Old Broad street, London, on Friday next, the 25th inst., at two o'clock :

The total receipts from July 1 to December 31, 1894, including the balance of £1,173. 8s. 5d. brought forward from the last account, amounted to £148,837. 4s. 7d. This sum, however, is subject to revision, as the financial result of the judgment given in favour of this Company against the Paris and New York Telegraph Company cannot yet be determined. The traffic receipts show a decrease of £6,948 as compared with the corresponding period of last year.

The total expenses of the half-year, including the repair of cables, &c., as shown by the revenue account, amounted to £55,851. 18s. 5d., being a decrease of £3,399. 0s. 10d.

The Directors, under the powers conferred upon them by the Articles of Association, have, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £80,985. 6s. 2d.

Interim quarterly dividends of 9s. per cent. on the Ordinary stock, and 18s. per cent. on the Preferred stock, were paid on November 1st last, absorbing £31,500, leaving a balance of £49,485. 6s. 2d., out of which the Directors recommend the proprietors to declare final dividends of 14s. per cent. on the Ordinary stock, and £1. 8s. per cent. on the Preferred stock, amounting to £49,000, making a total distribution for the year ended December 31, 1894, of £2. 2s. per cent. on the Ordinary stock, and £4. 4s. per cent. on the Preferred stock, leaving £485. 6s. 2d. to be carried forward to the next account.

The Company's repairing s.s. "Minia" has been engaged during the past half-year in the repair of the "Northern" and "Southern"—Placentia, the "Tricore," "Rantem," and "Duxbury" cables. She has also been employed by the Direct United States Cable Company and the Western Union Telegraph Company for the repair of cables belonging to those companies, the payments for which appear in the revenue account.

Two Directors of the Company, the Most Hon. the Marquis of Tweeddale and Mr. Charles Burt retire at this meeting, and, being eligible, offer themselves for re-election ; as also do the auditors, Mr. Joshua Dean and Mr. John Gane, F.C.A.

Direct United States Cable Company (Limited).

The following is the report of the Directors for the six months ended December 31, 1894, to be presented at the thirty-fifth ordinary general meeting of the Company, to be held at Winchester House (No. 174), 50, Old Broad street, E.C., on Friday next, the 25th inst., at one o'clock :—

The revenue for the half-year ended December 31, 1894, after deducting out-payments, amounted to £38,342. 8s. 4d., as compared with £41,051. 19s. 11d. for the corresponding period of 1893, being a difference of £2,709. 11s. 7d. against the half-year under review. The working and other expenses for the same period, including income-tax, but exclusive of cost of repairs of cable, amounted to £19,024. 6s. 3d., leaving a balance of £19,318. 2s. 1d. as the net profit, making, with £1,031. 17s. 2d. brought forward from the previous half-year, a total of £20,349. 19s. 3d. For the corresponding period of 1893, the working expenses and other payments amounted to £19,059. 16s. 8d. Interim dividends of 2s. per share for the quarter ended September 30, 1894 (paid October 24, 1894), and of 2s. per share for the quarter ended December 31, 1894 (payable January 26, 1895), together amounting to £12,142, have been declared, and after setting aside £3,400 pending settlement of disputed accounts with other telegraph companies, and £3,000 to the reserve fund account, the balance of £1,807. 19s. 3d. on the revenue account has been carried forward.

During the period under review repairs have had to be made of the Company's short section of cable at a cost of £1,611. 13s. 2d., which has been debited to the reserve fund account as heretofore, the balance of which, with the addition of interest, profit, and the amount set aside from revenue account, now amounts to £288,205. 2s. 1d.

The Directors record with deep regret the death of their esteemed colleague, Mr. Charles Meara, which occurred at Antwerp on November 16th last. It is not intended at present to fill up the casual vacancy thus occasioned in the Board.

NEW COMPANIES, STATUTORY RETURNS, &c.

INDUSTRIAL INVENTIONS DEVELOPMENT COMPANY (LIMITED).—This Company was registered on January 9, 1895, with a capital of £50,000, in £1 shares, to enter into an agreement made between this Company and F. L. Rawson for the purchase of an interest in certain inventions therein mentioned, and to carry on the business of bankers, capitalists, financiers, concessionaires and merchants. The first Directors are to be appointed by the subscribers to the Memorandum of Association. Registered office, 88, Queen Victoria-street, London, E.C.

LLANELLY ELECTRIC LIGHT AND POWER COMPANY (LIMITED.—The annual returns of this Company, made up to November 10, 1892, November 10, 1893, and November 10, 1894, were recently filed. Only 7 "A" shares were taken up out of a capital of £15,000, divided into 10 "A" and 14,990 "B" shares of £1 each. No calls have as yet been made.

LYNTON AND LYNMOUTH ELECTRIC LIGHT COMPANY (LIMITED).—The statutory return of this Company, made up to December 20th, has been filed. The nominal capital is £8,000, divided into 1,000 £5 per Cent. Preference shares of £1 each, and 7,000 Ordinary shares of similar value ; but only 8 of these have been taken up, no calls having been made.

SPANISH TELEPHONE COMPANY (LIMITED).—The statutory return of this Company, made up to November 27th, has been filed. The whole nominal capital of £16,000, in £10 shares, has been issued as fully paid to Messrs. A. Rüffer and Sons, of 39, Lombard-street, London, E.C., or their nominees, in part consideration for the sum of £32,000 agreed to be paid for the share capital now issued of and in the Compania Peninsular de Telefonos, the remaining £16,000 being paid in £5 per cent. debentures.

TAYLOR AND TUCKER, ART METAL COMPANY (LIMITED).—The annual return of this Company, made up to December 17th, was recently filed. Out of a nominal capital of £5,000, in £1 shares, 4,400 have been subscribed for and allotted, and the full amount has been called and paid on each.

TELEGRAPH IMPROVEMENT COMPANY (LIMITED).—The annual return of this Company, made up to December 28th, was recently filed. The Company has a nominal capital of £100,000, in £1 shares ; but the actual capital consists of 15,000 shares which have been issued as fully paid, and six shares which have had the full amount paid.

CITY NOTES.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The accounts of this Company for the half-year ended December 31st show a balance, after providing for the debenture interest and the full dividend of 5 per cent. on the Preference shares, sufficient to allow the payment of a dividend on the Consolidated Ordinary Stock at the rate of 1¼ per cent. per annum, carrying forward a balance of £950. The dividend for the corresponding period last year was at the rate of ⅝ per cent. per annum, with £1,063 forward. The traffic returns of this Company for the week ended January 13th were £1,001, as against £951 in the corresponding period of 1894, being an increase of £50. The total receipts for the half year amount to £2,005, as against £1,941 for the corresponding period of 1893, an increase of £64.

CROMPTON AND CO. (LIMITED).—Subscriptions have this week been invited for £100,000 Five per Cent. First Mortgage Registered Debentures in this Company. The trustees for the debenture-holders are Major Gen. Sir F. Richard Pollock and Mr. Samuel Pope, Q.C. The price of issue is par, payable £10 on application, £10 on allotment, £40 one month after allotment, and £40 two months after allotment. The debentures are repayable at par on January 1, 1920, but may be paid at the option of the Company any time after April 1, 1900, at six months' notice, at £105 per bond, or at any time, at six months' notice, at £110 per bond. The prospectus refers to the establishment of the Company in 1878 as a private concern, and its incorporation under limited liability in 1888, and states that the further capital now asked for is required to meet the growth of business, and for the paying off of existing First and Second Mortgage Debentures amounting to £80,000. The assets of the Company, without taking into account patents or good-will, are certified by the auditors of the Company, Messrs. J. H. Duncan and Co., as of the value of £262,688, and for the past six years the average profits have amounted to £10,320 per annum, after writing off for the six years £10,492 for depreciation. The lists were opened on Monday last, and closed on Wednesday.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 13th inst. amounted to £866. The amount for the corresponding week last year, £665.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended January 11th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,924.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Jan. 9.		Price Wednesday, Jan. 16.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 16.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	9 0	Anglo-American	39½	40½	41½	42½	4 14 2	Jan., Apr , July, Oct.	40¾	40
£2,993,560	Stock	18 0	Do. Preferred	73½	74½	77½	78½	5 1 11	,, ,,	78¾	73½
£2,993,560	Stock	5/0	Do. Deferred	6½	7	6¾	7¼	..	..	6¾	..
£184,600	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 16 1	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	10¾	11¼	11¼	11¾	5 10 8	Mar., June, Oct., Dec.	11½	10⅞
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	109	113	109	113	4 8 6	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	140	150	140	150	4 18 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12½	13½	13	14	6 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	19	20	19½	20½	4 17 7	,, ,,	19 13/16	..
12,931	5	1/8	Direct Spanish (fully paid)	4	4½	4	4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9½	10	9½	10	5 0 0	,, ,,	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	105%	103%	106%	4 4 11	,, ,,	..	..
60,710	20	2/0	Direct United States Cable, 1877 xd	8½	9	8½	9	5 0 0	Jan., Apr., July, Oct.	8⅝	..
400,000	10	2/6	Eastern xd	16½	16⅞	16½	16⅞	3 10 6	,, ,,	16⅞	16½
70,000	10	6%	Do. 6 per Cent. Preference xd	17	17½	17	17½	3 8 7	,, ,,	17 7/16	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	121	124	121	124	3 4 6	May and November	121¾	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	110	106	110	4 18 0	February & August	..	..
250,000	10	2/6	Eastern Extension xd	16¼	16½	16⅜	16⅞	4 4 10	Jan., Apr., July, Oct.	16⅞	16½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	121	124	122	125	3 4 0	February & August	124	122
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	102	106	102	106	4 14 4	January and July	105	103½
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	102	106	102	106	4 14 4	,, ,,	..	—
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	105	109	106	109	3 14 9	February & August	..	—
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	111%	114%	111%	114%	3 10 8	May and November	..	..
180,227	10	1/3	Globe Telegraph and Trust	8¾	9¼	8¾	9¼	4 18 8	Jan., Apr., July, Oct.	9¼	8¾
180,042	10	6%	Do. 6 per Cent. Preference	16¼	16¾	16¼	16¾	3 13 5	,, ,,	16⅝	16¼
150,000	10	5 0	Great Northern	21¾	22¼	21¾	22¼	3 17 2	Jan., April, and July	21⅞	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	107	..
17,000	25	12 6	Indo-European	48	50	48	50	5 0 0	May and November	49⅝	49
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	102	106	103	107	5 14 3	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	104	107	104	107	3 14 9	..	..	—
11,839	8	4/0	Reuter's	2	4	2	4	..	April and October	3¼	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	110	115	114	119	5 0 10	,, ,,	..	..
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	101	104	4 17 10	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	96	101	97	102	7 16 10	June and December	..	..
88,321	10	6d.	West India and Panama	1	1¼	1	1¼	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	5 6 8	May and November	10⅞	10
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	9¾	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	107	110	108	111	4 10 1	June and December	108½	..
64,242	15	3/0	Western and Brazilian	11	11½	11	11½	4 7 6	May and November	11¼	10⅞
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	..	6½	6¼
33,129	7½	4/6	Do. 5 per Cent. Deferred	4¾	5¼	5	5½	..	..	5⅛	4⅞
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	102	106	5 15 11	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	102	106	5 15 11	,, ,,	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115	120	115	120	5 18 2	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 17 8	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	—	..	..	..
224,850	10/0	2½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	..
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	¼	⅝	¼	⅝	..	Yearly	—	..
484,597	5	3/4	National	5¼	5½	5¼	5½	4 10 11	June and December	6 7/16	5 5/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 15 0	,, ,,	15½	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	,, ,,	..	..
119,234	5	3/4	Do. 5% Non-Cumulative 3rd Pref.	5⅞	6⅛	5⅞	6⅛	4 1 8	..	6	..
1,000,000	Stock	4½%	* Do. Debenture Stock, 4½% (red.)	..		..		—	January and July	..	..
58,000	5	1/0	United River Plate	1	2	1	2	..	,, ,,	..	—
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	86	91	86	91	5 9 11	,, ,,	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	14	16	14	15	..	—	15½	14½
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15	15½	15	15½	3 18 8	..	15½	15¼
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	130	133	130	133	3 15 2	June and December	133	131½
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	4½	5½	4½	5½	3 12 9	—	..	..
£57,400	£100	5%	Do. 6 per Cent. Debentures, 1900						—	..	..
8,322	£5	..	House-to-House Electric	..		..		..	..	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		—	—	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		—	..	..	—
45,000	£5	2/6	Liverpool Electric Supply (fully paid)	7 1/16	7 7/16	7	7½	—	January and July	—	—
111,000	5	..	London Electric Supply	¾	¾	⅝	⅝	—	—	..	—
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	9¾	10¼	9¾	10¼	2 8 9	..	10 1/16	10
£150,000	Stock	4½%	* Do. 4½% Debs. (Bonds of £10, £20, and £40) xd	116	119	116	119	3 15 8	June and December	116½	..
6,452	£10	..	Notting Hill Electric	7¼	7¾	7	7½	..	..	..	..
19,980	£5	2/0	St. James and Pall Mall	7¾	8¼	8	8½	..	..	8¼	8¼
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 15 8	..	..	
59,900	5	2/0	Westminster Electric Supply (fully paid)	7¼	7¾	7¼	7¾	2 18 1	..	7⅝	7⅝
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅝	2⅞	2⅝	2⅞	5 5 3	..	2 13/16	—
00,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2⅜	2⅝	4 11 6	..	2½	—
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	111	114	111	114	4 0 6	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	3	3½	3	3½	—	January and July	3¼	..
12,139	5	..	Edison and Swan United	—		—		—	..	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		—		..	—	—	..
120,000	2	..	Electric Construction	¼	½	¼	½	..	—	..	..
12,845	2	2/0	Do. 7 per Cent. Cumulative Pref.	1¼	2	1¼	2	—	—	—	..
01,195	2	10/0	Elmore's Patent Copper Depositing	1½	1½	1½	1½	..	—	—	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	—	1 1/16	1 3/16
60,000	10	10/0	India Rubber, Gutta Percha, &c., Works	25½	26½	25½	26½	4 11 4	February & August	26½	26¼
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 7 7	March & September	..	—
15,995	£10	6/4	International Okonite Ordinary	..		..		—	—	..	—
16,000	£10	..	Do. 8 per Cent. Preference	—		—		—	December and June	..	—
20,000	0	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	⅜	—	⅜	—	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	41	43	41	43	5 11 6	March and July	43	41¾
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 13 0	January and July	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	—		—		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	—		—		..	—	..	..
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	8½	9½	9	10	5 0 0	..	9½	..
£30,000	10	..	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1%	City and South London Railway	43	45	44	46	2 3 6	May and November	45½	44½
7,000	10	5%	Do. 5% Perpetual Preference	13¾	14¼	13¾	14¼	3 10 2	..	..	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	125	127	125	127	3 3 0	May and November	..	..
37,500	£10	1%	Liverpool Overhead Railway	8¾	9	8¾	9	1 2 3	..	..	..
6,296	10	5%	Do. 5% Preference	13	13½	13	13½	3 15 6	..	—	—
126,000	Stock	4%	Do. 4% Debenture	110	112	110	112	3 11 5	January and July	—	—

In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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NOTES.

In his second Cantor lecture on "The Electric Arc," Prof. S. P. Thompson discussed the crater as a source of light. The proportionality between the candle-power and the area of the crater visible from any given direction was described, and a diagram of the results of some experiments by Mr. J. D. F. Andrews was exhibited. These experiments seemed to show that the area of the crater is rigidly proportional to the current. Connecting this with the candle-power, the lecturer pointed out that the candle-power should be directly proportional to the current. Under ordinary circumstances, where current and resistance are concerned, the energy developed in the conductor is proportional to the square of the current. But in the arc there is no true resistance, but a back electromotive force, and the energy is proportional to the product of the amperes into the back volts, and is therefore proportional directly to the current. There is a general impression that twice the current gives more than twice the light; but whether this impression is wrong, or whether either Mr. Andrews' photometry or current measurement was liable to error, remains to be settled by further experiment. The last diagram in Mrs. Ayrton's article this week, and the formula constructed from it, go to show that the area of the crater is *not* simply proportional to the current.

Touching on the comparative merits of alternating- and continuous-current arcs, Prof. Thompson made a very guarded statement, which it is impossible to refute. Given the right kind of carbons and suitable mechanism, it is absurd to suppose, he says, if the energy be spent rightly, that there can be any difference in the light given out by the two systems; the idea that any such difference exists in the use of glow lamps was completely demolished by the experiments of Profs. Ayrton and Perry. This diplomatic pronouncement does not go far towards "settling" the question. It contains a hint that any comparative experiments ought in common fairness to deal with the kind of carbons and type of lamp which have by experience proved to be best in each case. Colza oil and paraffin could not be tested satisfactorily with the same burner and the same wick. There is a touch of irony about the small detail of spending the energy rightly in each case; one might say that an old-fashioned "A Gramme" would be as efficient as the best modern dynamo if only this condition were observed. We believe that there is a wide field for the use of alternate-current arcs in shops, public buildings and some kinds of factories; the effect would be even better than an inverted continuous-current lamp in certain cases. A mean must be found between a short arc in which the carbons get in each other's way and the long arc which hums, and the purple-banded arc; but these details come within the first two preliminary items of carbons and mechanism. The difficulty that has to be faced is the practical extinction of the arc between each alternation. During no inconsiderable part of the whole time during which the arc is being used, the carbon points are not white hot; it is no exaggeration to say that for one-half of the time the light is comparatively small. This surely is not the way of spending the energy rightly. An arc cannot be over-run, but it ought to be run up to the usual degree of brightness, and if this degree is not maintained it seems that the efficiency must be smaller.

In commenting on Mrs. Ayrton's article on the Electric Arc last week, we remarked that the early stages which are passed through by an arc a few minutes after it has been struck have never been intentionally investigated. We are, however, glad to find that although the behaviour of the arc during these early stages necessitated the rejection of a large number of experiments which were carried out before their abnormal nature was realised, this behaviour has been investigated and will be discussed in a future part of these articles.

The theory of phosphorescence propounded nearly half a century ago by Prof. Stokes has recently received a beautiful experimental corroboration at the hands of Prof. Dewar. Sir George Stokes regarded phosphorescing bodies as so many optical transformers; those popularly known as fluorescing substances occasionally transforming up, but strictly phosphorescent materials all transforming down; that is to say, converting the short non-luminous rays into light. Prof. Dewar, in the course of his investigations on the strange behaviour of matter at the uncomfortably low temperature of -200°C. or thereabouts, found that all manner of substances, photographic plates amongst other things, phosphoresced when exposed to this worse than Arctic cold. This being so, it was obvious from Stokes' theory that photographic materials when phosphorescing should not photograph.

On Friday evening last a Royal Institution audience was treated to the spectacle of a photographic paper being held within a few feet of an arc lamp and gently brushed awhile with liquid air and coming out unspotted from the experiment; at any rate, so far as the portion kept at the temperature of boiling air was concerned, the rest of the paper being of the rich brown tint so well known to ordinary temperature photographers.

Prof. Dewar is now engaged with Capt. Abney in making some quantitative experiments on the connection between photographic activity and temperature. At present it would seem as if only 20 per cent. of the original photographic activity were available at −200° C. With points obtained in the curve all the way from, say, +100° C. to −200° C., extrapolation may be resorted to with some degree of confidence. Will it reveal the existence at absolute zero of absolutely no photographic action, as it has already revealed that of absolutely no electrical resistance? Extrapolation, provided the points on the curve are sufficiently numerous, and provided the curve itself does not show any marked tendency to abnormal curvature as the temperature becomes excessively low, is, it seems to us, scientifically almost as satisfactory as actual experiment at −271° C., and considerably safer for the community. Electric lighting companies have recently been held to be public nuisances, inasmuch as they create vibration. Cannot the law courts *per contra* safeguard the public against the impending annihilation of vibration?

It is satisfactory to notice a growing disposition on the part of the Press—the independent section of it at least—to examine with a critical eye the falling revenue of the Post Office telegraph service—or, more correctly, the rising deficit which it exhibits unfailingly year by year. A few weeks ago *The Times* had a long article largely devoted to this subject and last week *Engineering* followed on with a fuller show of figures in illustration of the seeming contradiction of a constantly increasing business with a corresponding decrease of profit. The rivalry of the telephone has sometimes been made responsible for part of this result; and the falling off in the number of metropolitan messages in the last few years is no doubt attributable to that cause. But this falling off has not been general throughout the country; on the contrary, the grand total increases year by year with uninterrupted certainty, though not to the same extent as formerly. One would like to know how it comes about that this augmentation of business is, with equal certainty, always attended with a diminution of net gain; and it is disappointing to find that neither of the well-informed journals above named is able to throw any light on the problem.

Both papers refer in terms of disapproval to the Press tariff, described by one of them as "ludicrously inadequate," and by the other as a one-sided arrangement much needing revision. Both understate the case by erroneously supposing that Press rates rule only at night, and by the unwarranted assumption that, but for Press messages, the wires would be unoccupied. That is obviously not the case. Ordinary and foreign traffic during the night must be considerable, as most of the principal offices are open always—presumably for remunerative work. Why the Press should be subsidised—for that is what it means—at the expense of the telegraph, by being allowed to fill up all the remaining time with telegrams, at the net rate of a penny, for what other people are charged sixpence, is only to be explained by the Post Office being a branch of the political machine whose course is made smooth by newspaper lubrication. This is one—and only one—of the financial consequences to the telegraph of its affiliation with the Post Office. To be quite fair the Post Office ought to credit its adopted child with the money thus wasted for its own particular benefit. For similar reasons the loss on free railway telegrams ought not to fall on the telegraphs—for assuredly it was not in the interests of the telegraph service that the railways received and have been allowed to increase the enormous bribe which this concession implies. After all, however, these items, large as they are, do not account for the total and growing losses. It is evident that either too little is charged, or too much is paid, for the work performed, all round—and this also for reasons pertaining strictly to the Post Office, not to the Telegraph Department. It has always been our opinion that the State telegraph would pay well enough if the State chose to let it pay. The State does not so choose, and there is an end of it; but the fault ought not to be laid on the telegraph.

Because an electric furnace will produce a compound of calcium and carbon which, when acted on by water, will generate a hydrocarbon already the illuminating basis of coal gas, it by no means follows that there is any commercial value in the process. The article which we reprint from the *Journal* of the Franklin Institute this week, on "A New Product of the Electric Furnace," is the only one we know of which makes any attempt to state the cost of the new process of making acetylene gas. The attempt may be an unbiassed, but it certainly is not a satisfactory one. What about capital charges, depreciation, repairs, &c.? Are all these to be lumped together under the item "Labour, &c. . . , $2.50"? If the figures given in the article prove anything, they show that 2,000lb. of acetylene (C_2H_2) can *not* be generated by this process for $37. Still less can the gas be distributed and carried to the burners for anything like this small sum.

There has been an altogether premature attempt to "boom" this new process for making the well-known acetylene gas, and most extraordinary statements about it have been freely circulated. A lecture dealing with the subject was recently delivered by Prof. V. B. Lewis before the Society of Arts. The statement which he made that a 5-c.ft. burner, consuming pure acetylene, can develop 240 c.p. is to be balanced by the important considerations of the highly explosive and poisonous nature of this gas, as well as the fact that it would never do to distribute it commercially in the pure state. Moreover, heavy hydrocarbon gases, like acetylene, are the very basis of smoky flames, and they require to be diluted with other gases in order to burn cleanly. We are surprised that our usually cautious and reliable contemporary, the *Journal of Gas Lighting*, should have ventured to express itself so unreservedly in favour of this highly tentative and undeveloped process. For ourselves, we look upon the stage of development as being little past that of laboratory experiment; and consider it highly premature to talk of its commercial applications as is being so widely and incautiously done.

We alluded some months ago to the absurdity of the foreign system of trying to stimulate the evolution of valuable inventions by the offer of ridiculously inadequate pecuniary rewards. But the criticism does not apply to the modest prizes offered for pure science research work, although the results have not as a rule been more encouraging in one case than in the other. The Committee who drew up the regulations of the Elihu-Thomson competition are, however, to be congratulated on having elicited two valuable contributions to contemporary science, the nature of which is summed up in the *précis* of their report to be found elsewhere in the present issue.

Portsmouth.—Difficulties have, we understand, occurred in connection with the insulation of the oil transformers. On this account M. Ferranti has voluntarily extended his guarantee and responsibility for a sufficient period to permit of everything being put in a through state of efficiency.

Junction Box Explosion.—An explosion occurred last week at the bottom of St. James's-street, London, opposite the Thatched House Club. It was accompanied by a loud report, and the heavy iron lid of a manhole was blown some distance in the air, and fell on the footpath. No one was near at the time.

Government Telegraphy.—The twenty-fifth anniversary of the transfer of the telegraphs to the State will be celebrated on Monday next by a dinner in the Whitehall Rooms. The Postmaster-General will preside, and several Cabinet Ministers, as well as other distinguished guests, are expected to be present.

The Storage Battery Litigation.—The Chloride Electrical Storage Syndicate inform us that the litigation pending between themselves, the Electrical Power Storage Company, and the Electric Construction Company has been settled on mutually satisfactory terms, and that they continue to make and sell "Chloride" batteries as heretofore.

"Electrical Discovery."—This is the title of a fortnightly publication of Messrs. W. P. Thompson and Co., the well-known patent agents of High Holborn. The design of the publishers is to give "early, accurate, and complete information on patents relating to electrical inventions." A journal of this kind should prove of use to all interested in electrical patenting.

Institution of Junior Engineers.—The tenth anniversary dinner of the Institution of Junior Engineers is to be held tomorrow evening at the Westminster Palace Hotel. The President, Mr. A. Siemens, takes the chair, and Major-General Webber, C.B., Sir A. K. Rollit, M.P., and Profs. W. E. Ayrton, J. A. Ewing, George Forbes, and John Perry are expected.

The Wearing-away of Trolley-Wires.—According to the *Elektrotechnische Zeitschrift*, Herr Hefner von Alteneck's opinion is that the wearing away of trolley wires is not due to electrolytical action caused by damp weather, as has been suggested, but is due to the formation of sparks caused by the imperfect contact of the conducting wire and trolley-wheel.

The City of London Electric Lighting Company's New Engineer.—Mr. Frank Bailey has been appointed engineer to the City of London Electric Lighting Company, and Mr. J. Cecil Bull, the Secretary, has taken over, as well, the duties of Commercial Manager. Mr. Frank Bailey will retain his position as engineer to the Metropolitan Electric Supply Company.

Cable Interruptions :—	Date of Interruption.
Latakia—Cyprus	Nov. 27, 1894.
Cadiz—Teneriffe	Dec. 26, 1894.
Hongkong—Macao	Dec. 31, 1894.
Pernambuco—Ceara	Jan. 12, 1895.
Gibraltar—Cadiz	Jan. 14, 1895.
Gibraltar—Tangier	Jan. 14, 1895.
San Thome—Loanda	Jan. 22, 1895.

"James Watt" Dinner in Glasgow.—Last Saturday being the 159th anniversary of the birth of James Watt, the occasion was celebrated by a dinner given in Glasgow by the Institution of Engineers and Shipbuilders in Scotland. The company was representative of the engineering, shipbuilding, and manufacturing interests. Mr. John Inglis, president of the institution, occupied the chair, and he was supported by Lord Kelvin.

Glow Lamps.—In a recent issue *La Semaine Electrique* makes the announcement that the Société Française des Charbons has succeeded in making high candle-power high efficiency glow lamps with pure graphite filaments. According to this authority these lamps start at about 1·7 watts per candle, and last about 500 hours, the watts per candle at the end being 2·2. We understand that these lamps are on the market.

Electric Traction on the Three-Wire System.—Mr. W. C. Gotshall writes to the *Electrical Engineer* of New York to the effect that the Union Depôt Railroad Company have been operating for some time on the three-wire system, having the farthest and heaviest section on this system. Some very interesting results have been obtained, and the company is delighted with them. As the Union Depôt Company operate some 250 cars, the importance of its success to the company can readily be seen. Preparations are now being made to establish it permanently and so change the rest of the system.

Continuous Current from the Alternating Arc.—Mr. R. J. Feather states in the *Electrical Engineer* of New York that while doing some experimental work recently he placed the end of an ordinary bar magnet near an alternating arc, and found that it repelled the arc in such a manner as to make a flame on both sides of the magnet, and upon putting a pair of electrodes, connected with an ordinary galvanometer, into the two flames, he obtained a unidirectional current; upon reversing the electrodes in the arc flames it also reversed the current flowing through the galvanometer. We thus have a form of "commutator" for obtaining direct from alternating current, though hardly one of any practical use.

Research Fellowship.—The executive committee of the City and Guilds of London Institute have awarded the first Salters' Company's Research Fellowship, for the encouragement of higher research in chemistry in its relation to manufactures, to Mr. Martin O. Foster, Ph.D., F.C.S. Mr. Foster was a student at the City and Guilds Technical College, Finsbury, during three sessions (1888 to 1891), and subsequently graduated Doctor of Philosophy at the University of Würzburg. For several months he has been engaged in investigating some new derivatives of camphor in the research laboratory of the City and Guilds Central Technical College, and by the aid of the Salters' Company's Research Fellowship he proposes to pursue this line of work.

The Trolley Strike at Brooklyn.—The situation at Brooklyn remains unchanged. The street car officials are unable to move the cars, even under the protection of the militia and police. Men from outside who offer their services are either coaxed or scared away by the strikers. According to a Reuter cablegram, the linemen have finally obeyed the order of the strike leader to quit work, and 600 of them joined the movement yesterday morning. The militia are now using searchlights to detect wire-cutting, most of which is done in the early morning. Owing to the refusal of the companies to submit the dispute to arbitration, popular sympathy is entirely with the strikers. Subscriptions have been received from many labour unions, and one theatre will give a benefit on behalf of the men.

Electric Railway Bills.—Among the Bills which have been passed by the Examiners on Standing Orders of the House of Commons without opposition are the London, Walthamstow, and Epping Forest Railway, and the City and South London Railway Bill, to extend the railway authorised in 1890 and to raise £30,000 additional capital. On Wednesday, Mr. Thoms, Examiner on Standing Orders, dealt with the allegations of the memorial of the London Tramways Company against the London County Council Bill authorising the County Council to work tramways when acquired by them. The Examiner said he could not sustain the allegations. The Standing Orders were then declared to have been complied with. Among other Bills which passed the Examiner without opposition is the Bill for constructing an electric railway from Finsbury Park to Moorgate-street.

Light Railways.—The *Iron and Coal Trades Review* states that Mr. M. Madden, the retiring manager of the Midland and Great Northern Joint Railway, speaking at a dinner given in his honour at Spalding, on January 21st, referred to light railways, and expressed the opinion that they would do a good deal for that district in the future. By light railways they would be able to open up their marshes, and for the conveyance of the agricultural produce of the district they would be of great advantage. He thought that the Government insisted upon unnecessary equipment on some lines, and said that their lines in Lincolnshire did not require the same equipment as the main lines. For that district they wanted lines maintained at a less expense than those upon which every signal box cost £300 a year.

The General Electric Company's Glow Lamp Factory.—The *Electrical Engineer* of New York gives, in its first issue of the present year, an excellent description of "The Making of an Incandescent Lamp" as carried out at the factory of the General Electric Company at Harrison, N.J. The glow lamp is apostrophised as "the very essence, the soul, of incandescent lighting, around which all other details of current production revolve, as satellites to a central sun." Amongst the interesting items chronicled by the writer of the article we note that at the Harrison works the mercury is raised in the pumps by means of an Archimedean screw, which is hermetically sealed in a cylindrical case, and driven by a shaft projecting through the ends of the cylinder.

Electricity at Crewe Works.—Lord Kelvin distributed the prizes to the successful students at the Mechanics' Institute, Crewe, on Friday night last. Mr. F. W. Webb, chief mechanical engineer of the London and North-Western Railway, presided. In the course of his address Lord Kelvin emphasised the great value of technical training, not only because it helped young men to earn a livelihood, but for the pleasure and interest it would give them in their work. He said that in going through their great works at Crewe that day he had seen things which he should never forget. He was much struck with the great electrical developments which were going on. He himself took an intense interest in electricity, and it had been the greatest possible pleasure to him to see electrical science become a great auxiliary in the work of mankind. He did not suggest it as probable, but it was possible, and it was a subject for inquiry and consideration, that electric dynamos might supersede steam in the working of their trains. Were that to come to pass he did not think, from what he had seen, that the occupation of Mr. Webb or of Crewe workmen would be gone. The motto of Crewe was "Never behind," and he did not think they would be behind in any such development. Mr. Webb, replying to Lord Kelvin's remark, said that if ever the London and North-Western Railway Company wanted a train to run by electricity they had only to give instructions, and he would undertake that it should be ready in two months.

Influence of Potential on Confluent Jets.—Certain obscure phenomena connected with the mingling of two masses of liquid are dealt with by Herr E. Kaiser in the current number of *Wiedemann's Annalen*. Two soap bubbles or two jets of water when brought into immediate juxtaposition will not always mingle at once, and sometimes they will not do so at all. Impurities in the water or soap solution will encourage fusion, and so will a difference of potential. Whether the influence of the latter may be explained on the supposition of sparks breaking down the intervening layer of air, is a question which has been answered in the affirmative. But Herr Kaiser's experiments tend to show that in reality the difference of potential simply increases the pressure on the intervening air, and forces it out at the side, thus diminishing the distance between the two surfaces down to the radius of molecular action. He suspended a circular film of Terquem's sugar soap solution in a wire ring by a delicate spring balance and brought a bubble to bear against it from below. The film and bubble were placed in electric connection through their supports, and differences of potential due to 1, 2, 3 and more Daniells were subsequently introduced. With the films investigated the time necessary for fusion was about 3·2 seconds with no difference of potential, 1·4 seconds with one Daniell, and 0·4 with two. With more Daniells fusion took place instantly, and the films burst in most cases. The displacement of air from between the films was studied by the aid of the Newton's rings formed between them. The rings widened out, rapidly at first, then more slowly, and the mingling was heralded by the appearance of the grey-blue of the first order. A difference, of potential simply accelerated this process.

A Winter Thunderstorm.—Mr. G. J. Symons, F.R.S., writes to *The Times* of yesterday as follows :—

> Sir,—In other countries winter thunderstorms are common ; but in this country, when during a snow shower there is vivid lightning and loud thunder, many persons look upon it as unprecedented. It is unusual, but that is all. If I am not mistaken, there has already been one English house wrecked by lightning this year ; and this morning we had a short, sharp storm in London with hail and snow. The storm must have been extremely low in the atmosphere and very near this house, for the time-interval (that is, the interval between seeing the lightning and hearing the thunder) was extremely short. The times of the lightning, of the thunder, the time-interval, and the duration of each peal of thunder were as follows :—

Lightning.			Thunder.			Time interval.	Duration of thunder.
H.	M.	S.	H.	M.	S.		
	—		9	46	45	—	—
9	52	10	9	52	12	2 secs.	8 secs.
9	53	8	9	52	11	3 secs.	7 secs.
9	53	37	9	53	40	3 secs.	5 secs.
9	53	56	9	54	0	4 secs.	3 secs.
9	54	56	9	55	1	5 secs.	29 secs.
9	56	30	9	56	33	3 secs.	14 secs.

> Adopting the usual approximate rule that sound travels a mile in five seconds, we see that all these flashes occurred within a mile of this house, and most of them within about half a mile. There was, as usual, a sharp rise of the barometer, 0·49in. in about ten minutes, a fall of 5deg. in temperature, while the hail and snow when melted yielded just 0·10in. water. It was very soon over, and by 10·10 a.m. the sun was shining brightly.

The churches of St. Bride, Fleet-street, St. Clement Danes, and St. Stephen, Westminster, were struck by lightning during Wednesday's storm, but no great damage was done. At St. Clement Danes the storm started the peal of bells in the belfry, and at St. Stephen's the lightning ran down the conductor and fused an iron gas-pipe, igniting the gas.

They Do These Things Better Elsewhere.—By a coincidence we have just received a copy of a lecture on "The Evolution of a Switchboard," delivered at Wisconsin by Mr. A. V. Abbot, the title singularly resembling that of Mr. Kingsbury's Paper read last night at the Institution of Electrical Engineers. At the end of the American lecture, curves are given indicating the time consumed during the various periods occupied by typical connections. Two curves are given, the full line relating to calls originating and completed in the same exchange, while the dotted line shows corresponding calls which are trunked to an external office. The horizontal axis is devoted to the time in seconds occupied by the various operations required to complete a connection. The record starts with the fall of the drop, two seconds being required for the operator to insert the answering plug ; six seconds are required to complete the test to see whether the line is engaged, and at the end of ten seconds the operator has inserted the test plug. From 10 seconds to 32 seconds, or a period of 22 seconds, are occupied in calling the desired subscriber. From 32 to 132 seconds are usually occupied by conversation, while from 130 to 144 seconds are occupied in disconnecting and in restoring the apparatus by the operator. We cannot help comparing this with our experience of the London service on Wednesday last. To communicate with this office from Brompton-road occupied just about an hour. The first half-hour was occupied in waiting for a through line—no fault, probably, of the operator. Having got through, we asked that someone in another room should be asked to come to the telephone, and, in the interval, without the irritating inquiry "have you finished" the line was cut off. The operator at the Brompton end appeared to do her best to restore connection, but did not succeed until about another half-hour had elapsed. We admit that the London service is improving, but there is still room for a little more development, for our experience of this week is not unprecedented.

ELECTROMAGNETIC THEORY.—LXIII.*

BY OLIVER HEAVISIDE.

(Continued from page 297.)

§ 243. There is another simple case in which substantially the same process obtains as in the last example. Superficially considered, the problem of the effect of a terminal condenser in modifying the action of an impressed force on a cable is entirely different from that of the effect of a terminal resistance. Yet there is a very close analogy. Thus, let the terminal arrangement be a condenser of permittance s. Its equation is $C = spV$, so its resistance operator is $(sp)^{-1}$. Put this for Z in equation (13). Then

$$V_0 = \frac{e}{1 + \frac{1}{sp}\left(\frac{Sp}{R}\right)^{\frac{1}{2}}} = \frac{e}{1 + \frac{1}{aq}}, \tag{23}$$

if $a = s/S$, or that length of cable whose permittance equals that of the condenser, and q is as before.

Now, to show the analogy with the effect of a terminal resistance, put $Z = r$ in (12), making

$$C_0 = \frac{e}{r + \frac{R}{q}}, \quad \text{or} \quad rC_0 = \frac{e}{1 + \frac{1}{bq}}, \tag{24}$$

if $b = r/R$, or that length of cable whose resistance is the same as the terminal resistance in the changed problem.

Comparing (23) with (24), we see that the operational solutions are of the same form, only differing in the changed constant, a becoming b. So, if they are equal, we see that the potential at the beginning of the cable due to the impressed force runs through the same course when the condenser is interposed as the current (multiplied by r) does when a resistance is interposed.

To obtain the effect at a distance requires in both cases the introduction of the same operator ϵ^{-qx}. Consequently, we know that the course of the potential throughout the whole cable in the condenser problem is the same as that of the current in the resistance problem, due to the same impressed force, which may be any function of the time. And, we do not need to algebrize the solutions in order to predict this result.

Perhaps some people will say (as usual) that they do not like "algebrize"; that it is un-English, &c., &c. People are always saying something. What is more important is that a word to express the idea of conversion from operational to algebraical form is much wanted, and that "algebrize" seems to answer the purpose very well. Similarly we might say that we logarize a number when we take its logarithm, and delogarize it when we find the number whose logarithm it is; and so on.

When e is a steady force, beginning when $t = 0$, we may algebrize (23) in two ways as before, and I will do it rather fully now, merely remarking that the work can be done at sight after a little practice by using equations (A) and (B), extended in the latter case to fractional degrees, a matter to be considered later. Thus, to obtain a convergent solution, expand the operator in descending powers of aq by division, making

$$V_0 = \left(1 - \frac{1}{aq} + \frac{1}{a^2q^2} - \frac{1}{a^3q^3} + \dots\right)e. \tag{25}$$

Here the even powers of q involve complete integrations, to be done by (B) at sight. The odd powers involve complete integrations performed upon $p^{-\frac{1}{2}}1$, with limits 0 and t. Thus,

$$V_0 = \left(1 + \frac{1}{hp} + \frac{1}{h^2p^2} + \frac{1}{h^3p^3} + \dots\right)e$$
$$- \left(1 + \frac{1}{hp} + \frac{1}{h^2p^2} + \dots\right)\frac{e}{(hp)^{\frac{1}{2}}}, \tag{26}$$

where $h = RSa^2$, which is a time constant. Also, we know already that $p^{-\frac{1}{2}}1 = 2(t/\pi)^{\frac{1}{2}}$, so (26) is converted to

$$V_0 = e\,\epsilon^{t/h} - 2e\left(\frac{t}{h\pi}\right)^{\frac{1}{2}}\left\{1 + \frac{1}{3}\left(\frac{2t}{h}\right) + \frac{1}{3.5}\left(\frac{2t}{h}\right)^2 + \dots\right\}. \tag{27}$$

This is complete, and answers well, except when t is big, so that many terms have to be used.

To get the alternative solution, expand the operator in (23) in rising powers of qa. Thus,

$$V_0 = \frac{qa}{1 + qa}e = (1 - qa + q^2a^2 - q^3a^3 + \dots)\,qae. \tag{28}$$

Here the even powers of q contribute nothing (which is not so simple a matter as it looks), so

$$V_0 = (1 + q^2a^2 + q^4a^4 + q^6a^6 + \dots)\,qae. \tag{29}$$

Here we have to find $qa\,1$, which is known, and then execute complete differentiations upon it. Thus,

$$V_0 = e - e\,(1 + hp + h^2p^3 + h^3p^3 + \dots)\left(\frac{h}{\pi t}\right)^{\frac{1}{2}} \tag{30}$$

$$= e - \left(\frac{h}{\pi t}\right)^{\frac{1}{2}} e\left\{1 - \frac{h}{2t} + 1.3\left(\frac{h}{2t}\right)^2 - \dots\right\}. \tag{31}$$

This formula answers well for big t, and also when t is not so small as to render the initial convergency insufficient.

The condenser acts like a short-circuit at the first moment, so that the potential at the beginning of the cable acquires the full value e instantly. It then falls to zero as the condenser gets charged, in accordance with (27) and (31). Of course, the cable receives the same charge as the condenser; that is, the current is continuous through the condenser into the cable, according to Maxwell's now orthodox theory. But as the charge spreads itself over a condenser of infinitely great permittance, its density attenuates to nothing, so that $V = 0$ is the final state of the cable, although the total charge is finite. That the final V is zero is also to be seen by the operational solution (23), when we put $p = 0$ in it.

§ 244. As a third example, let the terminal arrangement be an inductance coil. For simplicity, let its resistance be zero. If really small the resistance may be merged in that of the cable itself without much error, and this is allowable when we desire to exhibit the effect of the inductance alone, which is materially different from that of a resistance or a permittance.

The terminal Z is now lp, so that, by (13), we have

$$V_0 = \frac{e}{1 + lp\left(\frac{Sp}{R}\right)^{\frac{1}{2}}} = \frac{e}{1 + (fq)^3}, \tag{32}$$

if $f^3 = l/R^2S$, a constant. It is quite easy to obtain the convergent algebraical solution. Expand in rising powers of rq, thus

$$V_0 = \frac{(fq)^{-3}e}{1 + (fq)^{-3}} = \{(fq)^{-3} - (fq)^{-6} + (fq)^{-9} - \dots\}e. \tag{33}$$

Here the even powers of q involve complete integrations on 1, and the odd powers complete integrations performed upon $(rq)^{-1}$, so there is no new difficulty. To ease matters, put g for RSf^2. It is a time constant. Thus (33) is the same as

$$V_0 = \left(\frac{1}{gp} + \frac{1}{(gp)^4} + \frac{1}{(gp)^7} + \dots\right)\frac{e}{(gp)^{\frac{1}{2}}}$$
$$- \left(\frac{1}{(gp)^3} + \frac{1}{(gp)^6} + \frac{1}{(gp)^9} + \dots\right)e. \tag{34}$$

So, using (B) in the second line, and the known value of $p^{-\frac{1}{2}}1$ in the first line, we obtain

$$V_0 = \frac{4e}{3}\left(\frac{t}{g\pi}\right)^{\frac{3}{2}}\left\{1 + \frac{(2t/g)^3}{5.7.9} + \frac{(2t/g)^6}{5.7.9.11.13.15} + \dots\right\}$$
$$- e\left\{\frac{(t/g)^3}{\lfloor 3} + \frac{(t/g)^6}{\lfloor 6} + \frac{(t/g)^9}{\lfloor 9} + \dots\right\}. \tag{35}$$

It is not laborious to calculate the curve of V_0 from this formula, at least up to $t = 5$ or 6 times g. I get the results in the following table:—

t/g	½	1	2	3	4	5	6
V_0/e	0·25	0·603	1·152	1·297	1·208	1·07	0·97

The inductance stops the current completely at first, so that V_0 is then zero. But, later on, the inertia of the current in the coil causes V_0 to rise above its final permanent value, which is e, and oscillate above and below it. An analogy in heat diffusion would need something far-fetched to illustrate the terminal condition and the inertia it brings in. A mechanical analogy is plainer, as in §215. Have a long flexible elastic string of insensible mass suspended from fixed supports in a viscous medium which resists the transverse motion of the string with a force varying as its velocity. Let the string be first in equilibrium. Then apply a force e close to the fixed end. The string will at once be transversely displaced to a distance V_0, say, proportional to e, and the rest of the string will follow suit in time, but without any vibration, owing to the absence of inertia. This illustrates the case of no terminal inertia in the cable problem, V_0 becoming e immediately, and V becoming e everywhere in the cable later.

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But next attach a mass to the string at the place of application of the force, close to the fixed end. When the force is applied it will now take time to fully displace the mass, which will then swing past its equilibrium position and oscillate about it. The attached mass corresponds to the coil in the cable problem. The above table shows the initial rise of V_0 and its passage beyond the value e to its first maximum, and back again to a little below the equilibrium position.

The alternative formula is more difficult to obtain, and as its derivation from the operational solution involves more advanced ideas than have yet presented themselves, I will merely give the result here. It is

$$V_0 = e - \frac{4e}{3}\epsilon^{-t/2g}\cos\frac{t\sqrt{3}}{2g}$$

$$+\frac{e}{2}\left(\frac{g}{\pi t}\right)^{\frac{1}{2}}\left\{1 - 3.5.7\left(\frac{g}{2t}\right)^{3} + 3.5.7.9.11.13\left(\frac{g}{2t}\right)^{6} - \ldots\right\} \qquad (36)$$

which is useful in the later oscillatory part of the phenomenon. The period is $4\pi g/\sqrt{3}$. The descending series must be counted up to the smallest term; but, of course, when it is close to the beginning of the series, and the accuracy of calculation becomes impaired to the possible extent of the size of the smallest term, or, more likely, to the extent of half its size, the previous convergent series should be employed. The oscillatory function in (36) arises from the infinite series of even powers of q in the operator when expanded in rising powers of q, a matter to be returned to.

In equations (16), (17), (18) Z should be regarded as r only, although it admits of extension.

§ 244. I have worked out the above examples (except the end of the last one) in a manner suited to one who has not done any work of the kind before, with a considerable amount of detail in the transformations. But when the go of it is perceived, the transforming work may be simplified by attention to certain rules which are obeyed. So now, before passing to problems of an elementary kind, concerning the propagation of effects to a distance, I interpolate some explanatory remarks about operators in general, and then on the practical manipulation of $p^{\frac{1}{2}}$, &c.

Observe, in the above, that we first obtain the operational solution, and that this is usually easily got and is of simple form—at least in the examples used, which admit of generalisation. Now, the operational solution is got by algebraical processes, of the same nature as if we were dealing with merely conductive circuits, only replacing the resistances concerned by the appropriate resistance operators, though treating them as if they were still resistances; that is, constants. Thus, in getting (33) for example, if the condenser were a a resistance, say Z, and the cable also a resistance, say z, then the current due to e would be

$$C_0 = \frac{e}{Z+z}, \qquad (37)$$

obviously, and the potential on the right side of Z would be

$$V_0 = e - ZC_0 = \frac{e}{1+Z/z}. \qquad (38)$$

Now, in the real problem, we work in the same way, with different meanings attached to Z and z. They become the resistance operators. They are the functions of p, the time-differentiator, which take the place of resistance in the equation V = RC; viz., Ohm's law applied to a simple conductor, which connects the V and C thereof, V being the fall of potential through R in the direction of C, the current. If this becomes V = ZC where there is stored electric and magnetic energy concerned, we call Z the resistance operator, because it replaces resistance, and reduces to one in steady states. That the Z's may be treated as resistances may be seen by considering the nature of the well-known problem of a conductive mesh of wires. We have an equation V = RC for every branch, or, more generally,

$$e + V = RC, \qquad (39)$$

if e is an additional impressed force therein. If, then, we sum up along any path in the mesh, we get

$$\Sigma e + \Sigma V = \Sigma RC. \qquad (40)$$

But ΣV is zero in any circuit, so we have

$$\Sigma e = \Sigma RC \qquad (41)$$

for every circuit in the mesh. This being the case, or, more generally, (40) being true for any particular path in the mesh, there is only one thing more required to determine C in all the branches due to all the e's, and that is the circuital nature of the current itself, which connects together the values of all the C's meeting at a junction, and makes $\Sigma C = 0$ there. The problem is now determinate, and the algebra of simple equations enables us to write down the expression for the current in any branch due to the impressed force in the same or in any other branch. When it is a very complicated mesh determinants are useful; but in most practical problems they are a useless complication, and the work is easier without them, and is more instructive from the physical point of view.

Now, instead of the branches of the mesh being simple conductors following Ohm's law in the above way, let them be arrangements storing electric and magnetic energy—that is, arrangements of condensers and coils; but still such that the current in any branch is the same at both ends, and such that there is no mutual action between one branch and another, though there may be mutual action between the constituents of a branch. Clearly, then, the currents, though now variable with the time when the forces are steady, are subject to identically the same conditions of continuity. But the equations of voltage are changed. We now have

$$e + V = ZC \qquad (42)$$

in any branch where Z has to be found from its detailed structure. Also

$$\Sigma e + \Sigma V = \Sigma ZC \qquad (43)$$

along any path in the mesh, and, ΣV being zero in a circuit,

$$\Sigma e + \Sigma ZC \qquad (44)$$

in any circuit in the mesh. There is, therefore, a complete formal similarity between the problem of merely conductive circuits and the general one involving stored energy. Every R becomes a Z. The equations which find the C's in terms of the e's are, therefore, identically the same, only with the R's replaced by Z's. These equations are the operational solutions. So the rule is, work out the given problem as if the independent branches were mere resistances; then give to the Z's their actual functional expressions in terms of p and constants; the result is the operational solution. It follows that anybody can work out electrical problems of an advanced nature so far as the operational solutions are concerned, by common algebra, assisted by electrical ideas. Nor need he stop there, for the very important case of simply periodic variations can be fully investigated by a continuation of the algebra from the operational solution to the algebraical. For, when a single simply periodic impressed e acts with frequency $n/2\pi$, the *power* of p^2 in the operators is $-n^2$; so, by putting $p = ni$, we obtain an algebraical solution which may be reduced to the simple form $(a+bi)e$, where the i signifies $d/d(nt)$. It is then fully realised.

Geometrical methods are sometimes used, involving the rotation of vectors in a plane. Their value seems to me to be principally illustrative. Their drawback is the great complication of the diagrams that arise when we depart from very simple problems, and the hard thinking and labour required to work out results. The algebraical method, on the other hand, works with admirable simplicity, even in complicated problems. It is, however, only a special case of resistance operators, in the general use of which we are not confined to simply periodic variations, the e's being any functions of the time in the operational equations. The application of these

Yours truly

R.E. Crompton

operators is not confined to condensers and coils, but extends to electromagnetism in general, with waves in conductors and dielectrics, and dissipation in space, the ultimate reason being the linear nature of the equations. Nor is it confined to electrical problems, but applies generally to the mathematical sciences involving linear equations, and can be used with advantage therein.

Returning to the mesh before considered, if a branch is itself complex, its Z must be got by properly eliminating all the internal V's and C's, so as to lead to a resultant equation $V = ZC$, where V is the voltage on and C the current in the branch as a whole—that is, at the terminals. But should there be mutual influence between a branch and some other one, a further generalisation is required, which presents no difficulty save in the extra work involved, which, however, is still of the same nature in treating p and functions of p as constants for the time.

A remark should be made here about the figure in § 242. The impressed force is put between the Z and earth. It is therefore necessary that the current should be the same at both ends of Z. But if we put the e between Z and the cable, which will make no difference in the state of the cable in the examples above, we can attack more general problems. For Z may now have many branches; for example, a complicated arrangement of condensers and resistances like the cable itself. Thus we shall have

$$C_0 = \frac{e}{\left(\frac{R_1}{S_1 p}\right)^{\frac{1}{2}} + \left(\frac{R}{S p}\right)^{\frac{1}{2}}} \qquad (45)$$

when e is put between two cables, R_1 and S_1 being the constants of the new one, on the left side. If $R_1/S_1 = R/S$, the current is halved by the substitution of the second cable for direct earth. To find V_0, multiply by the resistance operator of the first cable, viz., by $(R/Sp)^{\frac{1}{2}}$. To find V_1, the potential of the beginning of the second cable, multiply by the negative of $(R_1/S_1 p)^{\frac{1}{2}}$, the resistance operator of the second cable. The changed sign is necessary on account of the current being *from* one cable *to* the other. If $R_1/S_1 = R/S$, the potentials are $\frac{1}{2}e$ and $-\frac{1}{2}e$. But in general they will not have the same numerical value, though $V_0 - V_1 = e$ always.

It should be understood that these potentials have nothing indeterminate about them, like the electrostatic potential, for they are really transverse voltages in the dielectric of the cables. They are proportional to the displacement, and to the charge, so that the diffusion of V in the cables is representative of the diffusion of the charge on the wires. No constant can be added to this kind of V, of course, in our problems, as it would introduce extra energy, having no connection with our impressed force.

(To be continued.)

MR. CROMPTON'S PRESIDENTIAL ADDRESS TO THE INSTITUTION OF ELECTRICAL ENGINEERS.

(Concluded from page 326.)

There is another development of the use of electricity for motive power to which I think your attention should be directed. The President of the Institution of Mechanical Engineers, in his address to the mechanical engineers in April of last year, drew attention to the efficiency that we claim for electric transmission of power to machine tools, and compared it with the efficiency of existing systems. I have Prof. Kennedy's permission to use his address as a means of carrying this highly interesting problem a step further. He said that, "in any given factory running on the ordinary system there is a large continuous waste of power due to the running of the whole shafting, no matter how many or how few are at work; under such conditions, the waste work in shafts and belts may well be 25 per cent. of the average useful work, and the distribution of total work may be approximately—

"For the useful work	100
Wasted in belts	25
Wasted in engine friction	20
	145"

He compared this with an electric transmission as follows:—

Useful work	100
Wasted in motors and dynamos	24
Wasted in leads	2
Wasted in engine friction	20
	146

so that he shows that the two sets of figures are practically the same as to amount of power required. I think that the cases where the comparison would work out on such equal terms would be very rare indeed, and would only be likely to apply to textile or similar factories. In engineering shops, where the time during which each machine tool is standing for the work to be fixed is very large compared with the time that the tool is actually running, I think it would be not too much to say that in most such shops the useful hundred horse-power he gives in his first table might be divided by three, the other losses remaining constant, so that the average useful effect throughout the day is not as 100:145, as given by him, but rather as 33:78; in other words, the average efficiency, instead of being 68½, would be really about 42; but in such a case, if electric transmission with separate electric motors for each tool be used, the efficiency can remain at 68, as before. Therefore I believe that the cases where electric transmission of power can be substituted with considerable advantage over present systems are far more numerous than Prof. Kennedy's figures would lead us to suppose. It will be noticed that the difference between my assumptions and those of Prof. Kennedy lies chiefly in our estimate of the load factor of each of the tools.

Several times when addressing you here I have used the term "load factor" to denote the ratio which the total useful time during which the appliance is worked discontinuously bears to any given period, whether it be an hour, a day, or a year. As you know, I found myself compelled to investigate this question when dealing with the cost of electrical energy in my Paper before the Civil Engineers; but this load-factor question has a far wider application. If an attentive observer walks round a factory where machinery of any kind is being used, and takes careful note of the relation of the periods of useful work of each machine to its periods of idleness, he will be struck by the large proportion which these hours of idleness bear to the hours of usefulness. As regards the machines themselves, the only loss caused by these long periods of idleness is that due to the interest on the money invested in them; but in the case of the engines which drive them or of the transmission devices, such as shafting or belting, in addition to the loss of interest, there are continuous losses due to the waste of power and cost of attendance that is required to keep them in motion at the required speed during these idle periods.

This matter is of great importance to us electrical engineers, for of all methods of transmission of energy that now exist, none can be worked with so little waste of power during these periods of idleness as electrical transmission. I have already shown this to be the case where the source of power is obtained from an electric supply station, and it is certainly the same in any works where any considerable number of tools are required to be intermittently driven.

One of the chief difficulties that have been met with in replacing the muscular energy of ourselves or of animals by that of the forces of Nature has been that of providing a variable ratio between the two factors of speed and torque that is necessary if we have to obtain from a constant source of energy the varying duty that we usually demand from our muscles. All our machine tools are provided with a few changes of the speed gear which forms a clumsy approach to this requirement. I have sought in vain for a short expression to define such a variable gearing, but am obliged to content myself with calling it "Speed torque ratio gear." In all attempts to carry this out mechanically the change of ratio can only extend through very narrow limits, and at the outside four or five steps in the change of ratio can be given. Mechanical engineers for many years have been looking for such a gearing which will vary the ratio exactly as required, and not by steps. The nearest approach to this has been by two reversed cone pulleys with a round belt of constant length which is moved or retained in any desired position by a fork sliding in guides. Quite recently Mr. W. W. Beaumont has introduced a mechanical variable ratio gear which is a decided improvement; but in my view the first real step which promises to revolutionise our ideas on these matters has been the working out of this problem in the electrical portion of our plant—*i.e.*, in availing ourselves of our really flexible connecting rod, electricity itself.

One arrangement of this kind has been worked out in America by Mr. Ward Leonard. If it is desired to provide from a constant source of energy at the axle of the motor C, either great torque at very low speed, or the same energy in the form of reduced torque at the higher speed, this is done by Mr. Leonard by passing the energy through a motor-generator, A B, the motor, A, of which may be either an electric motor driven from a central station, or a steam, gas, or water engine; but in every case delivering a constant supply of mechanical energy to the spindle of the generator portion B, the armature of which is connected by short conductors of low resistances to the motor C. If the magnets of motor C are kept supplied with a constant field from a constant source of supply, and the magnets of the generator B receive a variable degree of excitation by inserting a rheostat in series with them, so that the field may be varied through wide limits, by commencing with an extremely weak field in the generator B, the motor C can be started with a large current, giving large torque at low E.M.F., then as the excitation of the field of B is gradually increased, the E.M.F. of the generator and of the motor will also be increased, and at the same time the torque diminished, so as to get the spindle gradually into motion, and the machine driven by the motor C steadily brought up to its proper speed.

I give the description of this beautiful electrical gear just as it is given to me, and am told that there are no difficulties found in working it in actual practice; but I feel sure that it is only one of many similar methods by which this variable torque and speed ratio can be worked out electrically, and with a simplicity in the moving parts resembling that of the muscular system of the animal world. The application of this invention to working long lines of railway would appear to get over the great difficulty which would be due to the heavy fall of potential which occurs at the times when large currents are taken by the ordinary train motors whenever a train starts from rest, this difficulty being only slightly reduced by the device of motors arranged in series, and afterwards switching them into parallel. With Mr. Leonard's arrangement a long line may be worked at a high E.M.F. of 1,000 volts, generated by monophase alternating machinery, transformed at intervals and supplied to sections of the line at an E.M.F. sufficiently low to be easily dealt with—say, 500 volts—but still in the form of an alternating current. This alternating current could be collected from the line and used to work the motor A, as the arrangement I have just described would allow that this motor A should be a monophase sychronising motor, worked at extremely high speed, and having the generator B driven by it; the generator B and the main motor C would be of the continuous-current type, and there is no reason why the motor C should not be of extremely low E.M.F., and, consequently, easily made direct-acting on the driving axle.

I have described this invention at some length, for, although it may have been noticed by some of you, it has probably escaped the notice of many who are engaged in thinking out the interesting problems of electric traction, haulage, or other uses to which the use of electric power is every day being applied.

We electrical engineers are frequently complimented on the perfection to which we have brought our measuring instruments, and in most cases this praise has been fairly earned, but I think some protest should be made against the very impossible degree of accuracy which is often claimed for electrical measurements. Such claims for accuracy those more thoroughly conversant with the subject know to be unwarranted; they arise from an incomplete appreciation of the difficulties which attend the making of very accurate measurements of any kind. We often see the efficiencies of the various classes of electrical apparatus worked out to several places of decimals, when it is well known that no instruments exits which could record the measurements to this degree of accuracy. Electrical measuring instruments depend in the majority of cases on the accuracy with which they can indicate the amount of the minute forces to which their moving parts are subjected. In order to make them as sensitive as possible, these moving parts must be delicately adjusted or suspended, and the accuracy of the readings depends entirely upon the degree to which the instrument can be depended on to reproduce exactly the same readings under the same conditions as those observed when it was originally calibrated. It is evident, however, that this accuracy can only be maintained if the friction of the parts and their correct position and the strength of the controlling forces remain exactly the same as they were were at the time of calibration. In practice it is found impossible to guard against minute changes in these conditions; so that, however accurately the instrument of precision may be calibrated in Scotland, the very delicacy of its pivoting or suspension, which are necessary for accuracy, make it quite certain to lose its correct calibration after a journey to London, and no one could swear to the correctness of the readings. The case becomes worse if such instruments have to be used as travelling standards of reference. Take the very common instance of an inspecting engineer going to a maker's works to test the efficiency of a steam dynamo, the passing of which may depend on 1 per cent. of efficiency. In order to simplify this matter, I will suppose that there is no dispute to the measurements of indicated horse-power, but that it is confined to the difference between the electrical readings of the maker's instruments and those of the inspector. One per cent. error in the readings of either current or volts, or ½ per cent. error in the readings of both of them, is sufficient to reject the machinery. How is it possible for an inspecting engineer to avoid dispute? How can he say that he feels more confidence in his instruments than in those of the maker? The balance of probability is that the maker's instruments, having remained *in situ* since their calibration, are less liable to error than the travelling instruments, which may have received shocks during their journey. If, however, the dispute had not been an electrical one, but had turned on questions of size or weight, the size measurements would have been easily dealt with by the ordinary steel rules in the shop, which can generally be depended upon to one part in a thousand; and the weight would have presented no difficulty, as, if an ordinary beam balance were available, it could be adjusted in the presence of both parties, or, at any rate, the positions of the standard weight and of the object to be weighed could be exchanged, so that the mean of the weights thus taken would give the correct result. I have always thought that all important and accurate electrical measurements should be as easily checked and referred to a standard as the measurement of weight can be in the beam balance; but no existing measuring instruments having moving parts can be thus easily checked. For this reason, for the past eight years I have been attempting to reduce all electrical measurements to a balance of electrical forces—that is to say, by referring them to a standard fall of potential obtained on a carefully calibrated slide wire—in other words, the potentiometer. I have occupied much of my leisure time during the above period in perfecting this potentiometer system, which is already well known to most of you. I only mention it here in order to point out that with this instrument there are no moving parts, and that the only calibrated portion—the slide wire—can be subjected to extremely rough treatment without altering the accuracy of the instrument to any material extent. Once this slide wire is accurately divided, and that portion of it on which the sliding contact works is made of equal and even resistance per unit length, and is stretched rigidly over an accurately divided scale, it is almost impossible for the instrument to lose its calibration, short of actually severing the wire; and, even if the wire is severed, a new wire can be applied and calibrated without the necessity of sending the instrument home to the maker, or to any standard laboratory, in order to compare it.

Whilst on the subject of electrical measuring instruments I must not neglect to notice that very beautiful instrument, the bolometer of Prof. S. P. Langley, and its recent developments in the hands of Messrs. Lummer and Kurlbaum. The bolometer is really the most refined method of measuring temperature that has yet been proposed. Its readings are obtained by measuring electrically the varying resistances of a platinum film when submitted to minute changes of temperature. It is, in fact, Siemens's electric pyrometer or Callendar's platinum thermometer in its most complete form.

I should also not fail to call your attention to the splendid work of Prof. Callendar and Messrs. Griffiths and Clark in perfecting the platinum thermometer. By the aid of this instrument, and by electrical means, Messrs. Griffiths and Clark carried out the most recent determination of J, the value of the mechanical equivalent of heat. In my own practice I have found that the ease with which the platinum thermometer can be used in connection with my potentiometer system has given to me the most accurate, sensitive, and convenient methods of measuring temperatures in the various electrical apparatus which I have to examine. Anyone who possesses a potentiometer can take almost simultaneously any desired number of temperature readings by employing a number of platinum coils all made equal in resistance to an external standard with which they have been compared and adjusted at the temperature of melting ice. The external standard must, of course, be of manganin, which at ordinary temperatures has practically no temperature coefficient. If we adjust our potentiometer so that the readings on this standard are equal to 100 on the scale, the readings taken over the various platinum coils that are coupled in series with it will give directly the percentage rise, from which the temperature can be read off on a table calculated from the temperature coefficient of that batch of platinum wire.

I do not know if this beautiful method of measuring temperature is generally known to electrical engineers who are investigating such matters as the changes of resistance due to changes of temperature in insulating materials, the rise in temperature of the various parts of dynamos, transformers under varying conditions of load—in fact, in the everyday quantitative work of the electro-dynamic designer.

I have stated that in my researches I have adhered rigidly to the principle of making accurate electrical measurements by obtaining a balance of E.M.F.'s—in other words, by using a zero method. I should here explain that there are two zero methods—namely, that obtained from the simultaneous balancing of two forces, as in the Wheatstone bridge or any other split-circuit device; the other, by balancing each of the two forces in turn (*i.e.*, the one to be measured, and a standard with which it is to be compared) against a third force, the two comparisons being made as quickly as possible one after the other. This is the zero method that I prefer, as it avoids the very great possibilities of error which I find are likely to arise whenever divided or shunt circuits are used. With this latter method the determination of several falls of potential can be obtained off different portions of the same circuits through which one and the same current flows in series. One can be certain that, apart from the minute variation due to the difference of time, the conditions of current-flow are absolutely identical. From my point of view the only permissible use of shunt circuits is in the potential leads attached to the two points, and by means of which the difference of potential is measured; but a circuit through these leads cannot strictly be called a shunt to the main circuit; for, although a small current may be passing through it before perfect balance is obtained on the potentiometer, as soon as such balance is obtained absolutely no current passes through this potential lead circuit, so that any change in their resistances, or in the resistance of their contact with the standard conductor, does not affect the readings. For accurate measurement of large currents we use sheets or strips of suitable alloys, so as to reduce the correction for change of resistance due to change of temperature as far as possible. The copper-manganese nickel alloy called "manganin" has turned out to be very useful to us in this respect. It has the great advantage of having a falling curve between the temperatures of 30 and 70 centigrade, and can consequently be compensated by being combined with a metal having a rising curve, in such a way as to produce a standard having no temperature correction necessary between the above limits.

No doubt you will expect me to say a word on the subject of electric storage. Although comparatively little has been written or said about the improvement in the design and manufacture of the lead secondary battery invented by Planté, yet the progress in its development has been quite as marked and quite as satisfactory as that of the dynamo machine or alternator. I do not allude to new patterns of accumulators which claim to be new inventions, but solely to the improvement in detail and in manufacture which has followed on the competitive use of well-known existing forms. No doubt one reason why members of this Institution are not kept as well informed on the development of the storage battery as on other subjects is that the questions involved, being electro-chemical ones, are extremely complex, and require long periods of time for their thorough investigation. Moreover, I regret to say that a dead set has been made at accumulators by some members of this Institution, who never rise in their places to mention them otherwise than by a sneer. It is curious this should be so. The secondary battery demands as high qualities for its patient investigation as does any other branch of electrical engineering; and those who are never tired of telling us that they can cannot see the importance of improving electrical storage, as much as that of any other portions of electrical plant, only show that they have a very incomplete grasp of the requirements of our art. At any rate, if we can judge from cost price and from cost of upkeep only, the advance in the construction of accumulators during any period—say the last ten years or last five years—has been quite as rapid as that of the advance of the construction of dynamo-electric machinery. A reference to the price list of makers of dynamos and accumulators will show that this is the case, and from my own knowledge I can state that recent improvements are reducing the cost of maintenance to an equal extent. The study of the proper application of accumulators for electric supply is not confined to the design of accumulators themselves, but to the many adjuncts necessary to use them to the best advantage. The difference between the E.M.F. of charge and discharge has been satisfactorily dealt with by the various booster systems that have been introduced during the last two or three years; and the proper proportion which the output of the accumulators themselves should bear to that of the station, and the most economical size of generating unit to charge these accumulators, have also been carefully worked out.

It is probable that most of the early troubles with accumulators were due to want of knowledge of the necessity for extreme purity in the materials used. These impurities concentrated themselves in the active material on the negative plate, and caused the now well-known phenomenon of self-discharge of the negative plates, which of itself is sufficient to account for the majority of the early breakdowns which at one time appeared to be so mysterious. We know how important it is for dynamo construction to have iron absolutely free from manganese and copper from arsenic, minute quantities of these, which could hardly be detected by chemical analysis, having the effect of largely altering the permeability of the iron or the conductivity of the copper. No less it is the case that minute quantities of certain metals, such as copper and arsenic, have an equally prejudicial effect in the lead used for accumulators; and the discovery of this effect has had a most important effect on the cost of manufacture and the cost of upkeep.

I feel that I should be failing in my duty towards you if I did not raise a note of warning on a point on which I feel very strongly. Owing to a combination of causes, the chief of which has been the great extent to which public money is now being spent on electrical supply undertakings, the control of large sums raised on the security of the public rates has been placed in the hands of very young engineers whose engineering life and experience has been a very short one. I am afraid that, in some cases, the extent of their responsibility has not been as fully realised by these gentlemen as it ought to have been. Local and special requirements have been insufficiently studied, designs have been hurriedly prepared, the *pros* and *cons* of the various systems which could be used have been inadequately balanced, and I feel great misgivings as to the criticism that will be passed on these hurried designs after a few years have passed. I go further than this: I think that in many cases failure in part or in whole will follow; and so soon as this takes place a reaction will set in, which will damage the interests of our profession almost as much as the speculation in electric light companies' shares in 1882. We all know, or ought to know, that an electric supply system, to be successful, ought to be worked out from beginning to end as a complete scheme, with due regard to the special conditions of the town as to probable light and power requirements, and to the habits of the people; and that this is a very different thing from the mere preparation of a design for a building containing some plant, for laying a few miles of mains in the principal streets, with variations in the shape of providing power from the dust destructors or utilising thermal storage, in order to humour the vagaries of those of the electric lighting committees who fancy themselves engineers. I fear that this Institution is in some degree to blame for this: the Papers that have been read, discussions that have taken place, have turned far too often on purely scientific matters, of interest only to the scientific men who took part in them; and that this has thrust into the background the more prosaic matters which must be studied by those who hope to deal thoroughly and economically with the many and varying conditions of electric supply.

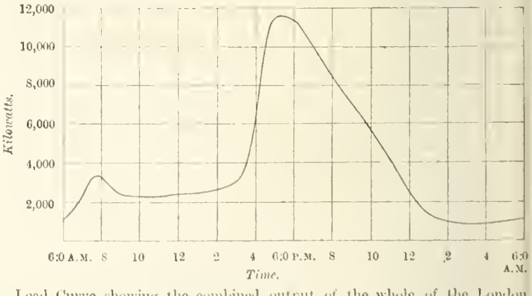
I hope these remarks will be taken in the sense that they are intended to be taken. It is even now not too late for those who are already carrying on works to inform themselves more fully than they have hitherto done on what is going on around them, and on the respective merits of existing electrical engineering practice. I know that many of those who are now so engaged, and who are responsible for the designs of the supply works that are now arising throughout the United Kingdom, and many of those who are now on the look-out for such employment, are setting out insufficiently equipped for their task; they have, I fear, studied their subject too much as book students, and have not spent sufficient time on travel and on the careful study of electrical machinery as it exists in England, the Continent, and America. As an engineer intimately connected with the management of several important supply works I know that the number of young engineers who really attempt to practically examine and study the working of existing supply works is small. If I ask the engineers in charge of these works how often they receive visits, or have really serious inquiries addressed to them on these matters, I am answered that such inquiries are practically not made; in fact, I am afraid that the interchange of ideas, the comparison of experiences in the use of various novel kinds of plant, the exchange of statistics, exists chiefly among us, the older members of the profession, and that, although we are most willing to impart what we know to our younger brethren, we are practically never asked to communicate the results of our experience.

I hope, also, that what I am now saying will not be put down to the natural conservatism or grumbling of an older man dissatisfied with the existing order of things. Think the matter over for yourselves; compare the length of time that you have occupied in your training, and the number of years' experience that you have in your new profession, with that of the engineers employed in other branches of engineering who are put in charge of undertakings of equal importance. However brilliant may be your talents, you cannot hope to acquire that unerring critical faculty, that power of rapid decision between two methods that offer themselves to you, of dealing with an engineering difficulty, and which was so ably described and put before Section G at the last meeting of the British Association by one of our members—the president of that section, Prof. Kennedy—until you have added years of practical observation to your training as a pupil, or your workshop experiences. I feel sure that Prof. Kennedy will allow me to quote his own words: "The whole use of college training, of workshop practice, of practical experience, is to provide the engineer later on with the means of critically examining each question as it comes up, of reviewing systematically the *pros* and *cons* of each method of dealing with it, of coming finally, rapidly, positively, to some definite condition, which may then be irrevocably carried out."

I am now addressing the whole body of electrical engineers, old as well as young. None of us are too old to learn and profit from the experience of others; in fact, as I have already said, I find that such interchange of ideas as now exists is far more among the older than the younger members of our profession. This is much to be regretted. It may be partly due to the diffidence or shyness of the young men, but I greatly fear in many cases it is due to their fear that their crude and hastily-formed ideas may be adversely criticised. Never during the 16 years which I have named as the life of our art have there existed more momentous questions to be solved than at the present moment; and if I can by my words induce a freer interchange of ideas, so that we help one another more than has been done in the past, I shall feel that I have been of some service to the Institution. Such interchange takes place most naturally in the tea room after each of our discussions. I think the time spent in the tea room is very valuable, and is far too short; and I think the practice, recently started by the Institution of Civil Engineers, of prolonging the evening meeting in the form of throwing open several rooms in which may be exhibited models or new instruments of interest, is a good one, and might be with advantage copied by us. This time after the meeting is often much curtailed by the length of the discussions, and I hope that you will support me in the chair when I try to shorten the discussion, particularly when it runs away on matters irrelevant to the Paper of the evening.

The ideal method of best spending the time of the session is in discussions on the points of most interest to us at the time —*i.e.*, on burning questions, which might be started by comparatively short Papers, printed and distributed before the discussion, so that the whole evening might be devoted to it. I, for one, hope that we shall have free, fearless, and open discussion on all matters which affect our art. Let us keep away from any imputation of personal motive; but, at the same time, let us not hesitate to condemn as well as to praise, simply because such condemnation may appear to hurt the commercial interests of A, B, or C; I say advisedly "appear," because honest criticism in most cases is likely to prove to the advantage of A, B, or C, as it may open their minds to matters which they had never had fairly put before them.

After such a long spell of what I am afraid you will consider too plain speaking on my part, I end my address by calling your attention to the diagram on the wall, which shows the combined output, or load, of the London electric supply stations for a night in December, 1894, and which was taken simultaneously for the purposes of this Address, and for which I have to thank the engineers of the supply companies. I have not had the opportunity to compare this with the load of any other city in the world; but I fully believe that it will be found to be one of the largest that has ever been drawn out.



Load Curve showing the combined output of the whole of the London Central Stations during the 24 hours ending 6:0 a.m. on the 20th December, 1894. (From data kindly supplied by engineers in charge). Maximum Load 5:30 p.m., 11,600 K.W. Minimum Load 4:0 p.m., 800 K.W. Load Factor, .33%.

I have to thank you for listening patiently to what, after all, is a recapitulation of facts which have been already known to many of you. I can only hope that they were not known to others, and that they may be of use to them.

A NEW PRODUCT OF THE ELECTRIC FURNACE.*

A recent discovery, made with the aid of the electric furnace, is that of a calcium carbide (CaC_2), which, quite apart from its scientific interest, gives promise of serving several valuable uses in the arts. This compound is not unknown to science, having been produced for the first time, in small quantity, by the distinguished chemist Wöhler, over fifty years ago, in the course of some investigations on the preparation of acetylene; and analogously constituted carbides of potassium and barium have been produced by various more or less indirect and costly methods.

The discovery of the method of producing the calcium carbide directly in the electric furnace was made by Mr. Thomas L. Willson, and appears to have been an unlooked-for result obtained in the course of experiments carried on at Spray, N. C., for the manufacture of alloys of aluminium and calcium.

While attempting to produce metallic calcium in his electric furnace, Mr. Willson succeeded in obtaining from a simple mixture of lime and carbon, subjected to the heating effect of a current of 4,000 to 5,000 amperes, a fused, black, homogeneous mass, which on cooling became solid and brittle, and which proved upon analysis to be a very pure calcium carbide of the composition CaC_2. This substance, when dropped into water, readily decomposes liberating pure acetylene with the formation of calcium hydrate, the reaction being expressed by the formula, $CaC_2 + 2H_2O = C_2H_2 + Ca(HO)_2$.

Dr. Wyatt very appropriately refers to this contribution to organic chemistry of a plentiful and cheap source of acetylene, by so easy and simple a method of manufacturing calcium carbide, as one of the most important of the valuable resources added to the chemical industry by electrical engineers. The value of the discovery was duly appreciated by its author, and arrangements have been practically consummated for undertaking the manufacture of the carbide on the large scale.

The construction of the electrical furnace designed and patented for the purpose by Mr. Willson, does not appear to differ materially from others of the type that have preceded it, embodying merely certain changes in minor details to adapt it for yielding the best results. It may, therefore, be passed over. The same comment may apply to the operative features of the process, which Dr. Wyatt describes as "decomposing, deoxidising, or reducing refractory metallic ores or compounds by subjecting them, while intimately commingled with an excess of finely-divided carbon to the continued heat of an electric arc, the mixture being between the separated electrodes." These are essential conditions of operation in every electrical furnace. The special feature, if it may be so called, appears to be embraced in the explanation that arc shall be maintained quite close to that portion of the mixture that is immediately under treatment, while reference is made to the part played by the presence of an excess of carbon in preventing violent fluctuations of electrical resistance.

Of much more direct interest are the statements given by Dr. Wyatt of the cost of manufacturing the carbide based upon the results obtained in actual practice, and his references to the probable commercial value of this new source of acetylene.

These statements we give in the author's own language, viz.:—

As the actual result of its recent practice, the Willson Aluminium Company has found that it can produce one short ton of calcium carbide from a mixture of 1,200lb. of fine coal dust and 2,000lb. of burnt lime, and at an expenditure of about 180 electrical horsepower per hour for twelve hours. These figures are not very far from those required by theory, and they agree very closely with those given by H. Moissan, who has also produced the carbide in an electrical furnace of his own invention. It would, therefore, seem safe to formulate the approximate cost of production somewhat as follows for both the carbide and the acetylene:—

1.200lb. coal dust, say	$2 50
2,000lb. powdered burnt lime	4 00
180 E.H.P. from water at, say, 50 cents per hour for 12 hours	6 00
Labour, &c.	2 50
Cost per 2,000lb. CaC_2, say	$15 00
Cost per 2,000lb. C_2H_2, say	$37 00

These figures would hold good, not only for the present works in North Carolina, but at any other place where very cheap water-power and equally cheap coal, lime and labour are procurable and accessible.

The specific gravity of calcium carbide is 2·22 at a temperature of 18 C., and, as may be judged from its formula, it is practically insoluble in all the ordinary reagents. Its qualities and characteristics have not been fully investigated, but Moissan has found that it may be heated in hydrogen gas, or exposed to nitrogen at 1,200°, or to the contact of silicon or boron at a bright red heat, without undergoing any change, and that it is not affected by sodium or magnesium at the softening point of glass, or by tin at a red heat. At a higher temperature than a dull red heat it alloys with iron, and this is well worth noting, because it may be of interest in the future industry of steel. It becomes incandescent in contact with chlorine, bromine and iodine at the respective temperatures of 245°, 350° and 305°. It burns in oxygen, with formation of calcium carbonate, at a dull red heat, and at 500° it becomes incandescent in sulphur vapour, and yields calcium sulphide and carbon bisulphide. Water is decomposed by it very rapidly and with evolution of pure acetylene, but its action upon steam is not so rapid, even when it is red hot, and the gas evolved is not pure acetylene, but contains free hydrogen. In dilute acids it behaves in the same way as with water; but it is only slightly attacked by fuming nitric and sulphuric acids, although ordinary sulphuric acid readily decomposes it, giving off an odour of aldehyde. Dry hydrogen chloride makes it incandescent, and the gas evolved contains a large proportion of hydrogen. With fused chromic anhydride it forms carbonic anhydride with incandescence, but with a solution of chromic acid it produces acetylene only. It is oxidised by potassium chlorate or nitrate at a red heat with incandescence, and formation of calcium carbonate. Lead peroxide oxidises it with incandescence below a red heat, the reduced lead containing calcium, and it becomes incandescent by trituration with lead chromate at the ordinary temperature.

This rapid summary of the results of preliminary investigations would seem to strengthen the opinion, already expressed, that calcium carbide chiefly claims our attention as a practically unlimited and most convenient source of pure acetylene; and there is little reason to doubt that its utilisation in this direction will soon cause it to be manufactured extensively in this and other countries.

The fascinating scope for intelligent and painstaking research thus opened up in so many and so varied directions, must strike all those who are in any way interested in organic chemistry as practically boundless, and the results will undoubtedly be revolutionary. For the purpose of giving us better and cheaper illumination than the ordinary coal, water and oil gases, acetylene is already occupying much attention, and it is from this direction that results will in all probability be first made apparent. The hydrocarbons of the ethylene and acetylene series give the illuminating value to gas made from the distillation of coal; while the illuminating value of water-gas is derived from a mixture with the non-luminous gases of the same series of luminants obtained from the vapourisation and cracking of petroleum oils. Since the power of the illuminants in any gas is in direct ratio to the relative proportion of its carbon and hydrogen, it must be plain that acetylene (C_2H_2), on account of its great proportion of carbon, must be highly diluted to prevent it from burning with a smoky flame. When, however, it is diluted by mixture in proper proportion, either with water gas or with ordinary atmospheric air its flame is smokeless and, of the utmost brilliancy and whiteness. The experiments that have been made by the Electric Gas Company have satisfactorily demonstrated that one short ton of calcium carbide will produce, by merely mixing it with water, about 10,500 cubic feet of acetylene, which, when mixed with the required amount of air, produces a gas equal in illuminating value to 100,000 cubic feet of city gas of 22 to 25 c.p. per 5-foot standard burner.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, January 25th.

PHYSICAL SOCIETY.

5 p.m. The following Papers will be read:—(1) "Tests of Glow Lamps," by Prof. W. E. Ayrton and Mr. Medley; (2) "The Temperature of Water and its Maximum Density," by Prof. Anderson and Mr. McClelland.

MONDAY, January 28th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture III.: "The Arc Light," by Prof. S. P. Thompson, F.R.S.

TUESDAY, January 29th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper will be read: "Boiler Explosions," by W. H. Fowler.

THURSDAY, January 31st.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Annual General Meeting at 25, Great George-street. Report of Council, Election of President, &c. The following Paper will be read: "The Determination of the Dryness of Steam," by Prof. W. C. Unwin, F.R.S.

FRIDAY, February 1st.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Annual General Meeting at 25, Great George-street. The following Paper will be read: "Comparison between Governing by Throttling and by Variable Expansion," by Capt. H. Riall Sankey.

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* Abstract from the *Journal* of the Franklin Institute.

The Electrician.

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SPECIAL NOTICE.

With this week's Number of "THE ELECTRICIAN" is issued (Gratis to Subscribers) a fine STEEL-PLATE PORTRAIT of Mr. R. E. CROMPTON, President of the Institution of Electrical Engineers, 1895.

Complaints of non-receipt should be at once sent to the Publisher.

TRAMWAY ENTERPRISE IN THE UNITED KINGDOM.

In another column will be found a series of curves plotted from some statistics relating to English tramways, which are to be found in a return called for by the House of Commons last summer. The United Kingdom, as all electric traction men know to their cost, is, from the tramway point of view, "saturated"; whether permanently or temporarily is, perhaps, a moot point. So accustomed are we English to regard any retrogression or stagnation as a purely momentary phenomenon, that the vast majority are, no doubt, thoroughly convinced that this particular check cannot be other than for the time being, and, acting on this sanguine assumption, are gathering up a store of knowledge from the experiments and experience of other folk more go-ahead than ourselves, and laying it by with a view of turning it to account in the good time coming. Beyond this already well-ascertained fact of "saturation," it cannot be said that these recently-published tramway statistics, whether in their original serried array of columns of figures or as curves, convey at first glance very much to the mind desirous of discovering the why and wherefore of the present state of stagnation.

Up to 1886, as the curves of capital authorised, capital expended, and line-mileage tell us, all went tolerably well. The increase of capital expended and of line mileage for the eight years 1878-1886 was respectively 200 per cent. and 218 per cent., but for the period 1886-1894 the corresponding figures are only 14·5 per cent. and 12·75 per cent. A gradual decrease in the rate of increase is, of course, to be expected in industrial enterprise of this description. A sudden check, however, or an actual retrogression, such as is shown by the line-mileage curve to have occurred between 1890-92, is an unhealthy symptom. And especially so is this the case when this peculiar paralysis takes place side by side with a tremendous expansion and a marked improvement of tramway traction elsewhere. The populations of the United States and of the United Kingdom are in round numbers 63,000,000 and 39,000,000 respectively; that is to say, they are in the ratio of 1·6 : 1. The tramway mileage of the United States, according to the latest reliable returns available, amounts to more than 12,000 miles of *track*, that of the United Kingdom being but little more than 1400; the track mileage ratio is, therefore, 8·5 : 1. Figures, we admit, can be made to prove almost anything. However, taken at their lowest value, comparative statistics such as these "must give us pause." Meanwhile, during this period of arrested constructive development, the number of passengers carried has risen almost by leaps and bounds. In 1878 the total was 146 million, and in 1886 no less than 384 million, an increase of 163 per cent. To-day 617 million people anually patronise tramcars. In other words, during the eight-year period in which capital expenditure increased only 14·5 per cent., and miles of line open for traffic only 12·75 per cent., the passenger traffic increased 60 per cent. Evidently it is not because the British public has tired of tramways that the British investor has turned a deaf ear to the persuasive promoter. Neither do the figures and curves relating to revenue carry us much further towards a solution. Gross receipts have increased nearly 230 per cent. upon the total for 1878, and net receipts have not fallen off appreciably. The average ratio of working expenses to total income brings us on the other hand to the pith of the puzzle. English railways consume only 57 per cent. of their total income in earning it; for English tramways the figure is nearly 80 per cent. When to this consideration we have superadded the climatic, social and municipal purchase disadvantages adverted to in our recent review of the past year, the paralysis which has overtaken tramway enterprise in this country is no longer a mystery.

To facilitate the adoption of an entirely new system of traction it is desirable that the tramway business should be in a condition of medium prosperity and in high favour as a safe and fairly remunerative investment. When dividends are fat, directors are lazy, revolutionary innovations are discountenanced. When dividends are for the most part non-existent or extremely modest, when there is no security of tenure, no pressing public want to be filled, and, above all, no particular weakness for tramways as a mode of investment, directors cannot, as a rule, obtain capital for extensions or improvements, except by way of loans and debentures, or, on the other hand, do not care to risk the loss of the meagre pittance now being earned. This last is the present state of affairs at home, an evidence of which is the fact that since 1878 loan and debenture capital has increased from £900,000 to £5,000,000, whilst share capital has only grown from three to nine millions. Financial expedients are not to our liking; but the circumstances being what they are, it would seem as if something of the kind will have to be resorted to if electric tramway traction is to make any immediate progress in England. American and German experience has conclusively shown that there is money in electric traction, and in view of this there should be no great difficulty in raising capital for electric traction construction and maintenance Many a struggling horse tramway company would be only too glad to lease its undertaking for the poor remainder of its existence in consideration of a certain percentage on the gross annual receipts. Many a concern too poor and too insecure in tenure to start all afresh as an electrical line could be worked remuneratively by a lessee company in a big way, making every bolt and nut for itself, and able, when the day of municipal purchase arrives, to pack up and be off with but little loss to fresh fields and pastures new, unless the terms offered are adequate. Moreover, municipalities, it must not be forgotten, are at present debarred, except in three instances, from working their own lines, and would therefore be ready listeners to proposals coming from a corporation with ample capital, practical experience, and the latest thing in mechanical traction. Small firms pulling at random and working lines at a loss—as an advertisement, big firms looking upon electric traction as a mere addendum to their other business, do not strike us as exactly adequate to the task of pushing forward electric traction against the obstacles, passive and active, which beset its path in this country. On the other hand, a concern, such as we have suggested would have to be honestly promoted, energetically and carefully worked—and hitherto a mixture of finance and manufacture has not proved to be an ingredient compounded of all the virtues or, for matter of that, of all the talents.

ROOKES EVELYN BELL CROMPTON.

Mr. Crompton, though still a comparatively young man, is quite venerable as an electrical engineer. He is a Yorkshireman and a Harrow boy. He began his career as a soldier; but his strong bent towards engineering led him, when in the Department of Public Works in India, to become an expert in the driving and all else that appertains to a traction engine. In 1876, at the age of 31, he left the service, and devoted his whole time to engineering, and when electric lighting saw the light of itself in 1878, he took up the subject with his characteristic vigour, and at once came to the front.

The secret of his success from the beginning lies in his insisting on good engineering design and solid work, where the mere electrician would have fallen back on the flimsiness of the optician. His works developed rapidly by manufacturing Bürgin machines, and arc lamps of his own and Mr. Crabb's invention. In 1882 he and Mr. Kapp invented and made the first constant potential machines ever turned out, though a double-wound machine had been made previously by Varley and Brush. In those days the influence of the unpractical electrician and the optician was still rampant in electrical engineering, and dynamos were flimsily made, with no great attention to proportions of iron and copper. Mr. Crompton threw over all the old ideas of dynamo design, and introduced a solidified Gramme machine with comparatively little armature wire and what was then considered a prodigiously strong field, and this has been the typical ring armature machine ever since.

Life at the works did not consist entirely of designing dynamos. Mr. Crompton was always a man of large interests. It was not known at what hour he got up, because no one was up early enough to see. The morning would be spent in going through the works, calculating out windings with a pocket-slide rule, preparing estimates off-hand for the illumination of unknown towns, dictating letters, looking through drawings and saddening draughtsmen by sketching in pencil on their work, in discussions with his electrician who wanted to do something another way, taking draughts of boiling water, and getting out patent specifications. All this would cease at 1:23. He would then have a sumptuous lunch and drive a mile, catching the 1:27 to London. The journey was a concentrated mixture of technics, reminiscence and anecdote. The afternoon would be devoted to weaving webs around the wily town councillor or other customer, to rushing round to different installations, to dictating Papers for learned societies while he crammed a heterogeneous collection of papers into a handbag, and finally, a rush off to Liverpool-street, changing a three-volume novel at the bookstall and catching the train to Chelmsford, where the discarded novel would be again changed. Then messages to one or two members of the staff to tackle some business at 8:30. The meantime would be occupied in the racquet court adjoining the works. Mr. Crompton plays tennis, both "real" and "lawn," with the same vigour that he does everything else. He regards real tennis as a far more scientific game than billiards, and has more than once astonished players at "Princes" who have judged him by his white hairs to be an old man. He always enters for the squash ties at Chelmsford, and can beat most of his pupils. The perfect freedom with which Mr. Crompton always treats those under him would alone account for their loyalty towards him. It must be admitted that when the representatives of the local authorities came to complain that his pupils serenaded girls' schools in whitened top hats and night-shirts; that he was outwardly grieved at their depravity; but the twinkle in his eye showed that he really regretted not having been among the serenaders. The business to be done at eight generally degenerated into supper and yarns; but the real business of the day always began about 11:30, and Mr. Crompton was left completing it alone in the small hours of the morning.

His technical policy has always been to put in good solid engineering work, and he was one of the earliest to realise fully that the whole success of a central station does not depend only on the electrical efficiency of the dynamo, and that a real electrical engineer is more concerned with boilers than with Fourier's series. Mr. Crompton is no high mathematician, and his dynamo designing has not been carried out in the style inculcated to the second-year student at the leading technical colleges. But he has confessed, long ago, that he has "an eye"; and Mr. Crompton's "little eye," about which he used to be chaffed, has done him good service, and has helped England to take the lead in first-class electric engineering construction and design.

Mr. Crompton is a first-class fighting man, and the keenness with which he debates at Westminster has led some of his hearers to think that he is a man of narrow ideas. Nothing could be wider of the mark; but a skilful barrister often appears to an ignorant lounger in the law courts to be hopelessly prejudiced towards his clients. Mr. Crompton probably understands the conditions under which alternate-current supply is suitable as well as anybody. He has good reason. For he made an emphatic success of continuous currents, and, being proud of it, he analysed the accounts and dissected the expenses of the supply systems which he equipped, in a way that no other man attempted, though many are now endeavouring to imitate. He therefore knows the shortcomings and limitations of continuous-current distribution, and is perfectly ready to recommend alternating transformer systems in suitable places, and has developed for this purpose an alternator and a transformer which do credit to the Chelmsford works.

Of late years the beams of an arc lamp or two have been seen shining over Kensington Court from the topmost story of his house until late at night, and here, in a well-equipped laboratory, Mr. Crompton has been carrying on experimental work and investigations of a high order. The calibration of Crompton and Co.'s measuring instruments was, until lately, carried on here by the aid of the accurate measuring apparatus and powerful battery of accumulators which the laboratory contains. A research on the most economical size of arc carbons has been recently carried out, and the results were most carefully worked out in grammes of carbon per spherical candle-hour, Mr. Crompton being a photometrist of no mean order. The development of the potentiometer, to which we referred last week, and of the platinum pyrometer, has occupied him more recently, and he proudly shows to visitors d'Arsonval "galvo" coils wound with his own hands in a winding jig of his own construction, and claims that the sensitiveness of his pet "galvo" has never been approached by any other maker.

The development of the Crompton Howell accumulator is another important work, and there is, or was recently, in this laboratory a cell which it is claimed beats record. A railway company recently "lost" it until a claim for £200 was made for it. Of Mr. Crompton's pioneer work at Vienna, where many of the now well known features of supply stations were first adopted, of the thorough success of the Kensington and Knightsbridge Electric Lighting Company, and of the others which followed it, it is unnecessary to write; suffice it to say that they largely contributed to restore the confidence of the financial world in electric supply. Mr. Crompton, as a writer, is well known to our readers; his Paper read before the Institution of Civil Engineers in which he first discussed the "load factor," was a landmark in the development of electrical engineering. In an article contributed by him to *Industries* so long ago as March, 1888, he discussed the question of distribution by continuous-current transformers, and clearly indicated what has since been called the Oxford and Chelsea system. This article shows that the alternating transformer system was in full use at that time, although there is a tendency now to make out that it has not yet had a fair chance and it has only been recently improved. Further, it shows that at that time he laid down as an absolute necessity what has only quite recently become general—*i.e.*, the providing of a surface box opposite every other house; and lastly, the cost of plant per 100 kilowatts was worked out at about £81, which is almost precisely the figure at which various speakers fixed it during the discussion on one of his recent Papers. Mr. Crompton, in fact, knew, and was prepared to assert in print, a good deal more in 1888 than is now generally believed. In the widest and best sense of the term, there can be little doubt that Mr. Crompton is the leading electrical engineer of the land.

THE ELECTRIC ARC.

BY HERTHA AYRTON.

(Continued from p. 339).

A glance at Figs. 4, 5, and 6 (pp. 336, 337, *The Electrician*, January 18th) is sufficient to show the general character of the changes in the curves caused by varying the diameters of the carbons employed. The chief of these is the change in the smallest current which causes hissing.

These hissing points, as they may be called, must not be trusted too implicitly however; they are very difficult to determine, and are liable to change with the smallest change in the construction of the carbons. For instance, with both carbons solid, hissing occurs with a much smaller current for a given length of arc than when the positive carbon is cored; it is, therefore, reasonable to suppose that some of the vagaries which I have met with regarding the hissing point with cored carbons are caused by some variation in the diameter or construction of the core. No absolute law, therefore, for the determination of these points could possibly be relied on that was not based upon a very large number of determinations with carbons of the same sizes and construction.

Even with the same pair of carbons the smallest current with which continuous hissing first takes place, and the largest current with which a silent arc can be maintained continuously for a given length of arc, are almost impossible to determine with absolute certainty. Within the unstable part of the curve, before even arriving at the currents which simply refuse to go through the arc at all, one gets currents which act in a very exasperating manner. They will flow silently for several minutes, and when you think the carbons are just formed for that current and length of arc, down goes the pressure, up goes the current, and the arc begins to hiss.

And, *vice versâ*, when the arc is apparently hissing quite steadily, it will suddenly become silent with a reversal of the action of pressure and current; and, of course, when once either of these changes has really set in, you have to change the outside resistance to bring the arc back to the state you require, and wait while the carbons form again.

But, although the actual current with which hissing takes place is not to be relied on within a certain range, the general nature of the change in the hissing point caused by varying the sizes of the carbons may be very well observed by comparing Figs. 4 and 6. One may say at once, for instance, that hissing certainly occurs with very much smaller currents with the smaller carbons than with the larger ones. Comparing, for example, the 2mm. arcs on the two figures, whether hissing occurs with 15 or with 17 amperes with the smaller carbons, or with 46 or 50 amperes with the larger, it is absolutely certain that, with that length of arc, the larger carbons can burn silently with a very much larger current than the smaller.

Thus one point is established—namely, that the largest current which can maintain a silent arc of given length—in other words, the hissing point—increases with the cross section of one or both of the carbons employed.

Again, it is evident from the same figures that the hissing point always occurs on the flat part of the curve; that is to say, the potential difference has always gained a fairly constant value before hissing begins. And, still further, the potential difference is constant for a much larger range of current before hissing begins with large carbons than with small. Thus, if the object were to keep the potential difference of the arc constant for a large range of currents large carbons should certainly be used.

Fig. 6 shows that the largest current that can maintain a silent arc with a given pair of carbons is greater for long arcs than for short. This is only another way of stating a very well-known fact—one that has caused much misapprehension—namely, that if with a certain length of arc you have hissing, by lengthening the arc and keeping the current constant you will eventually get a length of arc which will be silent with that particular current flowing through it. But that length of arc has also its hissing point, only with a bigger current, and that is what has not been generally understood.

We may thus arrive at two very definite conclusions:—

(1) The smallest current which produces hissing with a given length of arc increases with the cross-section of the carbons.

(2) The smallest current which produces hissing with a given pair of carbons increases with the length of arc.

But from Figs. 4, 5, and 6 it would appear that increasing the cross-section of the carbons has much more effect in increasing the current that can flow through the arc without causing hissing than increasing the length of arc in the same ratio. This is clearly seen from Tables Nos. I. and II.

Table I.

Diameter of carbons in millimetres.		Sum of cross-sections of carbons in square millimetres.	Approximate ratio of sums of cross-sections.	2mm. arc, approximate largest current in amperes not producing hissing.
Positive	Negative			
18	15	549	4	48
13	11	290	2	28*
9	8	145	1	14·5

Table II.—*Positive Carbon 9mm. cored, Negative Carbon 8mm. solid.*

Length of arc in millimetres.	Ratio of length of arc.	Approximate largest current in amperes not producing hissing.
8	4	22
4	2	19
2	1	15·5

Hence with the small pair of carbons, having a joint cross section of 145 square millimetres, it is impossible to obtain a silent arc with a current larger than about 20 amperes, even when the arc is lengthened to 8mm. While with the large pair of carbons, having a joint cross section of 549 square millimetres, a current of about 40 amperes will produce a silent arc even when the arc is as short as 0·5 mm.

Next, as regards those portions of the curves in Figs 4, 5, and 6, which refer to *silent* arcs. From inspection it is seen that the permanent value of the potential difference required to send a particular current through a given length of arc depends but little on the cross section of the carbons, although the carbons for the curves in Fig. 4 had about four times the cross section of the carbons for the curves in Fig. 6.

In Table No. III. some examples are given illustrating this point.

Some of the potential differences in this table for a given length of arc and current are almost identical for the three different pairs of carbons; for example 43, 43 and 43·7 volts for a 2 millimetre arc with 10 amperes, or, again, 44·5, 45 and 45·8 for a 3 millimetre arc with 15 amperes. In other cases the agreement is not so marked; for example, 36, 37·5 and 41·5 volts for a 1 millimetre arc with six amperes. It might, therefore, be thought that the permanent value of the potential difference required to send a particular current through a given length of arc was really independent of the size of the carbons, and that the want of identity of the three values of the potential difference in certain cases was due to inaccuracy in the observations.

Table III.

Length of arc in millimetres.	Current in amperes.	Potential difference between carbons for		
		+18mm. cored −15mm. solid.	+13mm. cored. −11mm. solid.	+9mm. cored. −8mm. solid.
0·5	6	33·0	...	36·7
1·0	6	36·0	37·5	41·5
2·0	6	47·0	46·0	44·2
3·0	6	50·5	50·2	48·4
4·0	6	53·0	54·0	53·8
5·0	6	54·75	56·0	55·8
0·5	10	34·9	...	39·0
1·0	10	35·0	38·5	42·0
2·0	10	43·0	43·0	43·7
3·0	10	50·5	46·7	46·2
4·0	10	53·0	49·7	53·8
5·0	10	54·75	52·0	55·8
0·5	15	36·5	...	hissing.
1·0	15	37·5	39·7	43·0
2·0	15	42·0	43·0	44·0
3·0	15	44·5	45·0	45·8
4·0	15	45·8	47·5	48·5
5·0	15	47·5	50·0	50·2

On plotting, however, the curves on Fig. 11, connecting potential difference with length of arc, each of the three groups of curves A, B, and C being for a particular current for the three pairs of carbons, it is seen that the three curves for any group are in reality different parts of curves having the same general shape, but differing in the proportions of their parts; in fact, if we compare the curves in Figs. 7, 8, and 9 (p. 338, *The Electrician*, January 18th) *for the same current* we see that the three curves have the same general shape, only the bent parts differ in width and height; that is, the rate of change of ratio of potential difference to length of arc is different in the three curves.

Compare, for instance, the curves for currents of six amperes in Figs. 7 and 9. In Fig. 7 there is a fairly straight part from 6mm. to 2mm., at which length the potential difference is about 47 volts; then there is a rapid bend in the curve to 0·8 mm., where the potential difference is about 35 volts, and then there is a part that is much more nearly horizontal.

Turning to Fig. 9 we have the same thing—with a difference. The straight part of the curve stops at 4mm., at which point the potential difference is about 58 volts; then the bend down is much less rapid, extending, as it does, over a longer period to 1·75mm. where the potential difference is 44. Then comes the fairly horizontal part, extending to about 1·1mm., and then a new part altogether, where there is a rapid bending down of the curve.

It appears, therefore, to be correct that, while for some cases in Table No. III. the potential difference for a given length of arc and current should be the same for the three pairs of carbons, for other cases there ought to be a difference in the values of the pressure.

In their Paper read before the Physical Society in 1882 (Vol. V., p. 203) on "The Resistance of the Electric Arc," Messrs. Ayrton and Perry said, in speaking of the curve given in that Paper, which they had drawn from the results of their experiments connecting potential difference between the carbons and length of arc from arcs up to 31mm. long: "The curve we have obtained is also strikingly like that obtained by Drs. W. De La Rue and Hugo Müller for the connection between the electromotive force and the distance across which it would send a spark. These gentlemen also made experiments on the electric arc with their large battery . . . the result of an experiment in air between two brass points is given; but, according to that, when the arc was half an inch in length the

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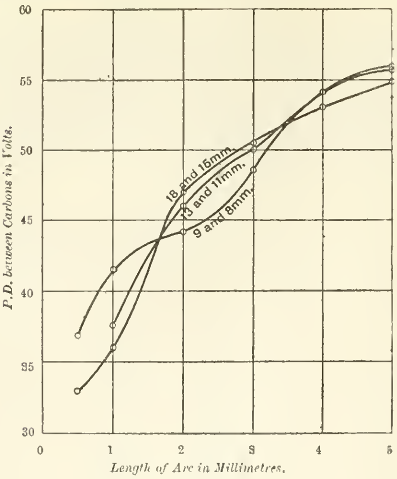
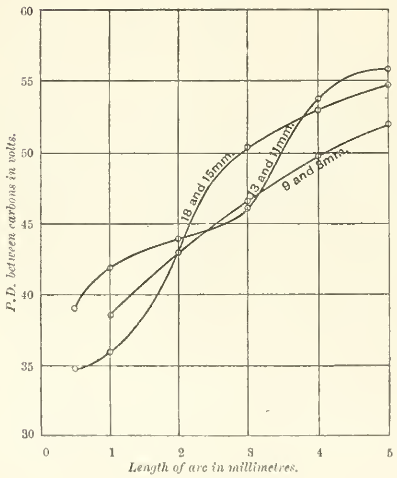
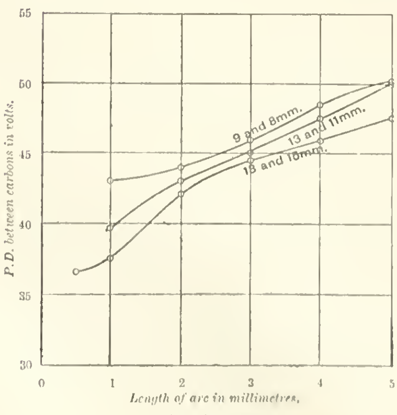
* This current is known from the laboratory note-book, although not stated on Fig. 5.



A.—6 Amperes.



B.—10 amperes.



C.—15 amperes.

difference of potentials between the brass points was about 700 volts. How far the very high electromotive force found by Drs. W. De La Rue and Hugo Müller to be necessary in this case arose from a combination of the material employed for the electrodes and the smallness of the diameter of the brass electrodes, or whether the law that 'the electromotive force necessary to maintain an arc depends mainly on the length of the arc, and hardly at all on the strength of the current,' fails when the current is below a certain small limit, we are unable to say; but of course both the diameter of the brass electrodes they employed and the strength of the current that was passing (0·025 ampere) in the arc was very much less than that used in any ordinary electric light, and to which the experiments of Mr. Schwendler and ourselves especially refer. It is very probable that the difference in the material of the electrodes has mainly to do with the difference between their results and ours; and we think it very probable that with very soft carbons an arc of a given length could be maintained with a much less difference of potentials than that found by us, since it would be more easy for a shower of carbon particles to be maintained between the ends of the carbons."

Two results are here foreshadowed, the one that the potential difference for a given current and length of arc would be found to be smaller if the carbons were made softer, the other that the potential difference for a given length of arc would be far higher with very small currents than with those which are used practically with an arc lamp. The first result was found to be true when *cored* carbons were subsequently manufactured, and the second is borne out by the strikingly rapid rise in the curves in Figs. 4, 5 and 6, as the current becomes very small (pp. 336 and 337, *The Electrician* for January 18th).

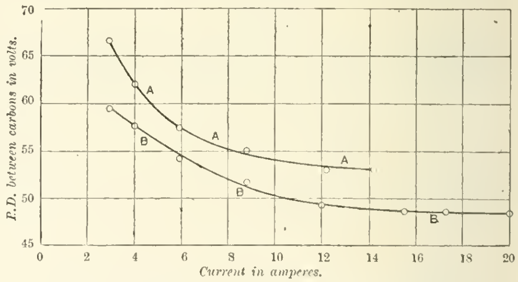


Fig. 12.—4mm. arc—A A A, Positive, 8mm. solid, 11mm. solid. B B B, Positive, 13mm. cored, 11mm. solid.

The curves in Fig. 12 have been drawn in order to see what change was actually made in the curves connecting difference of potential and current for a given length of arc when a solid positive carbon was substituted for the cored one of the same diameter, the negative carbons in both cases being solid.

These curves connect difference of potential with current for a silent arc of 4mm., A A A when both carbons are solid, B B B when the positive is cored, the positive carbon being 13mm. and the negative 11mm. in diameter in both cases. It is seen that the curve with a cored positive carbon is from three to six volts lower than that with a solid positive.

This diminution of potential difference with a cored carbon does not appear, from my experiments, to be uniform whatever the length of arc, and I find that it is much greater with short arcs than with long ones, evidently also from the curves in Fig. 12, it is greater with smaller currents than with larger ones.

The curves connecting apparent resistance with length of arc (Figs. 13, 14 and 15) will be instructive on this point. The ordinates of these curves were obtained by dividing the potential difference for each length of arc by each current used, after the current had in each case been kept constant for a sufficient length of time for the carbons to be properly shaped for the particular current and length of arc. The abscissæ are the corresponding lengths of arc, the current being the same for all the points on any one curve.

In 1886 Messrs. Cross and Shepard constructed resistance curves of this kind for *solid* carbons (*Proceedings* of the American Academy of Arts and Sciences, June 16, 1886), and found that in every case they obtained straight lines for both silent and hissing arcs, showing that the apparent resistance of the arc minus a constant varied directly as the length of arc, and upon this fact they founded their formula

$$R = a + b\,l,$$

where R is the apparent resistance of the arc, l the length of arc, and a and b are constants which depend on the currents and the carbons, and also on whether the arc is a hissing or a silent one.

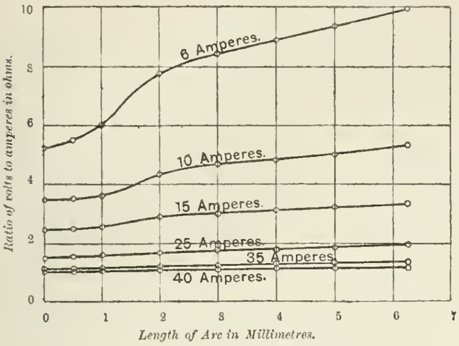


FIG. 13.—Carbons: Positive, 18mm. cored; Negative, 13mm. solid.

The results of my own experiments with solid carbons agree with this equation, but a glance at the curves on Figs. 13, 14, and 15, for cored positive carbons will show that no such equation could possibly fit the majority of them. It is evident that only the curves with currents of 20 amperes and more are straight lines while those with smaller currents are straight only when the arc is longer than 3mm., and that they give a great dip down from 3mm. to 2mm. This dip is less as the current becomes greater, until at 20 amperes it has ceased to exist. Now this dip evidently depends on the core of the positive carbon, for it does not exist when the positive is solid; and in order to see whether the hollowing out of the crater (which had been observed to be very great in cored carbons) had anything to do with it, measurements were taken of the depths of craters with different currents and lengths of arc. The results are given in Table No. IV. The carbons used were 13mm. cored positive, and 11mm. solid negative. The measurements were made by means of a microscope with a micrometer screw arrangement for focussing. The edge of the crater was first brought into focus and the reading taken on the micrometer, then the bottom of the crater was brought into focus, and the reading again taken. The difference of the two readings gave the depth of crater. Great care was taken that the craters should be completely formed with the given current and length of arc before the depth was taken.

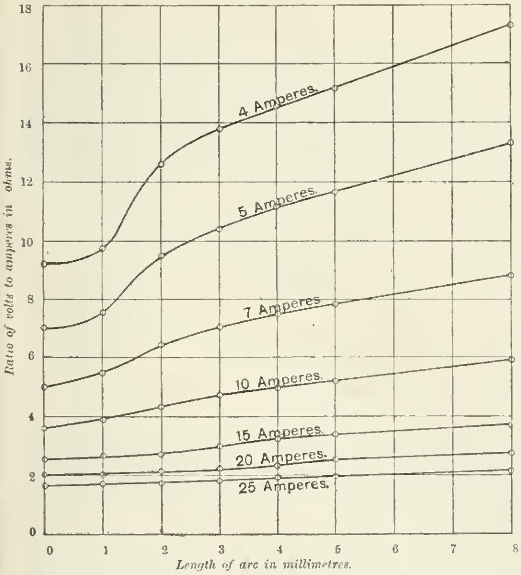


FIG. 14.—Carbons: Positive, 13mm. cored; Negative, 11mm. solid.

Table IV.—*Carbons 13mm. cored, 11mm. solid.*

Length of arc in millimetres	Current in amperes.	Depth of crater in millimetres.	Length of arc in millimetres	Current in amperes.	Depth of crater in millimetres.
1	6	0·96	3	20	1·06
1	10	1·33	3	30	0·98
1	15	1·6	6	6	0·72
1	20	1·38	6	10	0·55
1	28	1·266	6	15	0·63
3	6	0·82	6	20	0·77
3	10	0·95	6	25	0·65
3	15	0·96	6	30	0·65

It is not, of course, pretended that these measurements of the depth of the crater were absolutely accurate, a small excrescence upon the edge of the crater or a slight irregularity of form, such as those who are familiar with arcs will recognise as being of constant occurrence, would tend to obscure the real depth of crater; but the general character of the change in the depth with variation of current and length of arc is very apparent.

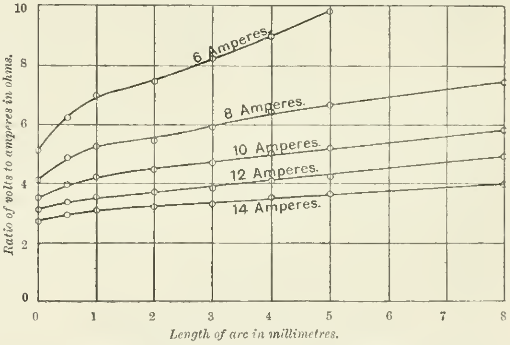


FIG. 15.—Positive, 9mm. cored; Negative, 8mm. solid.

It is evident that with a given current the depth of the crater is the greater the shorter the arc, and, therefore, the percentage increase of length of arc caused by the depth of the crater increases rapidly as the arc is shorter. For example, with a current of 6 amperes the depth of the crater increases the apparent length of the 6mm. arc by 12 per cent., the apparent length of the 3mm. arc by 27 per cent., and the apparent length of the 1mm. arc by 96 per cent.

Thus the influence of the depth of the crater on the arc, and therefore on its apparent resistance, must be greatest with arcs of less than 3mm., but this is just where the great fall of resistance is observable in the curves in Figs. 13, 14, and 15, and so it is pretty apparent that the two are connected—but how?

Well, there are two ways in which the soft core may act. (1) It may volatilise more easily, and so diminish the potential difference required for a given current; (2) it may increase the amount of volatile carbon given off per second, and so increase the cross section of the conducting medium, and thus lower the actual resistance of the arc itself. I believe the core acts in both these ways, and that to (1) is due most of the general lowering of the potential observable in curve B B B in Fig. 12, and to (2) may be attributed the diminution of resistance which causes the great drop in the resistance curves with lengths of arc less than 3mm. and currents under 20 amperes (Figs. 13, 14, and 15).

An extra amount of volatile carbon must be given off to hollow out the craters so deeply, and this must increase the cross section of the arc so much as to more than compensate for the actual increase in the length of arc caused by this depth of crater.

It may be objected that the crater is still deeper for a 1mm. arc with larger currents than with a current of 6 amperes, and yet the resistance curves for, say, 30 amperes show no fall of resistance with short arcs.

This is so, but the reason is not far to seek. With big currents the cross section of the arc is so large that the increase caused by the hollowing out of the crater is small in comparison, and, therefore, the change is practically unnoticeable in the resistance curves.

The influence of the soft core may be traced in the same way in the curves connecting potential difference with length of arc for various constant currents (Figs. 7, 8, 9, and 10). For while these curves all bend down rapidly for small currents and short arcs, the corresponding curves which I have obtained for *solid* carbons are straight for even small currents and short arcs.

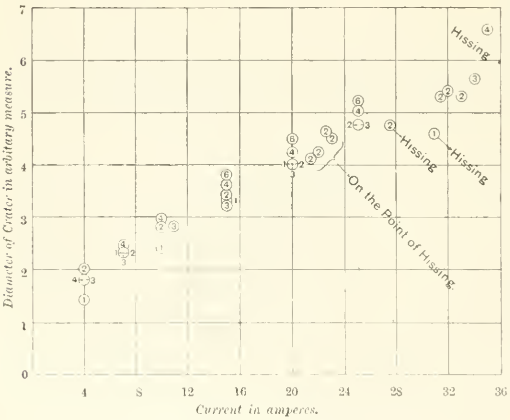


FIG. 16.—Carbons: Positive, 13mm. cored; negative, 11mm. solid. Figures denote lengths of arc in millimetres.

It was thought that the width of the craters might have something to do with the lowering of resistance, and the width of crater for different currents, and lengths of arc were measured very carefully in the following way:—

Strips of paper were placed across the enlarged image of the crater, when it was properly formed with a given current and for a given length of arc, and marks were made with a very fine pencil at the points where the paper cut the diameter of the image of the crater. These lengths were afterwards marked off on a sheet of squared paper (Fig. 16), and used as ordinates of curves, of which the abscissæ were the corresponding currents for the given lengths of arc.

The curves[*] for 1mm., 2mm., and 3mm. arcs are coincident; that for 4mm. starts at 25 amperes slightly higher than that for the other three, and gradually approaches it till they meet at 0 amperes. The curve for 6mm. starts still higher than that for 4mm., but also meets all the others at 0 amperes. The result, therefore, is as follows: The width of crater varies very slightly with length of arc for a given current; and for a given length of arc the width of crater, minus a constant, varies as the current.

The constant is about 3·2mm. for the carbons employed, so that the equation connecting D, the diameter of the crater in millimetres, with the current A in amperes is

$$D = 3{\cdot}2 + bA,$$

where b varies from about 0·145 to 0·156 when the length of the arc is increased from 1mm. to 6mm. For the mean line on Fig. 15 the equation is

$$D = 3{\cdot}2 + 0{\cdot}15\,A.$$

It appears, then, that the diameter of the crater does *not* vary directly as the current, as has been stated, for example, by Prof. S. P. Thompson in his "Cantor Lectures," January 14, 1895. Indeed, if that were true it would follow that, since the diameter is nearly 4mm. for a current of about 4 amperes, it would be about 30mm. for a current of 30 amperes, and therefore the diameter of the crater would be far larger than the entire thickness of the positive carbon.

It is apparent from the curves we have just been discussing that the width of the crater can have very little, if any, influence in lowering the resistance of the arc when it is short; for, if anything, the width appears to be slightly less than it should be, with arcs under 3mm., but probably the law is really a straight line one, at any rate for currents of from 4 to 25 amperes. What we should get with currents of from 4 to 0 amperes it is impossible to say—the curves may take a turn downwards, and 0 amperes may give width of crater 0. This remains for future experiments to show.

(*To be continued.*)

NEW SHALLENBERGER METERS.[*]

Mr. O. B. Shallenberger has designed a set of multiphase instruments at his laboratory in Rochester, Pa., with special reference to the requirements of the Niagara Falls plant.

In the integrating multiphase wattmeter a thin aluminium disc, stiffened by a bead or flange around its edge, constitutes the movable element, in which eddy currents are induced by the currents traversing the coils placed above and below it. The upper coils are connected as shown in Fig. 1. A and B are two-phase circuits. The series coils are connected in circuit A and the shunt coil across B through a resistance without self-induction. The currents in the two sets of coils are therefore in quadrature when there is no lag in the work-circuit, and would be exactly in phase with each other with a lag of 90deg. in the work circuit. The difference of phase between the currents in the meter coils is thus complementary to the lag angle of the work current. The conditions are such in the organisation of the meter that the torque exerted upon the disc is proportional to the sine of the angle representing the difference of phase between the shunt and series currents, and therefore to the cosine of the lag angle of the current in the work circuit—that is, the power factor. The torque is also directly proportional to the product of the shunt and series currents, so that it varies directly as the power transmitted.

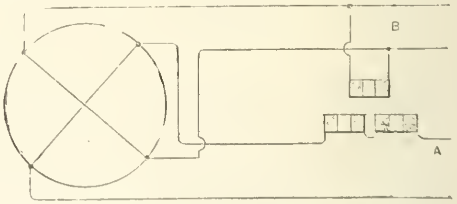


FIG. 1. Diagram of 2-phase Integrating Meter

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[*] These curves have been omitted in engraving the diagram, as they cross each other repeatedly. The readings for the 4mm. arc will be found to lie very closely on a straight line. It is to this straight line that an equation has been found.—[ED. *E.*]

[*] Abstract from the *Electrical Engineer* of New York

C-shaped permanent magnets embrace the disc between their poles, and cause a retarding force directly proportional to the rate of rotation, so that the speed is proportional to the power. The law of operation is as definite as that of the Siemens dynamometer, and in the actual instrument can be carried out with greater accuracy, owing to the absence of moving contacts. The range of accurate working is large, owing to the lightness of the moving parts and small friction in comparison to the forces at work, so that 1 per cent., or less, of the maximum capacity is measured with accuracy. The speed at full load is low, not exceeding about 40 to 50 turns per minute. The lightness of the disc, the slow speed, and the use of the form of lower bearing invented by Mr. Shallenberger in connection with his former meter all contribute to render the friction very slight.

This meter may be used in connection with three-phase as well as with two-phase currents. Fig. 2 shows the three-phase connection in a simple form. The shunt coil is connected across two branches of the circuit and the series coil in the third branch, so that, as in the former case, the current in the shunt coil is in quadrature with the electromotive force of the series circuit, although the currents in the three branches differ by 120 degrees. The resistance in the shunt circuit having been adjusted to suit the new conditions so as to have a correct constant, the operation is exactly as in the former case. For greater accuracy, two or more of the branches of a multiphase circuit are connected to corresponding series coils in the meter, and the shunt coils properly related to each, but for commercial purposes the single form is quite accurate enough when used on balanced circuits, as in the case of a multiphase motor.

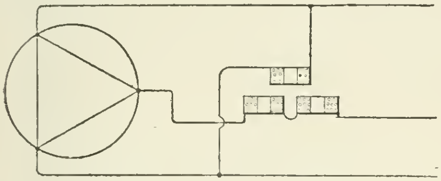


Fig. 2.—Diagram of 3-phase Integrating Meter.

In the form of watt indicator known as the "Niagara Type" the scale is in the form of a band, which encircles the disc and moves the latter behind a fixed index. This arrangement allows the use of a long scale with large divisons, so as to be easily read at a distance. The operation is the same as that of the integrating wattmeter, except that the rotation of the disc is, in this case, opposed by a spiral spring, the magnets acting simply to damp the oscillations. The damping action is so effective that the instrument is almost perfectly dead beat. Adjustments for the zero point and for temperature may be made from the front o the case.

In the voltmeter the two sets of coils are connected in series with a non-inductive and an inductive resistance respectively, the latter being of a form designed to cause a lag of nearly 90deg. in its current. For this purpose the iron and copper losses of the inductive resistance are reduced to a minimum, and a small air-gap is introduced into the magnetic circuit, so as to avoid high magnetisation of the core and render the magnetising current proportional to the induction. The current through this circuit is, therefore, directly proportional to the difference of potential, and this is, of course, true in the circuit containing the non-inductive resistance. The deflection is proportional to the square of the potential, and is also practically independent of the periodicity within the range now generally used, for reasons which will be referred to later. The amperemeter is a modification of the voltmeter, the windings being adapted for larger current and low potential.

In using these instruments at Niagara Falls, transformers specially designed for the purpose will be used to reduce the current and potential to convenient quantities. These transformers are proportioned so as not to introduce errors from change of phase, and they avoid the difficulty of constructing and connecting instruments for heavy currents.

Mr. Shallenberger has also designed an integrating meter for single-phase currents similar in its general features to the multiphase meter, except that instead of a non-inductive resistance a coil of high self induction is used in the shunt circuit, of the same construction as that used in the voltmeter. Owing to the extremely high ratio of self induction to resistance in this coil the shunt current lags nearly 90deg., giving practically the phase relations of the multiphase instrument. It therefore correctly takes account of the power factor within the limits found in practice.

Important features in this instrument are the use of an air-gap of the right proportion, and a core of a high grade of iron. The iron losses are so small, however, that even if increased by "fatigue" after long use, the lag would remain practically unchanged, and owing to the large angle of lag the change in the value of its sine, upon which the torque depends, would be still less. Owing, however, to the low induction in the iron, and entire absence of appreciable heating, it is almost impossible that any change should occur in the iron. The reluctance of the magnetic circuit of this coil is so nearly that of the air gap that the inductance coefficient is very nearly constant, so much so that the same meter may be used on either 50-volt or 110-volt circuits with an error of less than 1 per cent. in the registration.

In this form of meter the proportions are such that for given currents and difference of phase in the actuating coils the torque is directly proportional to the periodicity over the entire range now in use or proposed. Owing to the fact that the inductance coefficient in the shunt circuit is constant, the shunt current is inversely proportional to the periodicity for a given difference of potential. The result of these two laws of operation is evidently that the torque, and consequently the speed, is independent of periodicity. This is proved experimentally to be the case to a remarkable degree. Variations in wave form have no effect within ordinary limits, the constant being the same on circuits supplied from dynamos of radically different types.

One of the features of this type of meter is its extremely long range, which is secured without the use of any auxiliary winding to overcome starting friction, or any other device giving an initial tendency to rotate. A 50-light meter starts with a load of two 100-volt 16-c.p. lamps in series on a 50-volt current, or about two-tenths of an ampere, and at one-half ampere registers with practical accuracy. Continuous rotation is maintained at a speed as low as one turn of the disc in fifteen minutes. The shunt current is about one-tenth of an ampere as a maximum, and since it is practically a wattless current, the actual energy not exceeding half a watt in ordinary cases, the energy consumed is negligible. The constant of the instrument is entirely unaffected by changes of temperature, since the retarding eddy currents induced by the permanent magnets are affected by changes of temperature of the disc in exactly the same ratio as those induced by the actuating coils, so that no change in speed results. There is also no temperature coefficient for the shunt circuit, as its resistance is purely inductive.

The Baltimore "Belt" Tunnel.—The Maryland Steel Company has, says the *Electrical Engineer* of New York, secured the contract for making and erecting the overhead electrical equipment for use in the Baltimore Belt tunnel. The work will cost about $80,000. Instead of using an overhead wire for the circuit, the General Electric Company, which is building the motors to haul the Baltimore and Ohio trains through the tunnel, has decided to build an iron trough 1½ft. in circumference. A flexible wire will be attached to a shoe which will pick up the current. The iron trough will be of heavy workmanship, and the work built to support it will be of light iron bridge construction. Iron poles will be placed 30 yards apart for the track inside the tunnel. On these poles will rest a framework of light iron, which in turn will support the trough. In the tunnel the trough will be near the centre of the tunnel roof, held in place by iron braces, 30 yards apart, and fastened by bolts to the side of the tunnel arch.

TRAMWAY STATISTICS.

The following curves are plotted from a return ordered by the House of Commons in July last, and recently published as Parliamentary Paper, No. 400, of the Session 1893-94. The subject is discussed at length in our leading article this week.

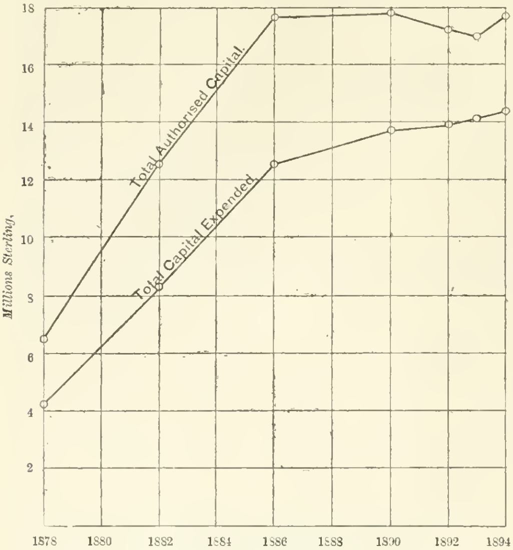


Diagram 1.—Total Authorised and Total Expended Capital.

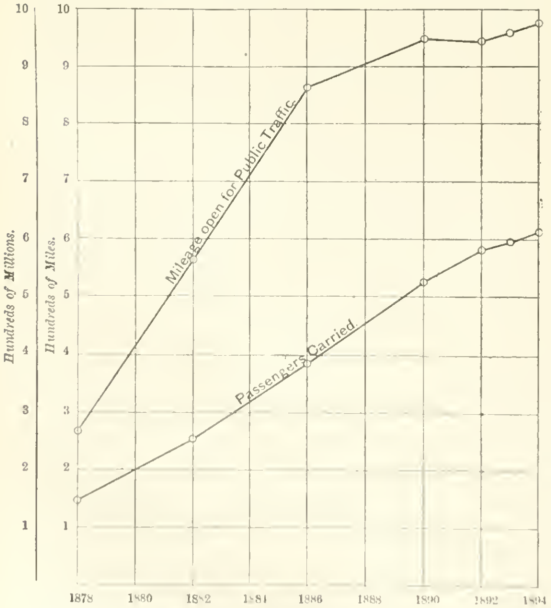


Diagram 2.—Line Mileage and Passenger Traffic of the Tramways of the United Kingdom.

As in the case of electric lighting, so in the case of tramway traction, municipalisation is still more of a bugbear than an actual fact. The mileage and capital cost of municipally-constructed tramways are a good deal less than one-half the mileage and capital cost of the lines built by private enterprise. Perhaps actual ownership of these municipally-constructed lines would have somewhat sobered the owners, and have made them less eager to insist upon their pound of flesh under the Tramways Act of 1870.

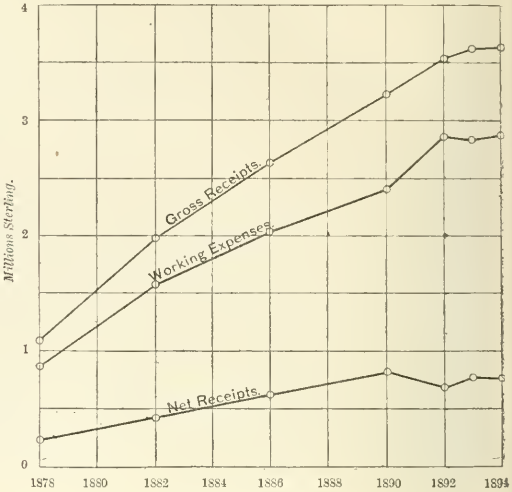


Diagram 3.—Revenue Curves.

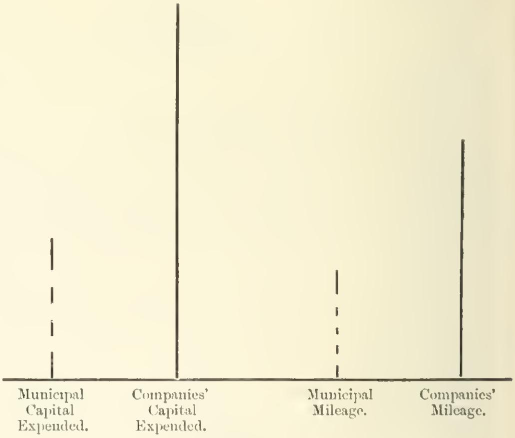


Diagram 4.

1in. = £4,000,000, and 1in. = 400 miles.

THE ELIHU THOMSON COMPETITION.

Towards the end of the year 1889 the City of Paris got up an electric meter competition, prizes to the value of 20,000fr. being placed at the disposal of the jury. Owing, however, to the short space of time allowed to intending competitors to send in their designs, there was but a very mediocre response. Nevertheless, prizes to the value of 7,000fr. were distributed, and a second competition was organised. In this second competition the Elihu Thomson meter was awarded the first prize of 5,000fr. Prof. Elihu Thomson thereupon organised a third competition, the terms of which were made public in September, 1892. The Committee consisted of MM. J. Carpentier, Hippolyte Fontaine, E. Hospitalier, E. Mascart, A. Potier, and B. Abdank-Abakanowicz.

These gentlemen decided that the subjects for essays should bear upon the following points:—(1) The study of the heat liberated by successive charges and discharges of condensers; the amount of the charge, the frequency, and the nature of the dielectric being varied. (2) The formula for the period of the oscillations which take place on the discharge of a condenser not having been completely verified, an accurate verification of the formula by a method permitting of exact measurement of resistance, capacity, and self-induction is desirable. (3) A charged condenser made of an imperfect insulator, left to itself, gradually dissipates its charge, the time required for its charge to be reduced to a given fraction of its original value depending on the nature of the insulator. Are there analogous formulæ in the case of metallic conductors, are there experimental reasons for thinking so, and what is the order of the time of discharge of such bodies? (4) Graphic methods for solving electrical problems similar to those used in graphical statics.

The essays sent in were to be written in English, French, German, Spanish, Italian, or Latin, and had to reach the secretary by September 15, 1893.

Four essays were sent in under the mottos:—(1) Die Bewegung der Erde ist die Quelle des Lebens. (2) "Vigentia": Sur l'hysterésis diélectrique. (3) "*ηλεχτρον*": An examination of the absolute accuracy of the formula for calculating the period of free oscillation of a discharged condenser under circumstances such that the resistance of the circuit has no appreciable disturbing effect. (4) "*Ουτις εμοι γ ονομα*": An experimental determination of the period of electric oscillations.

The Committee decided that essay No. 1 did not comply with the conditions, and essay No. 2 did not throw any new light on dielectric hysteresis. Essay No. 3, devoted to the verification of the formula of the oscillatory discharge of a condenser, was deemed by the Committee to be a very valuable contribution to science; the verification, however, was only approximate, and the method used was open to criticism, inasmuch as the discharge circuit was periodically closed by a spark which introduced disturbances impossible to estimate. Essay No. 4 related to the same subject investigated by means of a new method which permitted the author to attain and measure periods of a few hundred-thousandths of a second. The influence of all the principal causes of error seemed to be small, although there were some doubts as to the influence of the capacity of the induction coil. The formula was verified to within 1 per cent. Time did not permit the author to complete his researches by varying the conditions of his experiments.

The Committee reported as follows:—We consider that memoir No. 4 is entitled to the prize offered by Prof. Elihu Thomson, and we hope that this award will encourage the author to continue his beautiful research. At the same time, the Committee regrets that it has not at its disposal two prizes of equal value, which it would be glad to award to memoirs Nos. 3 and 4. The Committee has reason to congratulate itself on the success of this competition, which has given birth, in addition to the two remarkable memoirs just referred to, to other contributions of value.

In order to comply with the expressed wish of the Committee, Prof. Elihu Thomson, the Compagnie Française pour l'Exploitation des Procédés Thomson-Houston, the Compagnie pour la Fabrication des Compteurs, and the British Thomson-Houston Company joined in offering a second prize.

The envelopes containing the names of the writers of the memoirs were then opened, and it was found that the author of memoir No. 4 was Dr. A. WEBSTER, of Clark University, Worcester, Mass., U.S.A., and of memoir No. 3 Prof. OLIVER LODGE, of University College, Liverpool, and Mr. R. T. GLAZEBROOK, of Trinity College, Cambridge.

MR. HENRY EDMUNDS' PRESIDENTIAL ADDRESS TO THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

GENTLEMEN: I feel a peculiar responsibility in addressing you this evening; and it is at some personal inconvenience to myself that I have come down here to-day from London, where I have to return early to-morrow. It was kindly suggested by some of the members that I might write my address and it should be read for me; but I felt it would be better to speak face to face, especially when I remembered that this was the *first* presidential address. Now if we are serious and want this Society to take a lasting and dignified position in the country, it is well for us to carefully consider the objects and future of the Society, and see what each individual member can do to further the interests of the Northern Society of Electrical Engineers as a whole, rather than consider his personal convenience, business interests, and self-advancement. In some quarters the question is asked, "What need is there for such a society as ours? Have we not already the Institution of Electrical Engineers and other kindred societies?" The answer may be considered chiefly as geographical. It *is* difficult for men living in the north to attend regularly the meetings held in London, and the mere reading of the proceedings of the London meeting does not compensate for the absence of personal contact and debate. This Society is not an offshoot, nor an affiliated member of the Institution of Electrical Engineers, but an independent body, though composed of men having kindred interests and tastes and many of whom, like myself, happen to be members of both the Institution of Electrical Engineers and the Northern Society of Electrical Engineers. Therefore, as an independent body we must carefully consider what our aims, interests and objects are, and see if they differ in any way from those of other institutions. If our objects are exactly alike, we may be said to be in competition; and if in competition we must naturally try to excel and do better than those we compete with. I think a little competition among societies may be as healthy as in commerce. Now, we are a formed Society, one year old. We have 125 members, a balance at the bank, and are financially sound. Our Society is respected so far as it is known by kindred societies, and its Papers and discussions have been published and commented upon by the technical journals; and now at its first birthday it may be said to have justified its existence. But what is its future going to be? That brings me to the most serious and important part of this, the first, presidential address. If we wish to live, grow, and be respected each member must contribute his own individual effort. Each one must feel himself honoured by being elected a member of this Society rather than consider that he confers an honour to the Society by joining it. I speak in this way as I fear that at some of the meetings during the past year this idea may have been overlooked. It is probably excusable when we consider the youth and consequent inexperience of the Society; but as we grow older we must grow wiser and stronger; we must consider what the aims and objects of this Northern Society of Electrical Engineers should be. We may divide these objects into (1) the practical and technical, and (2) the social.

I put practical first because in looking around me I see so many men who are interested rather in the everyday work of constructive electrical engineering than in the pursuit of scientific research. We may further divide our engineers into two classes, consulting and constructive. A word to the consulting engineer may be well brought in here. In the first place, the profession is an important and useful one. It is the duty of the consulting engineer to plan out, design, and to guide those who have no technical knowledge of their own. Corporations and individuals employ the electrical engineer in the same manner as they employ their architect, their gas or water engineer. But our profession is a young one. During my connection with it, which dates back from 1877, I have seen the gradual falling into rank of men who in 1877 were unheard of and unknown. The electrical engineer of that day was essentially a telegraph engineer, and his ideas, with few exceptions, were limited to the working of land or submarine telegraphy. I often think that the rapid advance of electrical engineering was retarded in consequence of the limitations to the mechanical and engineering side of the question, which limitations were set by men whose knowledge was mostly confined to magnets covered with fine silk-covered wire, and currents that could not vibrate the indicating needle of a modern central station ammeter at zero. I would not for one moment reflect on the gentlemen of 1877, but only wish to indicate to you that the electrical engineer is a creation made since then. He has had a very long childhood, and, like the rest of us, has had a great deal to learn and unlearn. Naturally, when work was placed in the hands of the new engineer, when he became consulting rather than constructive, he was apt to please his vanity and to try to justify his existence by changing every dimension and detail he possibly could in existing machinery and appliances. And it did not end with merely painting the machine another colour ; but each engineer varied the speed of his dynamo, the pressure of his mains, the type of engine which should drive, and the thousand and one details which, while they might not interfere with the result of the whole, have had a very serious interference with the advance of the electrical industry. In England, I think, we have been as much cursed with amateurish engineers as they have been blessed in America with the absence of them. I recollect very well when I first met Mr. Brush in Cleveland, in 1879, and saw his very plain, but useful, arc lamp, I thought it might be considerably improved, and told him so. He looked at me and said : "It works ! What we have to do is to sell them !" And they did sell. I was instrumental in the introduction of that system into England. Many people came to see our first installation in Hatton Garden, and then at the Liverpool-street Railway Station, and nearly everybody said how much prettier they might make the arc lamp. Engineers and others who were asked to tender for building the Brush plant and apparatus in nearly every case had some suggestion to make for the alteration of dimension and detail, in order to suit each individual whim. The result was that we were much longer in making progress in England in the introduction of the arc light than they were in America. Though I do not wish to infer that this was wholly attributable to this cause, yet it was to this among others.

Now, what we want in a consulting engineer is a man who can recognise first what is best in the market, best for actual merit and most suitable for his requirements. A man who can guide those whom he advises in their selection of the best thing for the work to be done, and who will be content to leave matters of constructive detail in the hands of honest manufacturers whose interest and profit shall lie in making a good thing, rather than producing some type or variation of design of which he practically makes only one, and that an unsatisfactory one, instead of many which can grow each in quality through experience in manufacture, and where there is a margin of profit, which in many manufacturing operations, is larger in consequence of numbers and output. My remarks refer, of course, to the immature engineer, and naturally can have no reference to individuals present. Our consulting engineer can be of great help to us if he works conscientiously. He will see that what is undertaken by the contractor is carried out efficiently and well ; and I also think it is his duty to see that not only do those who employ him get good value for their money, but also that those he employs get a reasonable margin of profit on their work. This brings me to another and very important point. We find all around us towns, corporations and companies that are going in for the public supply of electricity. We find a huge new industry, in which thousands of pounds of capital are invested. Many of the most advanced minds are at work in developing mechanical and electrical details, yet we find that with very few exceptions nearly every manufacturer who tenders competitively for work says he will be practically without profit if he gets the contract. Now, something is wrong in this. I admit that competition (which, after all, cannot be prevented) has a great deal to answer for ; but I think on the other hand that many of our consulting engineer friends (and as I said just now it is their business to see, they being disinterested themselves) should see that both parties to the bargain, those who buy and those who sell, are taken reasonable care of. It is a curious fact that there are large corporations around us, that have plenty of money that they can borrow at a low rate of interest, buying electrical machinery and plant that barely pays a profit to anyone concerned. And yet these same corporations, acting under the advice of their engineers, would be perfectly willing to pay a fair price. In many cases I have known that engineers' estimates are allowed that would have given a reasonable working profit to all the contractors and undertakers ; but these were undercut by the competing firms. I merely mention this here in connection with our consulting friends, who, I am sure, can be of great assistance to us. But the fault is not theirs.

Now, we will pass from the consulting to the constructive engineer. In this class we include both manufacturers and installers ; and we may consider these gentlemen from both an electrical and mechanical standpoint. In electrical engineering of to-day—I mean where we are converting heat energy into electrical energy through the medium of dynamos and generators—the mechanical engineer plays an important part ; and I am glad to see that the Society has among its members many gentlemen who may be said to belong exclusively to the mechanical side. They must, however, in order to justify their membership of a Society of Electrical Engineers, see how closely the union between the electrical and mechanical is growing. It must not be sufficient for them to say that they make an engine that can run at a given speed, and that such engines as they have built have been working in connection with Lancashire boilers in our cotton and other industries here for the last 25 or 30 years. I do not suggest that many engineers say this to-day, but I remember in the early days of electric lighting the man who made a small portable agricultural engine said he had got everything that was required for our purpose ; and I remember what difficulties we had in getting these people to see that the requirements of a mechanically-driven dynamo were different from that of driving a threshing machine. To this engineer they both went round, and I remember that a man would say that his engine could do such and such work, and could certainly drive that bit of a thing—the dynamo. He would come and watch his engine, the stoker perspiring, the water running down, and the steam running down still quicker ; and he would stand and wonder where on earth the power was going to. We have left these days, however, and the mechanical engineer is awaking to the fact that perhaps the biggest field he will have in the future will be in connection with electricity. In a district like this, where thousands of engines are used daily for driving mills, with their miles of shafting and belting, manufacturers are beginning to wonder why they should use such huge engines at times when their loads are light and only part of their works are running, and they have to lose so much in unnecessary shafting and belting, friction, &c. In many places I am glad to say that following the electric light plant has come the electrical distribution of power plant. Electric motors are taking the place of shafting and wires the place of belting, and I advise our engineer friends to look well to this outlet for their industry during the coming period.

Now for our electrical as apart from our mechanical engineers—the men who by their thought and work have designed our alternate-current dynamos, our continuous-current machines, our multiphase machine, our transformers, our arc and incandescent lamps, our measuring instruments, and the multitudinous accessories. These men must try to get as far as they can from the traditional millinery of the philosophical instrument maker, and must see that they must combine with their electrical requirements the very best mechanical conditions and surroundings. They must also work hand in hand with the mechanic. They must get away, as they are doing, from the sealing wax and brass lacquer, and they must remember that in work of the magnitude that is likely to come on durability is going to play as important a part as efficiency, and they must not sacrifice to efficiency the many other requirements of practical everyday use. I have not intentionally spoken slightingly of our friends the telephone and telegraph engineers. Some of my references have only been to those earlier and respected men whose knowledge was necessarily limited to the electrical portion of their work, so that they did not appreciate the conditions of the mechanical portion. I am glad to say that we have among the members of our Society those who are interested in telegraphy and telephony. Telegraphy, more especially as relates to submarine work, could be effectively dealt with by one who, I regret to see, is not here to-night, I mean our respected member, and one of our founders, Mr. George Preece ; but, that being a branch in which the assembled members take little interest, I will not refer further to it. Telegraphy, I may say, seems to be a completed and perfected branch, which may probably continue to grow in bulk, but which will more probably be more or less supplanted by telephony, which has made giant strides during the last few years. Among telephone engineers large and important problems have to be worked out. An ever-increasing number of subscribers means an ever-increasing difficulty in way-leaves and communications. I have no doubt that we shall receive in the future interesting Papers from gentlemen connected with this branch, and they will be able to point out to us how they have overcome both their mechanical and electrical difficulties. They will watch with jealousy the introduction of those large power systems for fear of interference by induction and other causes, and engineers will do well to consider here in concert with one another how they can each give and take, how they can each learn something of the conditions and requirements of the other without experiencing either annoyance to themselves or interference with public requirements.

Our telephone engineers must not think that they "own the earth" because they happen to have been born first, nor must our electric-traction friends think that because they wish to come in as well, they can ruthlessly remove all existing systems. There has been during the last few months an animated discussion with regard to these matters, and if the discussion necessary for the removal of these difficulties can be carried on here by Papers and debate, I have no doubt that those will be among the things that will justify the existence of this Society. We shall have in the near future an enormous advance in connection with electric traction. In 1883 I was interested in being asked by the Blackpool Winter Gardens Company if I could run a small electrical carriage. I placed this in the hands of my friend Mr. Holroyd Smith, of Halifax, who afterwards constructed the Blackpool Electric Tramway. And it is interesting to see that since that date till practically within the last 12 months, there has been comparatively no advance in this country in connection with electric traction. On the other hand, in 1885 I was in America, and there interested in the Pioneer Company, the Bentley-Knight. I went out to Cleveland to see the experiments in electric traction, and since then (1888) to the present moment (January, 1895) there has been such an advance that there are now 9,000 miles of electric tramways, as against 4,000 miles of horse tramways; 20,000 electric cars are run, and hundreds of thousands of horse-power are employed in driving the electric plant. And the capital invested amounts to $225,000,000 (£45,000,000). Now, one reason among others why we have been held back so much has been the miserable petty jealousies among our own engineers, among men who ought to know better, who would rather that the work of construction should go to America than that it should be done by an old competitor and countryman. Of course, in these remarks I have no reference to the members of the Northern Society of Electrical Engineers, for fortunately they have not lived long enough to have a history of this kind. I wish this Society to avoid these personal petty jealousies. On several occasions on which I have had the honour to address you I have referred to questions of this kind.

And this brings me now to my installing engineer. It is somewhat difficult to define an installing engineer or contractor. I believe that every man who can use a piece of cotton-covered wire, a pair of pliers, and a soldering iron, describes himself as an electrical engineer. We do want to give limitations to the aspirations of the man who begins at the bottom of the ladder with his wire and pliers; but we do want to give limitations that will secure reasonable productive profits to a business that ought to be carried on well, and not subjected to the ceaseless and unnecessary cutting competition that we experience. In our installing engineers we ought to have men who have the interests of their work at heart. They have to go into buildings and instal their system of wires and cables, making them as little obtrusive as possible, and to take care that there is the least interference with the carrying out of the ordinary work that is being done in those buildings. Now, they have to do, or ought to do, honest work; but I have unfortunately seen many cases in which a competing firm has determined to go for a job and get it at any price, and has then endeavoured to do as little as possible in order to try and do the work at somewhere near the contract price. In the old days we used to get 40s. a light, or point. I do not say that this was not too high, but when we come down to 7s. 6d. a point, either the people in the old time made an outrageous profit or the people in the present time do work that cannot be justified. There is, I am afraid, a tendency for a great deal of "eye-service" in this. As long as the switches will turn on the current to the lamps, and no questions are asked as to the condition of affairs between the dynamo and the lamp, or the wires, joints and cut-outs, some installers are satisfied, always provided they can get their bills paid. But after all this is a very short-lived policy. We must not bring our business into disrepute by cheap and ineffective work. I recollect in America that a manufacturer of cotton goods told me that he had had a large inquiry and was doing a considerable business in China, and that he believed some of his cottons were being imitated and sold under a similar mark by Manchester houses; which, while he considered it very flattering, was a great surprise to him till he looked into it. I myself looked into the question and found that in this district of Manchester there had been a practice of dressing or loading cottons with certain mineral substances and earths in order to give an attractive finish and a heavy weight, and which could be sold to the unsuspecting foreigner at a much greater profit in close competition, because it was naturally considerably cheaper to load with earth than with cotton. These goods were sent out to China, and poor John Chinaman and his friends discovered that the first shower of rain, instead of glancing harmlessly off his clothes, washed away all the earth in his cotton suit, and left him practically enveloped in a sieve. The Chinese then found that the practice of loading cotton had not been extended to America, in spite of the proverbial "'cuteness" of the Yankee, because, owing to his protective tariffs and other conditions, the American manufacturer was able to make a reasonably good article and sell at a comfortable price; and, although they commanded a higher value in China, they were preferred to the English article. Thus the Manchester goods got a bad name difficult to recover, and the American got in as maintaining his quality. Now I am not addressing you as generally being in the Manchester trade; but as we happen to live and work in this district let us be warned by the mistakes of others and take care not to commit them ourselves.

Now then, to you contractors. See that your work is well done! See that your work can pass muster by our friend the consulting engineer and by our esteemed friend Mr. Heaphy and other representatives of the fire insurance offices! If you do your work honestly and well, you will find that it will pay you. You will be able to say that for work bearing the reputation of your name you must have a certain price, and let the men who want to cut cut and do as bad work as they please. They will soon either go right out of the trade or find it is useless to do bad work for nothing. They will see the folly of their ways, and do better work at a profit. It must not be left (as is unfortunately too often the case) to contractors to say, "Well, we do not mind what we get for the work so long as we can vary the tender. We can then make our profit on the extras." This, gentlemen, to my mind is not right.

Now, I have gone carefully over the different interests of the Society. I have tried to call your attention to our individual selves, and now I want to look at ourselves collectively. As we have seen, we have grown during our first year rapidly and satisfactorily. But it is not sufficient that we should grow simply in numbers. I said that in addition to the practical and technical objects of our society we had another one, the social element, to consider. If this body poses as a purely scientific society, which it evidently does not, we might, in the regions of pure science, almost feel that we could ignore social considerations. But, as the bulk of our members are eminently practical, our social relations to each other become important; and it is here, I think, that this Society has a large field for usefulness; and I should say that the introduction of dinners, smoking concerts, excursions and other social gatherings, if judiciously carried out, may be found to be a most useful thing for us all. When men in similar pursuits only meet each other from a business point of view, they are apt to see each other to the worst advantage. I am glad to say that men whom I once did not care to meet because our interests were conflicting have on further acquaintance been those I honoured and respected most. You will probably find this to be the case here; and if, instead of the manifold petty jealousies that are apt to be fostered among members of the same profession, you will get into an inner or family circle, recognising that you are members of the same family and have an equal right to live and let live, and that by good feelings of brotherhood and give-and-take, and not each one going for himself, you may be able to do a vast amount of good in the future. How often would it be useful for men to honestly and honourably get together to discuss certain points and questions of price, policy, and quality of work, rather than only know the price when tenders come out, and the quality when the work is done. It is not as though there were not enough work for all. The extension of the electrical industry is practically unlimited. Lighting, traction, telephony are yet, comparatively speaking, in their infancy. And when we come to such things as electrical transmission of power, electro-deposition, electro-chemistry, electric welding, heating, cooking, and smelting we can see the field that can be practically and profitably occupied by everyone connected with this industry. But in order to occupy this field well we must have a proper recognition of the rights of each other; and I trust that you will receive the remarks that I have made in this address and apply them practically to yourselves. I hope that you will not consider that I have taken advantage of my position as President to give an address which is not to be discussed, and which may appear to be rather in the nature of a homily than of a technical discourse. The scientific and technical discourses must come along in the future. My only wish is to endeavour to lay a proper foundation on which the structure can be built, and I wish it to be that in ten years' time, when you hear your then President address you, that those there present may look back with feelings of gratitude and pride to the time when they first became members of the Northern Society of Electrical Engineers.

PHYSICAL SOCIETY.

At an extra meeting held on Friday, January 11, 1895, in the physical laboratories of University College (by invitation of Prof. Carey Foster), Prof. Rücker, President, in the Chair,

Prof. Ramsay read a Paper, by himself and Miss Dorothy Marshall, on—

"The Measurement of Latent Heats of Vaporisation of various Organic Liquids."

The liquid to be examined is placed in a small flask with a narrow neck, and within this is a platinum wire which has its two ends fused through the bottom, so as to be capable of conveying an electric current and thus giving heat to the liquid. The flask is completely enclosed in a jacket which is fitted with the vapour of liquid of the same kind, kept briskly boiling in a somewhat larger flask. Before the current is turned on, the vapour jacket is kept going for some time, so that the liquid in the flask is raised just to its boiling point, but no appreciable evaporation takes place. As soon as the current is turned on, boiling commences, and as the temperature of the liquid cannot be further raised, all the heat developed in the wire is expended in producing evaporation. By weighing the flask before and after, the mass of liquid vaporised is determined. So far, the authors have only used the method for comparative determinations. Two arrangements of the kind described are placed side by side, and the same current is sent through their two wires, which are joined in series, and have approximately equal resistances. The actual values of the resistances are found while the current is flowing, and allowance is made for their inequality. The ratio of amounts of heat expended on the two liquids divided by the ratio of the masses vaporised is equal to the ratio of their latent heats. As a standard liquid of known latent heat the authors prefer alcohol to water, as it vaporises more easily, and with less bumping. The determinations made by this method agree well with those of other observers; but the authors' object is to obtain values correct within about $\frac{1}{2}$ per cent. for a large number of liquids, rather than a highly accurate value for any one substance.

In reply to Mr. Griffiths, the authors stated that the platinum wire was found to rise about 20deg. above the temperature of the liquid, and Mr. Griffiths said that his experience had been similar. He did not see why a very high degree of accuracy should not be obtainable by the method.

Prof. RUCKER expressed his admiration for the work, and thought it justified by the fact that the results accorded more nearly with theory than those of other observers.

Mr. Eumorfopoulos read a Paper on

"The Determination of Thermal Conductivity and Emissivity."

In the first series of experiments described, two bars of the same material and polish, and each of uniform circular section, are heated, each at one end, until the distribution of temperature has become steady. By means of two thermo-joints (one on each rod) a series of isothermal points are then found. According to the ordinary theory, if the two bars agree in temperature at a given pair of points, they will also agree in temperature at distances x_1 and x_2 measured respectively from these points, where x_1 and x_2 are connected by the relation $x_1 . x_2 = \sqrt{(r_1/r_2)}$, r_1 and r_2 being the radii of the rods. This relation was not found to hold good for the rods examined, some being of brass, others of copper and of German silver. In all cases $x_1\ x_2$ was further removed from unity than the ordinary theory would require. One conclusion was that the formula usually adopted in such cases could not be used for the comparison of conductivities, unless the radii of the rods compared are equal, and their surfaces in the same condition. For it seemed unlikely that the thermal conductivity of the smaller of each pair of rods was less than that of the thicker one. To settle the question three brass rods were chosen, and their absolute conductivities compared by Angström's method, one end of the rod being alternately heated and cooled, and the alternations of temperature observed at two points along the rod, as soon as they had assumed a periodic character. At each point of the bar the excess of temperature over surroundings may be analysed into a Fourier's series, consisting of a constant term and series of sines and cosines. Hence both emissivity and conductivity were calculated. The emissivity was found to vary considerably with the radius, being greater the thinner the rod; moreover, the value of the emissivity deduced from the first sine term of the Fourier's series was in each case found to be about 1·2 times as great as that deduced from the constant term.

Mr. A. W. Porter then read a Paper on

"The Influence of the Dimensions of a Body on the Thermal Emission from its Surface."

The ordinary assumption is that, whether a body is *in vacuo* or surrounded by air, the "emissivity" (*i.e.*, the amount of heat passing outwards from unit area per second per degree excess of temperature) is independent of the size of the body. Results obtained experimentally by Péclet for cylinders and spheres of different sizes show that the emissivity depends materially upon the size of the body. Péclet's formulæ for cylinders and spheres surrounded by air show that for each of these forms the rate of emission per unit surface, exclusive of the radiation effect, may be represented by a constant plus a term inversely proportional to the radius. Experiments on thin wires by Messrs. Ayrton and Kilgour have also shown that the emissivity can be expressed through a considerable range of radius in the form given by Péclet, and the experiments on rods made by Mr. Eumorfopoulos, and already described in this report, lead to the same conclusion. The author examines the results of supposing the loss to follow only in part the law of radiation, the remainder being assumed to follow the law of conduction. He thus arrives at a formula –

$$e = h + \frac{c}{a(\log R - \log a)};$$

where e is the emissivity, a the radius of the rod, R the radius of a hollow cylinder which surrounds the bar, and above which the excesses of temperature are reckoned, while h and c are constants. This formula has been compared with experimental results of Ayrton and Kilgour, of MacFarlane, of Bottomley and of Péclet, and has also been directly checked by experiments on a brass rod when surrounded by water jackets of different radii, as well as on the same bar unjacketed. The author finds the agreement to be much closer than is the case on the theory of constant emissivity, or with empirically deduced formula of Ayrton and Kilgour, and he concludes that the enclosing boundary is as important a factor in determining emissivity as the size of the body itself.

Prof. CAREY FOSTER thought that in demonstrating the influence of the enclosure Mr. Porter had established an important point.

Prof. AYRTON agreed as to the importance of the influence of the enclosure. Some years ago he had noticed that when the diameter of a wire was small the power required to keep it red hot by the passage of a current was nearly independent of the diameter. This would also follow from Péclet's formula. He urged that in such experiments as those of Mr. Porter and Mr. Eumorfopolous, the conductivity and emissivity, which were functions of the temperature, should not be assumed constant along the bar.

Mr. TROTTER objected to the use of the term emissivity as including loss of heat by contact with the air in addition to the loss by radiation.

Mr. GRIFFITHS said that in some of his experiments where a wire conveying an electric current was immersed in a liquid in order to heat the latter the rise of the temperature of the wire above that of the liquid was found to be nearly independent of the diameter of the wire.

Mr. EUMORFOPOULOS, replying to Prof. Ayrton's criticism, said that in each case his comparison had been between portions of bars in which the range of temperature was the same. Moreover, the variation of emissivity and conductivity with temperature, as found by other observers, would be quite insufficient to account for his results.

Mr. PORTER said that the term emissivity had come to be accepted as referring to all heat lost at the surface of a body, whether by radiation or by conduction and convection. In that sense he had used the term.

Prof. RUCKER thought that emissivity, in this sense, was not a good term, but to change now would probably only make greater confusion.

Mr. G. U. Yule then gave a brief outline of his Paper on

"The Passage of an Oscillator Wave-Train through a Plate of Conducting Dielectric."

By a conducting dielectric the author means a substance whose conductivity and dielectric capacity are both of importance in the case under discussion, and the Paper is mainly an investigation of the following problem: A train of plane electromagnetic waves falls at normal incidence on an infinite parallel-sided plate of conducting dielectric, whose thickness is finite, and at the first face of the plate, the amplitude of the vibration-vector in the incident train is zero up to a certain instant, and then becomes equal to an harmonic function of the time, multiplied by an exponential function with negative index. To find what proportion of the energy of the whole incident train is reflected back, what proportion is transmitted through the plate, and what proportion absorbed at successive incidences of reflected and re-reflected wave-trains upon the two bounding faces of the plate, the amplitudes and phase-changes of reflected and transmitted portions have to be taken into account, and the resulting infinite series of terms have to be summed. The analysis is very long, but the results obtained are exact. Curves are given, showing (for special numerical values of the constants of the problem) the quasi-periodic variation of the amounts of energy transmitted and reflected as the thickness of the plate is increased from zero up to a high value. Other curves are given, showing the effect of varying the dielectric constant and the conductivity of the plate, and the difference between a "damped" and an "undamped" wave-train in regard to intensity of reflected and transmitted portions. The author compares his calculated results with measurements obtained in the case of oscillator waves travelling along a double-wire circuit about 100 metres in length; the wires at the middle of the circuit being run through a jar containing distilled water, alcohol, or a very dilute electrolyte. The necessary corrections, however, are difficult and uncertain, and the author has not found it possible to deal with them in a satisfactory way.

A letter from Dr. E. H. Barton was read, emphasising the necessity for taking into account the damping in the oscillator train, and at the same time pointing out why, in his opinion, the corrections applied by Mr. Yule were inadequate and failed to yield intelligible results.

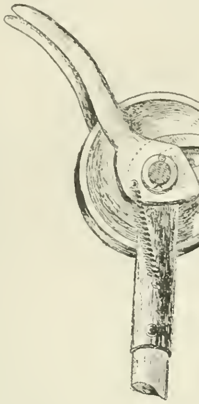
Prof. RÜCKER congratulated Mr. Yule on his work and on the importance of the results he had obtained. In returning the thanks of the Society to Prof. Carey Foster for the invitation to meet in University College, he expressed the pleasure he had felt in observing the extent and completeness of the laboratories. Hitherto London had been behind the provinces in this matter, and it was gratifying to find that students in London had now such opportunities for practical instruction in physics. The Papers which had been read at that meeting were a proof that good use was being made of the laboratories for the purposes of research. The educational experiments they had seen in the laboratories were excellently devised, and he hoped that many of them would become a part of the regular course of instruction in the country.

Prof. FOSTER briefly replied.

Electric Lighting in Spain.—The municipal authorities of Guipuzcoa (Irun) have recently decided upon the establishment of a central station for the electric lighting of the town, and are inviting tenders until February 8th for the carrying out of the work. The plant is to consist of two 70-H.P. engines, one dynamo giving 300 amperes at 125 volts, and one giving 180 amperes at 170 volts, together with a battery of 62 accumulators.

A NEW TROLLEY GUIDE.*

In this form of trolley guide two light brass prongs are placed on each side of the trolley wheel, and are held in position by two steel springs, each of 2½lb. tension. The object of the prongs is to hold the wheel to the wire, and when it jumps from its place to automatically guide it back again. When a cross-wire is reached the prongs are folded back automatically, being pressed under, so there is no interruption. When the cross-wire is passed the springs throw the prongs in place. The illustration shows the mechanism of the guide.



CORRESPONDENCE.

◆

MR. HEAVISIDE'S OPERATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I know that Mr. Heaviside will probably be a little annoyed at my interference; but I am only going to do publicly what I have done several times privately, and what I believe to be necessary. Anyhow, I have been greatly thanked for my private services. In "Electromagnetic Theory, LX.," p. 183, just before (5), insert this:—

If we differentiate t^r, n times with regard to t, we have

$$\frac{d^n t^r}{d t^n} = \frac{\underline{|r}}{\underline{|r-n}} t^{r-n}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Assume this to be true when $r=0$ and n is fractional, and let $\frac{d^n}{d t^n}$ be written p^n. Then, as $t^0=1$,

$$p^n 1 = \frac{\underline{|0}}{\underline{|-n}} t^{-n}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Now, Mr. Heaviside has satisfied himself by working all sorts of problems, and, for all I know, may have given a rigorous proof, that if p^n operates upon a function of time, which was 0 before $t=0$, and has the constant value C since, that the result is C times what is given as (2). He usually operates on unity, and quite usually leaves the 1 unwritten; that is, he would write (2) as

$$p^n = \frac{\underline{|0}}{\underline{|-n}} t^{-n}, \text{ meaning } p^n \mathrm{C} = \mathrm{C} \times \frac{\underline{|0}}{\underline{|-n}} t^{-n}. \quad . \quad (3)$$

Of course, the real test of one's right to use this operator is to test whether the answer one obtains is correct or not.

Our definition of $\underline{|s}$ is this, that

$$\underline{|s+1} = (s+1)\, \underline{|s}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and $\underline{|1} = 1$, but s is an integer. Now there is a function which is tabulated, called the gamma function, which is denoted by $\Gamma(s)$ where s is *any* number greater than -1, and s need not be an integer; and it also has the property

$$\Gamma(s+1) = (s+1)\, \Gamma(s);$$

and, when s happens to be an integer, we find that

$$\Gamma(s+1) = \underline{|s}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

That is:—Gamma function of 7 is factorial 6,
,, ,, 6 ,, 5,

and so on.

Make the assumption that this is *always* true, so that even if s is *not* an integer we still have (4) and (5) true. Now, it is proved in books on the integral calculus that

$$\Gamma(m)\, \Gamma(1-m) = \frac{\pi}{\sin m\pi}.$$

Put $m=\frac{1}{2}$. Then $\Gamma(\frac{1}{2}) = \sqrt{\pi}$.

Hence, by (5),

$$\underline{|-\tfrac{1}{2}} = \sqrt{\pi}$$

$$\underline{|\tfrac{1}{2}} = \tfrac{1}{2}\, \underline{|-\tfrac{1}{2}} = \tfrac{1}{2} \sqrt{\pi} \text{ by (4), and also}$$

$$\underline{|\tfrac{3}{2}} = \tfrac{3}{2}\, \underline{|\tfrac{1}{2}} = \frac{3}{2^2} \sqrt{\pi},$$

and so on. Also by (4), calculating $\underline{|s}$ from $\underline{|s+1}$

$$\underline{|-\tfrac{3}{2}} = \frac{1}{-\frac{1}{2}}\, \underline{|-\tfrac{1}{2}} = -2\sqrt{\pi}$$

$$\underline{|-\tfrac{5}{2}} = \frac{1}{-\frac{3}{2}}\, \underline{|-\tfrac{3}{2}} = \frac{2^2}{3} \sqrt{\pi}, \text{ and so on.}$$

Also $\underline{|1} = 1 = 1\, \underline{|0}$; therefore $\underline{|0} = 1$

$\underline{|0} = 1 = 0\, \underline{|-1}$; therefore $\underline{|-1} = \infty$,

and $\underline{|-s} = \pm\infty$, if s is an integer, being $+\infty$ if s is odd and $-\infty$ if s is even.

We now have an extended meaning of $\underline{|s}$, and Mr. Heaviside finds that, with this extended meaning, (3) can always be applied.

Thus
$$p^{\frac{1}{2}} \mathrm{C} = \mathrm{C} \frac{1}{\sqrt{\pi}} t^{-\frac{1}{2}}.$$

To find $p^{\frac{3}{2}}$, $p^{\frac{5}{2}}$, &c., or $p^{-\frac{1}{2}}$, $p^{-\frac{3}{2}}$, &c., it is not necessary to remember all the values of the factorials. For $p^{\frac{3}{2}} = p\, p^{\frac{1}{2}}$, so that to get $p^{\frac{3}{2}}\mathrm{C}$ we only need to differentiate $p^{\frac{1}{2}}\mathrm{C}$. Differentiate again, and we have $p^{\frac{5}{2}}\mathrm{C}$. Again, $p^{-\frac{1}{2}} = p^{-1} p^{\frac{1}{2}}$, so that we only need to integrate $p^{\frac{1}{2}}\mathrm{C}$ to find $p^{-\frac{1}{2}}\mathrm{C}$. Integrate again, and we have $p^{-\frac{3}{2}}\mathrm{C}$.

The gamma function of any other fraction than $\frac{1}{2}$ is given in books of mathematical tables.

Of course there are many (to me) obscure points about this subject of operators not touched upon in Mr. Heaviside's Papers read before the Royal Society. I leave all such matters for the mathematicians to speculate about. I rest satisfied with this, that it is quite easy to use these simpler kinds of Heaviside's operators, and I can always test whether my answer is right or not.

There is another place where the beginner may find a difficulty. After (13), p. 184:—

Observe that (13) is

$$\left(\frac{1}{\mathrm{R}kq} + \frac{1}{(\mathrm{R}kq)^3} + \frac{1}{(\mathrm{R}kq)^5} + \&\mathrm{c.}\right) \mathrm{V}_0 - \left(\frac{1}{(\mathrm{R}kq)^2} + \frac{1}{(\mathrm{R}kq)^4} + \&\mathrm{c.}\right) \mathrm{V}_0.$$

Now, it is the second part of this which gives rise to the exponential term of (14). For it is

$$-\frac{1}{(\mathrm{R}kq)^2} \left\{1 + \frac{1}{(\mathrm{R}kq)^2} + \frac{1}{(\mathrm{R}kq)^4} + \&\mathrm{c.}\right\} \mathrm{V}_0$$

$$= \frac{1}{(\mathrm{R}kq)^2} \frac{\mathrm{V}_0}{1 - \frac{1}{(\mathrm{R}kq)^2}} = \frac{\mathrm{V}_0}{(\mathrm{R}kq)^2 - 1} = w, \text{ say.}$$

Now, $q^2 = \frac{c}{k} p$, so that this is the same as $\mathrm{R}^2 k c \frac{dw}{dt} - w = \mathrm{V}_0$, the simplest of linear equations. Or

$$\frac{dw}{dt} - \frac{1}{a} w = \frac{1}{a} \mathrm{V}_0;$$

so that
$$w = \mathrm{V}_0 + \mathrm{C}\epsilon^{-\frac{t}{a}}.$$

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[*] From the *Street Railway Review.*

If this were part of equation (14), it is obvious that $C = -V_0$, because $V_1 = 0$ when $t = 0$.

Mr. Heaviside would, of course, say that all this, where it is not misleading, is unnecessary, either for men who have read his Royal Society Paper or his previous Papers in *The Electrician*. Well, I know as a fact that some men who are fairly good mathematicians have been glad to get the above explanations. I also know that a number of men have made up their minds to read Mr. Heaviside's Papers more diligently in future than they have done in the past. If he is angry at my writing this letter I shall be very sorry, but I know that the letter ought to be published.—Yours, &c.,

JOHN PERRY.

January 17, 1895.

P.S.—Nobody has asked me privately about the effect of p^r in operating upon $a \sin(nt+\epsilon)$. I take it that Mr. Heaviside's way of putting the thing comes to this: p^r multiplies a by n^r, and sets forward the angle $(nt+\epsilon)$ by the amount r right angles, or

$$\frac{d^r}{dt^r}\left\{a \sin(nt+\epsilon)\right\} = a\,n^r \sin\left((nt+\epsilon+r\frac{\pi}{2}\right)$$

This is true when r is a positive or negative integer, assume it true when r is fractional.

"LABOUR-SAVING" APPARATUS AS AN INSTRUMENT OF EDUCATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I went to Burlington House on December 14th last, intending to protest against the title of the Paper of Prof. Ayrton and Mr. Haycraft; but seeing several there with whom I felt I was sure to be in agreement, who could express themselves better than myself, I escaped to a more quiet place. Now, having received an invitation to give my views upon the controversy that has been raging in your columns, I feel bound to reply.

In the first place, allow me to say that when I read the proof before the meeting I was led to admire the very excellent arrangements of the experiment, and when I protest it is not because I object to the experiment as an experiment, but to its being described under the title *students' simple apparatus for determining the mechanical equivalent of heat.*

With this apparatus the student does not determine the mechanical equivalent of heat. I do not think that he "determines" anything in the sense in which I understand the word, unless it be that the various figures that are given to him when multiplied and divided in the manner he is told to employ will work out and produce an answer which is right. I purposely use the language of the school arithmetic class. In the experiment as it stands, so far as I can see, the student does not of his own knowledge and experience find any of the important data; he has no direct evidence, he depends entirely upon what he is told or hearsay (whether told by a direct-reading instrument, by a demonstrator, or even professor, it is much the same), and therefore his conclusions are no more valuable than the evidence of a witness who begins by saying that he has been told this and has heard that. The student has determined nothing. The measurement attributed to the student is really made by the original investigators who made the absolute determinations—*e.g.*, of the electro-chemical equivalent of silver, employed later for standardising a Kelvin balance, employed later for calibrating an ammeter—who made the absolute determination of the electromotive force of a Clark cell, or who found the value of the resistance of a piece of wire called an ohm. These people did the work of making the determination. Various middlemen passed this work along, and copied or compared, and after a time the actual ammeter and voltmeter worshipped by the student became calibrated, and finally a dummy,* in the form of a student, who, according to the provisions of the Paper, is carefully guarded from doing anything which involves either knowledge, pains, or skill, shakes out the magical figure, possibly under the impression that he has created it.

Of course, if the student has really found, or knows that he is going to find, as soon as his turn comes to use the apparatus for the purpose (for all cannot take it in the same order), that the instruments do what they are said to do—of course, I do not mean by merely copying other instruments of the same class, but by making the series of determinations which bring him ultimately to length, mass, and time alone—then he has made the determination. The intermediate use of the instruments is a matter of convenience.

Prof. Ayrton stated in his reply that the object of the experiment was to familiarise the student with the true idea of the mechanical equivalent of heat. My impression is that the student would obtain this more forcibly by employing mechanical means, which are direct, rather than electro-dynamical, for I do not believe that a first year's student in general grasps the principle of potential so completely that to him a fall of potential of a certain quantity of electricity is obviously expressible in foot pounds. I cannot agree that the experiment is useful in this respect exactly; but that it may be useful in enabling the student to see that a lot of figures and readings and equivalents do hang together I do not deny.

Now, it is not my province to have to do with technical students, and therefore any remarks that I may offer on their education may lay me open to the charge of presumption. I have some acquaintance with engineers and their work, and the one thing that seems evident is that it is their business under the most varied circumstances so to contrive, to make shift, and to manage that, somehow or other, they succeed practically and economically in the work that is entrusted to them. I imagine that their training should be similar, that difficulties should be left where they naturally are, not be put purposely in their way. That if they constantly have to get some sort of result with primitive or extemporised apparatus, it will not only teach them more at the time, but it will prevent them developing into the helpless creatures that a pure system of science-made-easy is apt to produce.

Putting the idea of education on one side, and looking upon technical training—a pleasant verbal equivalent for teaching a trade—then it is clear that the individual who will of necessity have to act in a subordinate capacity, and perform the eminently useful routine work that comes in his way, must be taught to use the tools of his trade; he must read the instruments which are provided, and which, of course, for convenience, are direct-reading. He may, according to his intelligence, be to his instruments what the machine-minder is to some marvellous automatic machine tool, or he may be able to take the higher position of a foreman who can adjust or even repair it in case of need. He has not learnt how to make "determinations" any more than a man I met in a steel works in Sheffield, who ridiculed the fuss that is made about squaring the circle, because he could do it with a slide rule; he does not want to make determinations. If the authorities at the Central and other technical institutes made the staring at direct-reading instruments their chief aim and object, the result would be the production of a kind of glorified plumber without the skill of a real plumber, and not so very glorified either now that plumbers have examinations of their own. This sort of training will produce not the self-reliant engineer but an eminently useful drudge. It is not by such methods that Hopkinsons and Kennedys are made to exist.

In conclusion, I wish to state explicity that I do not accuse Prof. Ayrton—and I do not think anyone has—of training students in the manner that I have been condemning. The fact that a Sumpner has been reared in, and has flown from, the Central nest is a sufficient answer to such a suggestion. The necessity, if it exists, for protesting against the title of the Paper of Prof. Ayrton and Mr. Haycraft is not to warn them of the danger of relying upon direct-reading instruments as a means of education, but to prevent less enlightened teachers from taking their Paper as a model of educational propriety.—Yours, &c,

C. V. BOYS.

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* Dummy, not duffer.

LEGAL INTELLIGENCE.

Modern Company Promotion.

Mr. Registrar Cooper, at the Liverpool Bankruptcy Court, last week held the public examination of Loftus John Barnacle, who traded without a partner, under the style of "A. Hall and Co., electrical engineers," at South John-street, Liverpool. The statement of affairs showed liabilities £496, assets £524, of which £520 was the amount put down as the value of 1,040 £1 fully paid-up shares in the Hall Electrical Company (Limited), of 1, South John-street. The petitioning creditors were the Electrical Company (Limited), London. The bankrupt attributed his failure to loss on a contract for lighting The Palace, New Brighton, bad trade, and keen competition. In December, 1893, he purchased the business formerly carried on by Mrs. Hall, for which he paid £90. He then entered into an agreement with Mrs. Hall's husband by which that gentleman was to act as manager at £3 a week for three years, and Mr. Hall was to receive half the net profits up to £400 a year by way of salary and one-third of the profits over £400 a year. Apprentices' premiums were to be treated as profits. There had been four apprentices bound for three years to learn the business, and from these £185 had been received. The business was carried on until October, 1894, when an agreement was entered into to sell the business to a limited company, formed for the purpose of purchasing it, and to be styled "The Hall Electrical Company (Limited)." The nominal capital was £4,000 in £1 shares. The bankrupt was to receive 1,400 £1 shares fully paid up for the business (£600 for business and goodwill, £600 for plant, machinery, &c., and £200 for book debts). The first directors were to be himself, Mr. Hall, and Mr. C. E. Keizer, and he and Mr. Hall were to act as managers at a salary of £208 each per annum. The bankrupt had writs and summonses out against him for money owing which he could not pay, and (on Mr. Hall's suggestion) he decided to turn the business into a limited company.

The OFFICIAL RECEIVER: Mr. Hall proposed, you say, to turn you into a company?—Yes.

I suppose you were utterly insolvent at the time? Did you know you were not solvent?—Yes. Mr. Keizer, a mechanical engineer to whom he owed money, was to purchase the business as trustee for the company.

The OFFICIAL RECEIVER: I see the first name in the list on the Articles of Association is your own for one share?—Yes.

Then comes Herbert Hampton Hall?—Yes.

He is an undischarged bankrupt?—Yes.

Then comes Edward James Bayly?—Yes.

He has been twice through the Bankruptcy Court and undischarged on either occasion?—Yes.

Then comes Mr. Leslie Wild, a clerk; William Paul, a workman; John Dickson Malley, a workman; and Harry Jones, another workman?—Yes.

No shares were offered to the public, because, on December 10th last, the bailiffs entered the premises and seized everything; but the goods were claimed by the Hall Electrical Company. He valued the shares of the limited company at the present time at 10s. each, and said that the Company were doing a good business.

The matter was adjourned to Feb. 14th, certain accounts being ordered to be filed, and the cash book written up.

Electric Construction Corporation, Limited (in voluntary liquidation).

A summons was heard by Mr. Justice Romer last week on behalf of Mr. H. P. Hope, asking that his name might be removed from the register of members and from the list of contributories in respect of 44 Preference shares in this Corporation. The applicant's case was that he never made any application for the shares, and this was not disputed, but Mr. Courtenay said there was a tacit understanding amongst the directors (of whom Mr. Hope was one) that they would take a certain proportion of the Preference shares. It was suggested that a letter of allotment was sent to Mr. Hope and that he did not return it. It was not certain that such a letter was sent, and Mr. Hope never received it; and though there had been several calls in 1892, no notice was sent to Mr. Hope, who had never paid any of them, or knew that his name was on the register until after the winding up in 1893, when the liquidator wrote to him. Mr. Justice Romer directed Mr. Hope's name to be removed from the register in respect of the shares in question, and ordered the liquidator of the Corporation to pay the costs.

BOOKS RECEIVED.

"Proceedings of the International Electrical Congress, held at Chicago, 1893. (New York: American Institute of Electrical Engineers. 1894.)

"Steel Works Analysis." By Prof. J. O. Arnold. Price 10s. 6d (London: Whittaker and Co. 1895.)

"Electrical Engineering." By W. Slingo and A. Brooker. New and revised edition. Price 12s. (London: Longmans, Green and Co. 1895.)

SUBMARINE CABLES TRUST.—Notice is given that on and after Feb. 1st the sum of £1. 5s., balance of the coupon due October 15, 1894, will be paid by Messrs. Glyn, Mills and Co., 67, Lombard-street, London, E.C., between the hours of ten and two. Coupons must be left with the bankers four clear days.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

IMMEDIATE.—**The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is in active preparation, and will shortly be ready. Subscription and advertisement orders should be sent in immediately. In addition to the old well-known features of the book, which will be brought up to date, a quantity of new and useful matter will be added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Alterations to existing entries and New Names must be sent in forthwith, and the Publisher requests that those who have received the circulars relating to the new edition will return them corrected at once.**

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices:—*

THE LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, presented with our issue of January 4th, can be obtained mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 2s.—each post free. The Map showing positions of Supply Stations is mounted on the back of the Table. The Coloured Map issued with the last Number is also mounted on some copies, and the price of these, complete, post free, is 5s.

LABORATORY NOTES AND FORMS.—With the above title, we have in the press a set of Elementary (now ready) and Advanced Exercises (ready shortly) for use in Electrical Engineering classes. These have been prepared in Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is just out, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. net., is now ready.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

TENDERS INVITED.—The Moss Side School Board invite tenders for the installation of the electric light in their schools in Prince's-road, Moss Side, Lancs. Particulars may be obtained from Mr. S. V. Clirehugh, Temple-chambers, Brazennose-street, Manchester, on and after the 28th inst., and tenders must reach Mr. W. E. Rowcliffe, the clerk of the Board, 30, Cross-street, Manchester, not later than 12 noon on Wednesday, February 6th. Some further particulars appear in our advertisement columns

——— Tenders have to be sent in by the 31st inst. for the supply of telegraphic apparatus, battery jars, &c., for the use of the Royal Portuguese Railway Company, of Lisbon. Particulars can be obtained at the offices of the Company, 28, Rue de Chateaudun, Paris.

——— Tenders are required for the purchase of a concession for an electric tramway, to be constructed from the railway station, Louvain, Belgium, to the Grand Place. Tenders must be in by February 1st to the Clerk to the Municipal Authorities, Hotel de Ville, Louvain.

TENDERS ACCEPTED.—As stated in our last issue, the tender of Messrs. Chamberlain and Hookham has been accepted by the Coventry Town Council for the supply of meters of various sizes. The following is the list of tenders received:—

Chamberlain and Hookam (Limited), Birmingham ...	£270	10	0
Westinghouse Electric Company, Limited, London..	295	17	9
Electric Construction Company (Limited), Wolverhampton	299	4	0
General Electric Company (Limited), London	336	7	6
British Thomson-Houston Limited, London	406	5	4
Charles A. Müller, Bradford	462	0	0

A certificate of efficiency to be supplied with each meter brings the total of the successful tenders up to £291. 4s.

Sale by Auction.—Catalogues are now ready of the valuable modern electric lighting plant, instruments, arc lamps, transformers, cable, stores, &c., which are to be disposed of by Messrs. Wheatley Kirk, Price and Goulty at the central station of the Brighton and Hove Electric Light Company, Gloucester-road, Brighton, on Wednesday, February 6th, at 10 for 11 o'clock prompt. Included in the sale is a quantity of heavy plant and apparatus in perfect condition, including 50-H P. nominal compound semi-portable under-type engines, with locomotive boilers, by Fowler of Leeds, Lowrie-Parker alternating-current dynamos, Lowrie-Hall transformers, switchboards, &c., &c., which may be viewed the day prior to sale, and of which some further particulars are given elsewhere.

Sale by Private Treaty.—Messrs. Wheatley Kirk, Price and Goulty have for disposal, by private treaty, a small engineering works in Salford, Manchester, of which particulars are given elsewhere.

Turbine for Sale.—Messrs. H. R. Lewis and Co., of Draper's-gardens, E.C., offer for sale in our advertisement columns a 146-H.P. turbine of the improved Jonval pattern.

Liquidations.—On the 18th inst., at the suit of a debenture holder, Mr. Justice North appointed Messrs. Watson and Hodson receivers and managers of the business of Priestman Brothers (Limited), of Hull and London. It was stated that debenture issues of £40,000 first and £20,000 second debentures had been issued. A notice has been given that a further petition will be presented for the winding up of the Company under the supervision of the Court. This petition is to be heard at the Royal Courts of Justice, London, on Saturday, 26th inst.

——— In an action brought by the Globe Debenture Corporation, Mr. Justice Chitty has confirmed the appointment of Mr. Grimwade as receiver of Elmore's Foreign and Colonial Patent Copper Depositing Company (Limited). The Globe Company are debenture holders for about £900, and in respect of further debentures forming part of a series of £10,000.

——— Notice is given that the creditors of the International Electric Subway Company (Limited) are required, not later than February 28th, to send names and addresses, and particulars of their claims, to Mr. C. W. Grimwade, of 32, Walbrook, London, E.C., the liquidator, and, if required, to prove their debts in the usual way.

——— A meeting of the Telpherage Company (Limited) is to be held at Winchester House, London, E.C., on February 26th, at 1 o'clock, to receive an account of the winding up.

Appointments.—The Gas Committee of the Blackburn Corporation have appointed Mr. W. A. S. Giles borough electrical engineer. The work at the central station, which has been carried out under the superintendence of Mr. E. M. Lacey, who was appointed engineer in September last, is nearing completion, and it is expected that current will be supplied in two or three weeks. Current for more than 1,800 lights has already been applied for.

——— Mr. A. E. Briscoe, A.R.C.Sc. (Lond.) B.Sc. (Lond.), has been appointed Dr. Sumpner's successor as head of the Electrical Department of the Battersea Polytechnic Institute, London, S.W.

——— Mr. J. Stottner, one of the engineers representing the Allgemeine Elektricitäts Gesellschaft at the Chicago Exhibition, has been appointed by the Electrical Company (Limited), of Charing Cross-road, London, W.C., to take charge of their power transmission department.

Caution.—Messrs. Russell and Co., of 11, Queen Victoria-street, London, E.C., caution tradesmen against a person calling himself Russell, of Melbourne, who is ordering goods and giving as a reference the name of the firm of Russell and Co.

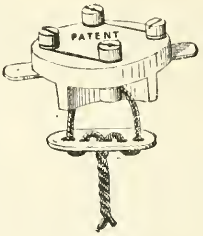
New Show Rooms, &c.—Messrs. Swinburne and Co. have opened show rooms and offices at 66, Victoria-street (2, Prince's-mansions), London, S.W., and request that all inquiries shall be addressed to the new offices. Messrs. Swinburne and Co. notify us that they have amalgamated their works at Teddington (but not their business) with that of the Electrical Accessories Company, Limited.

Fire Alarm and Telephone Call Apparatus.—The new Urban District Council, Tottenham, London, N., have placed an order with the Private Wire and Telephone Installation Company, of Cannon-street, E.C., for apparatus and material in connection with an extensive street fire-alarm system for the fire brigade. Telephonic or call bell communication with the officers and members of the brigade is included in the contract.

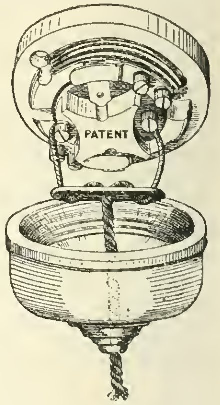
Messrs. Drake and Gorham.—If proof were needed of the excellent work carried out by this firm, it is forthcoming in the imposing list of installations for which Messrs. Drake and Gorham have been responsible during the past year. Contracts of considerable magnitude are included in the list, which includes town and country mansions, hospital buildings, railway offices, newspaper offices, educational establishments, including Balliol College and the City of London College, banks, insurance offices, and factories, making a total of over 70 installations, equal to 40,000 8-c.p. lamps, for the year. This satisfactory showing is not confined to the London offices, but is shared by the branches at Manchester and Scarborough. The firm have, in addition, supplied hundreds of the "D. P." batteries, spring contact switches, and earthing devices, the latter of which have been supplied to the leading companies, and no case of failure has been reported although over 2,400 have been in daily use. The measuring and recording instruments supplied by the firm have, during the past year, experienced satisfactory sales.

Indestructible Paint.—The Indestructible Paint Company, of 27, Cannon-street, London, E.C., are well known as manufacturers of preservative paint and solution, specially adaptable to both interior and exterior structures. Amongst the uses to which the preservative paint is put is the painting of cable and other steamers, foreign stations, and machinery; and the solution, owing to its specially preservative character, is adaptable for the preservation of ancient monuments, obelisks, &c., as well as for ordinary stonework. The Company have registered a new telegraphic address, "Weatherproof," which tersely describes the manufactures for which the Company are celebrated.

New Ceiling Rose.—Messrs. Cutting Brothers and Co., of Derby, have just introduced a new ceiling rose with adjustable double-pole fuse. The device is patented, and it is claimed that it affords the highest insulation, that the labour in fixing is greatly diminished, as the difficulty of making thoroughly satisfactory connections by flexible wires to the ceiling is overcome, these being made in the workshop, and can be easily examined and tested before erection. All flexible pendants can be made exactly the same length, considerable saving in time being thus effected. The rose is specially adapted for shop window illumination, and, being provided with a patent adjustable cord-grip, will sustain any weight to the breaking of the cord without disturbing the electrical connections. There is no external metal work, and the requirements of the fire offices is therefore fully covered.



Detachable Disc and Cord Grip.



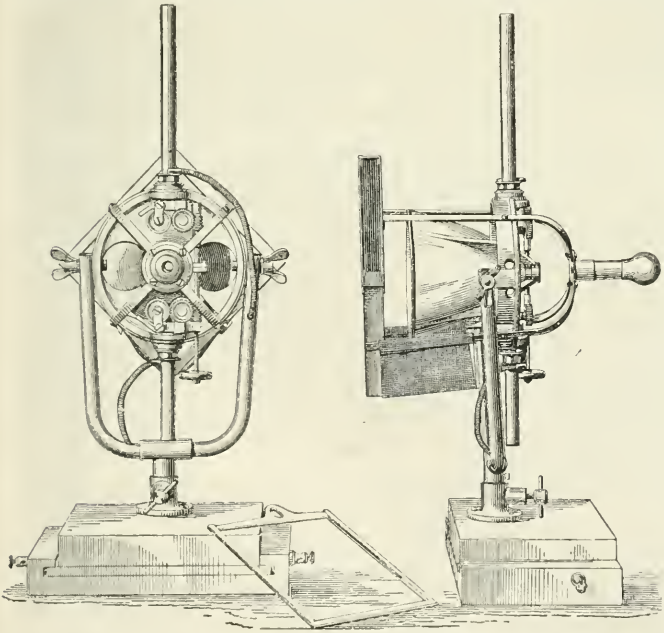
"Commudine."—The plot thickens. The following is the latest phase of this enthralling subject. The publisher protests that the advertisement columns is the proper place for the further discussion, but we await with anxiety and resignation Messrs. Mavor and Coulson's reply, after which we fear the subject must drop:—"You may be slightly puzzled to understand the meaning of Messrs. Mavor and Coulson's remarks last week concerning 'Commudine.' The material was manufactured for some time under the name of 'Commutine.' I do not know why the alteration of a letter was made in the name, probably for euphonic considerations. Messrs. Lea and Thornbery, of Birmingham, who are mentioned by Messrs. Mavor and Coulson, are not the manufacturers or proprietors of the article—they are consulting engineers; but it was largely owing to the kind interest they displayed in the material after prolonged tests on their own lighting plant that the manufacturer was prompted to introduce the substance to the public.—Yours faithfully, for the London Electrical Goods Agency, H. T. Barnett, Manager."

Resistance Wire.—Mr. M. Demaret, of 4, St. Mary-axe, London, E.C., notifies us that he has been appointed representative of the Westphalian rolling mills of Fleitmann, Witte and Co., of Schwerte, Westphalia, and sends us a circular giving a certificate of the late Von Helmholtz upon tests made with the wire supplied by his firm.

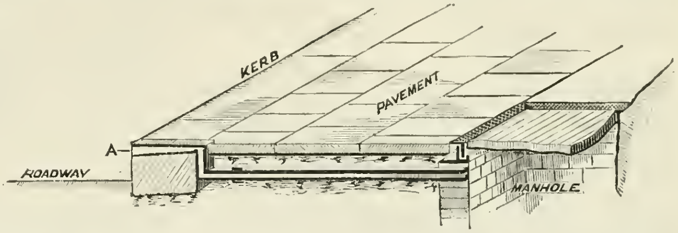
"Consolidated" Telephones.—We have received from the Consolidated Telephone Construction and Maintenance Company, of 109, Farringdon-road, E.C., a handy sheet list of telephones and telephone accessories. There are 27 sheets in all, giving illustrations of receivers, transmitters, telephones in all varieties (including neat pedestal sets), extension bells, switches, insulators, shackles, &c. The telephone companies, Government departments, foreign and colonial Governments, steamship companies, and dockyard authorities to whom these instruments have been supplied are briefly set out, and special attention is called to the fact that the telephones are made in London, and that best workmanship only is employed. The Company's many years' experience enable them to offer these instruments at the lowest possible prices.

Messrs. Gent and Co.—We have received from Messrs. Gent and Co., of Faraday Works, Leicester, catalogues Sections I., II., and III. Section I. is devoted to the illustration and description of electric and pneumatic bells, watchman's and workmen's check clocks, &c. It contains a large amount of very useful informationon a variety of subjects and with special reference to the apparatus for manufactured by the firm. Section II. gives practical instructions for fixing telephones of various makes. Section III., in addition to giving practical instructions for electric lighting work, with tables and diagrams for fixing, includes the prices of materials and plant. All three lists are very fully illustrated, and, as they are well printed, the illustrations show to best advantage.

A Hand-Fed Stage Arc Lamp.—The accompanying illustrations show a back and side view, in elevation, of the Crypto hand-fed focussing arc lamp, for stage illumination. This lamp is constructed to give about 500 c p., and works with a current of 5 amperes either on a continuous or alternating circuit. No attempt at automatic regulation has been made, as it is desirable that the attendants should not have the excuse for leaving their lamps which is afforded by an automatic arrangement. A single adjustment, however, actuates both carbons and keeps the arc in focus. The reflector is parabolic in shape, and is of copper; it is not silvered, as the silvering is not found to stand the intense light of the arc; but it may easily be whitewashed from time to time. Whiting is a very efficient reflector if kept quite clean. The handle at the back is for adjusting the direction of the rays of light, the lamp being mounted on a freely moving universal joint. This handle is hollow, to enable the operator quickly to extinguish the light by blowing out the arc. A set of coloured glass slides in front of the reflector enables the various colour effects to be produced. This lamp is now in use in many of the London and provincial theatres.



The Simplex Ventilating System.—The prevention of explosions in electric conduits and manholes is a matter of considerable importance, and engineers are busily discussing the relative merits of forced ventilation, gastight partitions, testing apparatus, and other means for preventing the trouble caused by the care lessness and bad work of the gas companies. Several suggestions for natural ventilation of conduits and manholes have been made, and amongst these is the "Simplex" system of Messrs. Peirson and Co. It consists of cast-iron ventilator pipes laid under and across the foot pavement. No special preparation is necessary beyond a small chase cut in the top of the kerb stone. A section of the arrangement is shown in the accompanying illustration. Small inspection and cleaning holes are provided at the end next the kerb, fitted with self-fixing covers. The end into manhole is so constructed that the channels for outlet of gas and inlet of air are at slightly different levels, and the makers inform us that from actual experiments carried out by them the simplex tube has been found to bring about a complete circulation of air in the chamber to which it may be attached. The tube is double channelled, of square section, about 4in. wide by 1½in. deep over all, and comprises a Z casting for clearing the kerbstone, and straight tubes to make up to any required length. The joints, being loosely socketted, allow for leading off at a slight angle where necessary, and are made up simply with clay or similar easy fixing. The outer portion of the Z casting is given a sharp incline with a small lip just inside to stay the inrush of water on such occasions as street cleaning, &c. Where it is impractible to ventilate at the curb this outer or Z piece is made to lead away to any desired point, such as up or through a wall, or into a chimney flue, &c., at very slight extra cost. We think that under some circumstances further provision should be made for preventing ingress of water, or for the effectual drainage of any water that may find its way in.



Cooking by Electricity.—Messrs. Crompton have recently fitted up a school of cookery for Miss Fairclough, at 84, Gloucester-road, London, where the cooking is carried out by electricity. It is claimed that this was the first school of cookery employing electricity. During the two months the school has been open it has been very successful, numbers having joined to get practical instruction in the use of the apparatus.

"Local Government Annual," 1895.—The fourth annual issue of this useful publication reaches us from the offices of the *Local Government Journal*, Dorset-street, Fleet street, London. The publication of the book has been somewhat delayed in order that information may be given regarding the late elections. The price of the book is 1s. 6d., and for this sum a very useful compilation is obtainable.

New Fittings List.—The Electrical Company have now ready a new fittings list, describing and illustrating portable accumulator sets, electroliers, pendants, brackets, standards, and a number of special designs of London-made fittings in polished brass, wrought iron, ceiling lights, figure standards, &c. In accessories, numerous items are catalogued, and the list concludes with illustrations of a variety of fancy shades in cut glass, &c. A useful reference index is given.

Wire and Cable Catalogue.—We have received from Messrs. W. F. Dennis and Co., the agents in this country for Messrs. Felten and Guilleaume, a strongly-bound export and wholesale catalogue of wire, wire ropes, &c., &c. A view on the title-page shows the extensive works at Mulheim-on-Rhine, with an annual output of

50,000 tons, employing 2,600 hands, and with a total power available of 2,600 H.P. All kinds of wire and cable are, as is well known, made by Messrs. Felten and Guilleaume, and the catalogue gives full details and prices of the various makes included in the list. The catalogue is rendered additionally useful by a comprehensive foredge index. Messrs. Dennis and Co. are also agents for the Blerchert patent improved wire ropeways, and are makers of the Dennis patent tubular telegraph pole, of which illustrated particulars are given in the list under review.

Smoking Concert.—The Electro Harmonic Society's smoking concert takes place this (Friday) evening at St. James's Hall Restaurant, Regent-street, London, W., at 8 o'clock.

Aberdeen.—The question of the charges made for electric current by the Corporation was discussed at the last meeting, and a report is being prepared showing the cost of production, and this will be discussed at the next meeting with a view to reduction at an early date in the charges made. The question of meter rents is also to be discussed.——Mr. E. T. Ruthven Murray's resignation on his appointment as an electrical engineer to the Worcester Corporation having been accepted by the Gas Committee of the Town Council, Mr. Blackman, assistant electrical engineer, in conjunction with Mr. Smith, has been asked to take over Mr. Murray's duties until the vacancy is filled up.

Ayr.—The Town Council have instructed Mr. Robert Hammond to make out drawings of the supply station building, to prepare the specification, and invite tenders for the work, which are to be sent in by February 5th next.

Bath.—Some time back the Surveying Committee of the Corporation agreed that no fines should be imposed upon the Bath Electric Lighting Company in respect to failures of light in consequence of the recent floods. The Company have recently had occasion to complain of some reductions made in the amount of their account against the Corporation, and opinion is generally favourable to the meting out of equal justice to both the gas and electric lighting companies. In the next contract with the gas company it is stated that a clause is to be inserted by which penalties will be imposed when the gas lamps are extinguished during contract hours.

Bristol.—A large number of tenders have been received by the Corporation for lighting the Bristol Guildhall by electricity. The tenders are not confined to local firms. Mr. H. Faraday Proctor, electrical engineer to the Corporation, has the tenders under consideration, and will submit them to the next meeting of the Council.

Bedford.—The surveyor's report just presented states, in regard to the supply of electric current to the Corporation buildings: "The Corporation buildings are supplied in a most efficient manner with the light at the very reasonable rate of 6d. per Board of Trade unit. The advantages of better light, purer atmosphere, and greatly reduced damage to the buildings is insured by this light." The cost of extending the light to the Shire Hall has been estimated at about £250, and the subject has been referred to the Ventilation Committee for their report. A trial of an experimental street lamp was made last week against the expensive Sugg lamps at present in use, and it is stated that the experiment was sufficiently successful to justify the Corporation in replacing these expensive gas lamps in the more important thoroughfares of the city.

Belfast.—Prof. Kennedy was on Wednesday engaged in testing the apparatus of the Central Lighting Station, and all was found in a satisfactory condition for the turning on of the light yesterday (Thursday). The switchboard gallery, manufactured by Messrs. J. H. Holmes and Co., of Newcastle-on-Tyne, from designs by Prof. Kennedy, is considered very complete, and everything points to a successful inauguration. Already wiring contracts have been completed for more than 4,000 8-c.p. lamps. Several of the leading tradesmen's premises were experimentally lighted on Wednesday, everything going off well.

Bournemouth.—The Lighting Committee has presented a report to the Town Council to the effect that the Board of Trade has approved the system of lighting proposed to be adopted by the Corporation.

Burglary.—The police have been unsuccessful in securing the villains who participated with a man named Finn, now in custody, in a burglary at the premises of the London Electric Wire Company. This prisoner has been committed for trial to the Sessions.

Cape Town.—It is expected that the current required for lighting this district will be ready by March 1st. The plant has been supplied by Messrs. Siemens and Halske, under an arrangement by which they maintain it in perfect order for twelve months from date of starting. Delay has been occasioned by the substitution of underground wires to the extent of 10,000 yards. The complete area of the municipality is to be illuminated by electricity; 25-c.p. incandescents, about 400 in number, will be used for a portion of the district, supplemented by 30 800-c.p. arcs. The plant is to be driven by water power from the Table Mountain reservoir, provision being made for steam-power when required. A large battery of accumulators is included in the plant. The price of gas at Cape Town is 9s. 6d. per thousand, and it is stated that the price fixed for current is 1s. 2d. per unit. With a view to popularising the installation, it is the intention of the authorities to hold an exhibition of electric cooking, heating, and power appliances.

Cambridge.—It is stated that Mr. W. B. Redfern is about to rebuild the Royal Theatre, and that the electric light will be introduced.

Cardiff.—The Town Hall building was on Thursday last week illuminated for the first time by electricity. About 400 incandescents are used. The assembly room is provided with 60 suspended ceiling lights and a large number of bracket lights. The work has been carried out by Messrs. Fergus and Co., of Cardiff.

Chelsea.—At the last meeting of the Works Committee the surveyor's report on street lighting by electricity was discussed. Mr. Brass proposed that the whole matter should be adjourned, as he feared the electric light would be too expensive; in the meantime, he reminded them that the incandescent gas light might be tried. Mr. Wright said he had had some experience of the incandescent gas light. A small mantle, very fragile, was placed over the light, and these mantles broke very easily; he understood it was necessary that the light should be always kept burning, so as to avoid risk of breaking the mantles when the lamps were lighted.

Dublin.—At a special meeting of the shareholders of the Dublin United Tramways Company on Tuesday the introduction of a Bill providing for the use of electric motive power on the Dublin street cars was approved. The Chairman, Dr. Carter, J.P., said the systems in Paris, Brussels, and Frankfort had been examined, and the Directors had come to the conclusion that the days of horses in street cars were numbered. The electric system was better and cheaper, and he looked to the Dublin Corporation for assistance in introducing it into their city. He approved of the system of overhead wires, and this system would be adopted, if they obtained the powers, for the Clontarf line.

Dundee.—Mr. G. Baxter, the Corporation's water engineer, has presented an exhaustive report on the water supply of the district in regard to the utilisation of surplus water. Mr. Baxter states that the power required at the electric lighting station is fully 700 H.P., and the power obtainable by the fall of water into Stobsmuir would not exceed 9 H.P. Therefore, the question of water-power for electric lighting in the Dundee district may be at once dismissed.

Fareham.—A meeting of ratepayers is to be held on Monday next to consider the proposed purchase of the local electric lighting company's undertaking, and to discuss a communication from the Board of Trade, in which it is pointed out that the proposal of the Local Board for sanction for a loan of £7,000 for electric lighting purposes, including the purchase of the local company's undertaking, does not appear to meet with the unanimous approval of the general body of ratepayers. The Board of Trade have, therefore, decided to defer dealing with the application until it is ascertained whether the new District Council proposes to proceed.

Grasmere.—The Urban Council have agreed not to oppose the application of the Windermere Company for a Provisional Order.

Hampstead.—The local butcher who claimed compensation for inconvenience caused by the erection of a transformer chamber opposite his premises has been notified that the Vestry could not give an undertaking not to proceed with the erection of the chamber, and see no reason to offer him any compensation. A date is to be fixed for removing the gas pillars in the roads now lighted electrically.

Hanley.—It has been decided to extend the time for lighting the arc lamps until half-an-hour before sunrise, and the local gas company has been requested to discontinue lighting the gas lamps in the vicinity of the arcs until further notice.

Harberton (Cornwall).—The Rev. Father Denys, of Buckfast Abbey, has erected in the church tower at Harberton an electric clock of his own invention, which, in addition to showing the time on a dial-plate 6ft. in diameter, strikes the hour on the tenor bell of the peal for which the church is celebrated.

Hartlepool.—It was unanimously agreed at the last meeting of the Corporation to approve the intended application for a Provisional Order sanctioning electric traction upon the tramways in this district.

Hotel Lighting.—The Hotel Avondale, at the corner of Dover-street, Piccadilly, London, W., is now complete, having been erected and furnished at a cost of £160,000. The hotel is lighted throughout by electricity, the designs and fittings being carried out by Messrs. Sabow and Co., of Linver-road, Hurlingham, S.W.

Huddersfield.—Councillor Calvert, in presenting the report of the Electric Lighting Committee to the Town Council, stated that in January, 1894, the number of consumers of current was 89, taking light for an equivalent of 8,229 8-c.p. lamps, whereas in January, 1895, the number of consumers had increased to 214, with current 15,342 8-c.p. lamps.

Hull.—On Thursday of last week the Mayor started the extension plant at the Corporation's electric lighting station. This consists of a new 300 H.P. engine and electrical plant. The station was originally opened in January, 1893, and was intended to supply the old town of Hull. The original cost was £23,072. This has been nearly doubled, and now amounts to about £40,000. Motive power has been increased from 560 to 860 H.P., and the dynamo capacity from 2,600 to 4,200 amperes. The lamps have increased from 8,035 to 14,208, and the units of current delivered from 74,600 to 163,357, the number of consumers being 271, against 148. A banquet followed the opening ceremony, at which Mr. Holder, the Chairman of the Electric Lighting Committee, gave an account of the undertaking, and received a vote of thanks, as did also Mr. Gibbings, the Corporation's electrical engineer. The inauguration was made the occasion of a visit from the Hull and District Institute of Engineers and Naval Architects to the lighting station.

Kingston.—At the last meeting of the Town Council Mr. W. H. Preece was publicly thanked for the important services rendered by him, free of cost, to the Corporation at the recent Local Government inquiry.——The gas lamp columns in this district are now being removed, having been superseded by electric lamps.

Lecture.—Mr. Albion T. Snell will lecture before the National Association of Colliery Managers, in conjunction with the Technical Education Committee of the County Councils of Nottinghamshire and Derbyshire, on the subject of "Electric Motive Power in Mining." The lecture is free, and is intended for the benefit and instruction of mining engineers, colliery managers, under managers, &c. The lecture is to be held at the Gerard-street Schools, Derby, on Saturday, February 9th, at 4 p.m.——Mr. W. Perren Maycock delivered a lecture on Saturday evening last at the Polytechnic, Thornton Heath, Croydon, on "Electricity," which was accompanied by a number of interesting experiments.

Leeds.—The agreement between the Corporation and the House-to-House Company for the lighting of the Town Hall and Municipal buildings by the Company has been completed, and current will shortly be supplied from the Company's mains.

Liverpool.—The Lighting Committee of the Corporation has presumably by its recent action desired to force the hand of the Liverpool Electric Supply Company, and has, for its trouble, earned a considerable measure of public distrust in connection with the lighting of the Corporation buildings and the possible utilisation of the heat from the refuse destructor. A discussion took place at the last meeting of the Health Committee, and Mr. Morgan pointed out that that Committee evidently understood electric lighting matters better than the Committee specially appointed on the subject, and he trusted that, so far as the electric lighting of the Corporation buildings was concerned, the Health Committee would keep its powers intact. Everything the Lighting Committee had done so far had gone wrong. It was ultimately decided that the engineer should furnish a report on the subject. It was reported at the end of last week that the negotiations between the Liverpool Company and the Corporation regarding the purchase of the Company's undertaking had fallen through, which, after the action of the Lighting Committee, is scarcely to be wondered at; but latest advices are to the effect that, although relations between the parties are "strained," negotiations are still proceeding. A special committee of the Company has been formed to consider the subject of the transfer, and an early indication of the decision arrived at is looked forward to with interest by many outside the city of Liverpool.

Llanelly.—Already the proposal to establish an electric lighting undertaking at Llanelly is bearing fruit. The local gas company have reduced the price of that "illuminant" from 4s. 2d. to 3s. 10½d. per thousand.

London County Council.—At the last meeting the Finance Committee recommended that sanction should be given to the St. Pancras Vestry to borrow £14,300 towards defraying the cost of electric lighting works, and that similar sanction should be given to the Islington Vestry to borrow £51,000 for the same purpose at a 3¼ per cent. interest; but the recommendations were withdrawn.

Maidstone.—A motion was discussed at the last meeting of the Council that their electric lighting Provisional Order should be disposed of by tender. The object of the motion was to "stir the Electric Lighting Committee up a bit." The mover stated that the Order cost them £392, and nothing further had been done. A number of people required the light, and one contractor had informed him that he had on order 2,000 lights, but could do nothing in the matter. It was announced that an application had been made to acquire the transfer of the Order. The matter was finally referred to a committee, in order that a report might be brought up at the next meeting.

Personal.—Mr. A. J. Mayne, of Messrs. New and Mayne, was married at Frimley on the 8th inst. to Florence Maud Pain, of Woodside, Frimley.

Rottingdean.—Messrs. New and Mayne, writing in reference to a note which appeared in a recent issue, inform us that they have put down a temporary plant for 150 lights at Mason's College, Rottingdean, and that they have applications for about 300 further lights in the neighbourhood. It is the firm's intention in the coming summer to put down a permanent plant driven by wind power, using steam as an auxiliary.

Scarborough.—A report of the Lighting Committee just presented to the Town Council states that, having considered the question of obtaining tenders for lighting certain of the main streets of the borough by electricity, the Town Clerk had been instructed to obtain a tender from the Scarborough Company. On the subject of the arrangements at the electric lighting station, Mr. Bernard Drake, the consulting engineer to the Council, made certain recommendations. The report generally was considered satisfactory, and a copy was ordered to be sent to the Company urging the carrying out of certain minor improvements.

Sheffield.—The Sheffield Electric Light and Power Company have for some time past had under consideration a considerable extension to their existing plant, and, pending its erection, have met with some difficulty in supplying all the current demanded. As this has led to some dissatisfaction on the part of large consumers, the Company called their customers together on Monday, and explained the causes which led to the recent temporary interruption of supply, and placed before them the steps now being taken to prevent a recurrence of these mishaps. Mr. Alderman Franklin said it was due to their customers that they should be put in possession of the facts of the case, and a meeting had been called in order that the directors might explain in a frank and friendly spirit what had led to the very regrettable interruptions in the supply of the electric light. Up to last week the Company had in use four separate plants, equal to an illuminating capacity of 10,000 lamps continuously lighted. The causes of failure had been due chiefly to electrical weakness in two out of the four plants. This weakness had only manifested itself when "heavy loads" had occurred, although the pressure was well within the margin of power which the machinery was supposed to supply. Early in 1894 the directors had placed an order for the plant, equal to a further 10,000 lamps. This was to have been supplied by December, but was not ready then, and had only been ready for work on Friday of last week. This machinery would enable them to dispense with the weak plant, or to have it strengthened, and so avoid any further breakdown. The chairman stated that it was astonishing what was expected of the electric light; not only was it to be the best and brightest of all artificial illuminants, but it must not be allowed to blink for an instant; and yet, during the past few weeks many districts in Sheffield had been at times without gas, and the public had borne the mishap with comparative indifference. As soon, however, as anything happened to the electric light supply an outcry was made. The Company fully recognised their responsibility to the public, and had ample capital at their back. The directors, therefore, were determined to do everything in their power to prevent a recurrence of these mishaps in the future. He had no hesitation in saying that no blame whatever attached to any of the officers of the Company, but it rested solely with the contractors. Several speakers complained of the difficulties the Company had in the past experienced, particularly with the harassing by the local authorities. The gas and water companies were allowed to take up the streets at their will and pleasure, whereas the Electric Light Company were compelled to do their work between 8 p.m. and 8 a.m.

Ulverston.—On condition that an agreement come to between the Windermere Company and the District Council is incorporated in the Provisional Order sought for by the Company, the consent of the Council has been given to the application.

Wolverhampton.—It is stated that the inaugural ceremony of switching on the electric light will be performed by Lord Kelvin on Wednesday, January 30th, although it is probable that current will be supplied at an earlier date. Certain tests and experiments have been made, all of which have proved satisfactory.

Worcester.—The County Council have confirmed the contract of Messrs. Verity and Son for the supply of electric light fittings to the Shire Hall, for £91. 3s. 11d. The confirmation of the contract of the New British Electrical Installation Contractors for wiring the building for the sum of £474. 6s. 6d. stands over for future decision.

Works Lighting.—The extensive range of premises occupied by Messrs. Andrews and Co., at Dudley-street, Wolverhampton, have been fitted throughout with the electric light, between 150 and 200 incandescents being employed.——The large new dye works of Messrs. I. and R. Morley, at Heanor, have been fitted up with the electric light, both arcs and incandescents being employed. The work has been carried out successfully, and is giving, we understand, every satisfaction.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Company (Limited).

The forty-fifth half-yearly general meeting of the Eastern Telegraph Company (Limited) was held yesterday at Winchester House, Old Broad-street, under the presidency of Sir John Pender, G.C.M.G., M.P.

The SECRETARY (Mr. George Draper) read the notice calling the meeting, and the minutes of the last general meeting were approved. The report of the Directors was taken as read.

The CHAIRMAN stated that the gross revenue for the half-year ended September 30, 1894, had been £362,557, or a decrease of £7,410 compared with the revenue of the corresponding period of 1893. The decrease was in the traffic with India. There was a small increase in the trans-Indian traffic, but otherwise there was very little difference between the receipts of the present six months as compared with those of the corresponding period of the previous year. The total ordinary expenses for the half-year had been £97,533, or an increase over those of the corresponding period of 1893 of £5,376. From this increase must be deducted about £2,412 for proportion of stationery charged against this half-year's account. As explained at the last general meeting, they now charged, for the purposes of comparison, a proportion each half-year of the amount paid for the annual supply of stationery sent to their stations, instead of charging the whole annual amount in the March half-year. They had lately made more favourable terms for the supply of stationery. The actual increase in the ordinary expenses was, therefore, about £2,964, but if they deducted items of an exceptional nature the increase was reduced to £1,338. The general expenses in London for the half-year had been £8,493, or a decrease of £762. The working expenses at the stations had been £79,316, or an increase of £3,609; but, deducting the item of stationery previously explained of £2,412, a net increase under this head was shown of £1,197. This was mainly due to the operation of the scheme to provide regular scale of promotion to the superintendents and the other members of the staff, £1,045 being due to this cause. There was also an increase of £582 in travelling expenses. They always endeavoured to improve their system when it was possible to do so; and being of opinion that an improvement might be effected in the speed and accuracy of the transmission of telegrams by adopting greater uniformity of working at their own stations and the stations of the associated companies, they brought to London as many of their principal superintendents as could be spared at one time to confer together and give them the benefit of their practical experience before finally adopting certain improvements which had been contemplated. This, in a great measure, was the cause of the increase in travelling expenses. The contribution to staff pension fund amounted to £1,347, as against £615 in the corresponding period of 1893, or an increase of £732. In the corresponding period of 1893 the pension fund scheme had been in operation only three months, so that the amount chargeable this time was necessarily larger. This Company's proportion of the expenses in connection with the twenty-fifth anniversary commemoration banquet and *fête* held at the Imperial Institute was £836, and the dinner to their home and foreign staff amounted to £790. The commemoration festival was very greatly appreciated by all who were present, who not only approved of the generous way in which they were treated, but also of the remarkably able manner in which the whole of the arrangements were carried out. Next Monday some of them were going to be entertained by the Post Office in commemoration of the twenty-fifth anniversary of the working of the land-line telegraphs. The expenses attending repairs and renewals of cables amounted to £43,709, or an increase on those of September of 1893 of £11,803. He wished that this item was less uncertain, but it was a great thing that they were able with their repairing ships at hand to effect their repairs without in any way interfering with their traffic or lessening their income. This was a very important feature, giving, as it did, very large additional strength to the submarine telegraph system. They had now eight or ten ships employed constantly in maintaining their system and their traffic, and they did so at reasonable cost—so much so, that it had not hitherto interfered in any way with their dividends. In the corresponding period last year their expenses under this head were comparatively small, owing to their having received substantial credits from other companies for the hire of their ships for cable-repairing purposes, and the amount of cable used on repairs was less than usual. This time they had not received very large amounts for the hire of their ships, and the quantity of cable laid in for repairs was considerably more than it was in the corresponding period of the previous year. Depreciation of spare cable amounted to £4,815, or an increase of £1,958. They had a larger stock of cable to depreciate this half-year than they had in 1893. The amount carried to maintenance ships' reserve fund was £4,860, or an increase of £1 768 on that of the corresponding period of 1893. As already explained, they had done comparatively little work for foreign Governments and other telegraph companies in the past half-year, so that a larger proportion of the depreciation of their ships had to be borne by themselves. After providing the usual amount for interest on debentures and debenture stock and the usual two quarterly dividends, they carried forward the balance of £59,175 compared with £86,252 in the corresponding period of 1893, which, it must be remembered, was an exceptionally favourable period. Although the amount carried forward was considerably less this half year he was pleased to say that they had recouped the decrease shown at September, 1894, and for the nine months to December 31st they showed a larger total than in the corresponding nine months of 1893; and he trusted that if the traffic continued as favourable for the next two months they would be able to show a very fair result at the end of the financial year, when he hoped to have the pleasure of meeting them again next July. Nothing very definite had transpired during the past half-year, but a considerable amount of work had been done. The connection made at the Seychelles and Mauritius was working satisfactorily, and the result, he might say, was better than they originally expected. Telegraphy had now taken a very strong hold not only on the political and commercial but also on the social life of the world. They were just negotiating for an extension of the South African system, the present concession having five years to run, and they were now disposed to make arrangements for continuing the Company's subsidy, under revised conditions, for a further 10 years. He believed the terms would prove equally advantageous to the telegraphic public, the Governments, and the Company. Every development of the Dark Continent must add in some way to the Company's income. When it was understood that France was sending an expedition to Madagascar the Directors thought that they could not very well do this without laying a line to connect Madagascar with the Company's system at Mozambique. They offered to do the work, but although their tender was many thousand pounds lower than that of two French combinations which tendered the latter got the order. If any hitch occurred in the work, their ships would probably not be far off, and he would not be astonished if in this case, as in others, they eventually laid the line. He alluded to the high market price of the debentures and shares of the Company as an evidence of the value in which their undertaking was held by the investing public, and, in conclusion, remarked that if they maintained their efficiency as they had done in the past there was no doubt that they would also maintain their progress. He concluded by moving the adoption of the report and accounts.

The Marquis of TWEEDDALE seconded the motion.

The CHAIRMAN, in reply to Capt. Goodsall and Mr. Barnes, stated that it was absolutely necessary for them to keep cable in stock in order to effect their repairs as speedily as possible. Their financial strength had been secured by having a good reserve, and this had greatly benefited the proprietors in the improved market price of their holdings.

The resolution was then unanimously carried.

The retiring Directors, the Marquis of Tweeddale and Sir Albert J. L. Cappel, were re-elected, as were also the auditors, Messrs. Deloitte, Dever, Griffiths and Co., and Messrs. Welton, Jones and Co.

A vote of thanks to the Chairman and Directors closed the proceedings

[*We shall publish a full report of this meeting in our next issue.*]

City and South London Railway Company.

The following is the report of the Directors of this Company for the half-year ended December 31st last, to be presented to the half-yearly ordinary general meeting, to be held at Winchester House, Old Broad-street, E.C., on Friday, February 1st, at 3 o'clock:—

The receipts from all sources for the past half-year have amounted to £24,252. 13s. 4d., and the cost of working has been £14,762. 6s. 2d., leaving a profit of £9,490. 7s. 2d. Inclusive of the balance brought forward from June 30th last, the net revenue account shows an aggregate total of £10,919. 8s. 10d. After making provision for the debenture and debenture stock interest, a balance remains available for dividend of £6,771. 12s. 10d. Out of this sum your Directors recommend that the full dividend of 5 per cent. per annum be paid on the Preference shares, and that a dividend at the rate of 1¼ per cent. per annum be paid upon the Consolidated Ordinary stock, leaving a balance of £950. 7s. 8d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway in each half-year:—

		Number of passengers (exclusive of season-ticket holders).	Receipts (including season tickets).		
Half-year ended	December 31, 1890 (11 days)..	165,000 ..	£1,568	3	9
Ditto	June 30, 1891	2,412,343 ...	19,403	6	9
Ditto	December 31, 1891	2,749,055 ...	19,798	16	6
Ditto	June 30, 1892	2,813,162 ...	20,931	4	2
Ditto	December 31, 1892	3,117,602 ...	22,002	17	5
Ditto	June 30, 1893	3,146,656 ...	22,458	6	9
Ditto	December 31, 1893	3,093,351 ...	22,067	14	10
Ditto	June 30, 1894	3,383,154 ...	23,564	10	6
Ditto	December 31, 1894	3,275,649 ...	23,540	12	4
Total since the opening of the line		...24,155,972	£175,335	13	0

During the past half-year there has been a very satisfactory and steady growth of the traffic during all the hours of the day, but especially between 8 a.m. and 10 a.m. in the trains bringing passengers to the City. The trains between these hours have been considerably overcrowded, and as the small accommodation at the King William-street Station prevents any increase in the number of the trains run, a further advance in the fares during those hours has been made. This has had the effect of diminishing the overcrowding of the trains without seriously reducing the receipts.

The substitution of motors on the train itself in the place of the present separate locomotives was found to be a more difficult operation than was at first expected, owing to the small size of the tunnels and the sharp curves near the entrance to the King William-street station. After various experiments, these difficulties have at last been overcome, and a new motor car train has been satisfactorily completed, and has been approved by the Board of Trade. As this alteration will give an increased carrying capacity to the trains, it is proposed to proceed with the conversion of the existing stock as rapidly as the exigencies of the traffic will allow. By means of these motor trains there is every reason to expect that the increased traffic which may be anticipated during the present year will be able to be dealt with. But beyond that time there will be no means available for providing for any further increase that may arise, though, from the steady growth of the traffic in the past, such increase may be confidently expected.

The Directors, therefore, feel that the time has arrived when some steps should be taken to carry into effect the powers granted by the Act of 1893 for the extension to Islington. They would recommend that the line should, in the first instance, be extended to Finsbury-pavement only, the estimated cost of which is £280,000. The first steps to be taken in connection with this operation will be the acquisition of the sites for the stations at the south side of London Bridge, the Bank, and Finsbury-pavement, and as these negotiations are likely to occupy a very considerable time, your Directors recommend that they be authorised to proceed with the purchase of these sites at once, leaving the question of the time for carrying out the works, and the most advantageous mode of raising the capital, to be discussed at a future meeting. This extension, when completed, would enable more than double the number of trains to be run, and a considerable increase in the accommodation of each train to be provided. The introduction of motor car trains will necessitate further siding accommodation at Stockwell, which it is proposed to proceed with at an early date.

Mr. J. P. Court has given notice of his intention to move a resolution to the effect that the remuneration of the Directors be reduced to £650 per annum until the Company pay a dividend at the rate of 2 per cent. per annum upon their Ordinary stock. The Directors state that they have always been willing to concur in anything that they believed would further the true interests of the Company; but, viewing the present resolution as practically one of want of confidence in the Board, they trust the shareholders will show by their presence at the meeting or by their proxies their confidence in the present Directors.

During the past six months £9,100 of the Terminable Mortgage Debenture Bonds have been paid off, leaving a balance of £78,000 of the bonds to be dealt with as they fall due. As the powers for the purchase of land under the Clapham Extension Act of 1890 expire this year, it has been necessary to promote a bill in Parliament for an extension of the times specified in that Act, and to sanction the raising of a small amount of additional capital to be expended on the new sidings at Stockwell and for other necessary works. There is also included in the Bill powers to enable the Company to hold its half-yearly meetings in January and July, when the accounts can be prepared and presented to the proprietors at a somewhat earlier date than at present. The Bill will be submitted for your consideration at the special meeting to be held at the conclusion of the half-yearly meeting.

The Director retiring by rotation is Mr. Charles Grey Mott, who is eligible for re-election. The auditors retiring are Messrs. Turquand, Youngs, Bishop and Clarke, who offer themselves for re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

THOMAS BROADBENT AND SONS (LIMITED).—This Company was registered on January 15th, with a capital of £25,000, in £10 shares, to carry on the business of electrical engineers, crane makers, &c.

W. AND B. COWAN (LIMITED).—This Company has been registered with a capital of £150,000, divided into 10,000 Ordinary and 5,000 Six per Cent. Cumulative Preference shares of £10 each, to acquire the business of Messrs. W. and B. Cowan, brassfounders, &c., carried on at London, Manchester, Edinburgh, and Sydney, New South Wales; and to carry on the business of gas, water, and electric meter and gas governor manufacturers, brassfounders, &c.

HUBERT GRENFELL (LIMITED).—This Company was registered on January 22nd, with a capital of £12,500, divided into 2,500 £6 per cent. Cumulative Preference and 10,000 Ordinary shares of £1 each, to carry on the business of electrical and mechanical engineers and merchants and manufacturers of and dealers in electric, magnetic, telegraphic, telephonic, and other appliances and apparatus, &c. The first Directors are: Captain Hubert Henry Grenfell, R.N. (Governing Director), Gilfrid G. B. Cresswell, Robert H. Bingle, Peter Strickland, and Evan M. Protheroe.

NEW RUBBER COMPANY (LIMITED).—This Company was registered on January 16th, with a capital of £35,000, in £1 shares, to carry on the business of merchants and dealers in rubber, gutta percha, &c.

STIRLING BOILER MANUFACTURING COMPANY (LIMITED).—This Company was registered on January 15th, with a capital of £60,000, in £1 shares, to enter into agreements for the acquisition of certain rights relating to the manufacture of "Stirling" boilers, and to carry on the business of engineers, boiler makers, suppliers of electric light, &c.

ARIEL ARC LAMP SYNDICATE (LIMITED).—The statutory return of this Company, made up to December 28th, has been filed. The nominal capital is £20,200, in £10 shares, of which 2,000 have been taken up. Of these 1,900 have been issued as fully paid, and the full amount has been called and paid on the remaining 100 shares. Special resolutions passed December 14th, and confirmed January 4th, provide for the increase of the nominal capital to £24,200 by the creation of 4,000 £5 per Cent. Cumulative Preference shares of £1 each.

ABIEL COMPANY (LIMITED).—The annual return of this Company, made up to December 24th, was recently filed. Out of a nominal capital of £15,000, divided into 1,000 Preference and 2,000 Ordinary shares of £5 each, 670 Preference and all the Ordinary have been taken up, and 400 of the former and all the latter have been issued as fully paid. Upon the remaining 270 Preference shares the full amount has been called, resulting in the receipt of £1,350

CITY NOTES.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended January 20th were £996, as against £947 in the corresponding period of 1894, being an increase of £49. The total receipts for the half-year amount to £3,001, as against £2,888 for the corresponding period of 1894, an increase of £113.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).—Notice is given that an extraordinary general meeting of the Edison and Swan United Electric Light Company (Limited) will be held at the Caonon-street Hotel, E.C., on Tuesday, February 5th, at half-past 12 o'clock, to consider certain alterations in the Articles of Association, rendered necessary to bring them into conformity with the present rules of the Stock Exchange, the shares in the Company which were issued in 1883 to the Swan United Electric Light Company (Limited), and which have been held by the Directors of that Company *en bloc* as trustees for the Company, having now, by reason of the liquidation of the Swan United Company, been distributed to the shareholders of that Company. An application is to be made to the Committee of the Stock Exchange for a quotation for both the shares and debenture Stock of the Company.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 20th inst. amounted to £900. The amount for the corresponding week last year, £656.

ROCHESTER GAS AND ELECTRIC COMPANY (NEW YORK STATE).—Messrs. Muirhead and Smith, of 54, West Nile street, Glasgow, are authorised to receive offers at par for Five per Cent. Gold Mortgage Bonds at $1,000 (£206), upon which the interest is payable half-yearly. The net revenue of the Company for the past year is said to have been £55,620, and the interest on the total issue of the Company's bonds amounts to £20,600 per annum. The present forms part of a total issue of $2,000,000, forming a first charge on the Company's undertaking.

"W. AND R. PATENTS."—From the Industrial Inventions Development Company (Limited) the shareholders and creditors of Woodhouse and Rawson United (Limited) have been favoured with circulars inviting participation in a number of patents "in which that Company is interested." There are in all 12 letters patent and five provisionals in the list, including processes for the electric pickling of metals, patents for smooth-running wheels, an arrangement for temporarily hardening incandescent gas-light mantles, galvanising, zinc recovery, "renovating rusty scrap by electrical process," &c. The circular states that Mr. F. L. Rawson has for some time past been in negotiation with Mr. Leslie, the receiver and manager for the debenture-holders, "with the object of saving the most valuable assets of the Company," and an arrangement has been come to, with the approval of the Court, by which such of the patents and provisionals as are the property of the Company have been secured for the sum of £1,500, and this purchase has been handed over to the Industrial Inventions Company "without profit to the vendor." For a further sum of £2,500 the option of a 40 per cent. interest in the galvanising, zinc recovery, and electric renovating patents may be acquired, if agreed upon by the shareholders of the new Company, who have 14 days after the date of allotment (which is not given) to decide this latter question. A number of agreements are mentioned in the circular, which must be referred to, as the arrangements therein are somewhat complicated, and require careful consideration before investment is ventured upon. Very little time has been given to shareholders and creditors for the consideration of the matter. The circular is dated January 16th, reached us on the 21st, and this day (January 25th) at 12:30 p.m. the Directors of the Company attend at the offices, 88, Queen Victoria-street, E.C., "prepared with any further information that may be required by intending subscribers." Certainly the circulars leave a great deal to be explained. The application form is for the first issue of 7,000 shares of £1, out of a total capital of £50,000, payable 2s. per share on application, 3s. on allotment, 5s. on April 14th, and the balance as required. The value of an interest in the new Company is briefly set out by Mr. F. L. Rawson in an additional circular, which informs the shareholders and creditors that since Woodhouse and Rawson United went into liquidation nearly the whole of Mr. F. L. Rawson's time has been devoted to an endeavour to save the most valuable assets for them. In the patents invented and perfected by his brother, Mr. W. Stepney Rawson, "who was for many years our head technical expert," Mr. F. L. Rawson came to the conclusion that there existed a source of large future profits, by which a considerable part of the losses incurred by the shareholders and creditors might be recovered. It appears that "this view has been borne out by subsequent experience." This may or may not be open to demonstration, but until proof is given investors will be shy. The Board of Directors consists of two of the inventors, Mr. R. Heathfield and Mr. W. Stepney Rawson, and Mr. J. W. Hughes (of Messrs. Hughes, Chemery and Co.), and Mr. F. L. Rawson states that it has been proposed that he should join the Board, but he prefers to offer himself for election at the statutory meeting of the Company, which, of course, assumes that the capital of the new Company (or a large part of it) will be subscribed.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended January 18th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,670.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company, for the half month ended January 15, 1895, were £1,958, as compared with £2,312, in the corresponding period of 1894. The September, 1894, receipts estimated at £3,301, realised £3,377.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Jan. 16.		Price Wednesday, Jan. 23.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 23.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£1,012,880	Stock	9 0	Anglo-American	41½	42½	41	42	4 15 3	Jan., Apr., July, Oct.	41½	..
£2,993,560	Stock	18 0	Do. Preferred	77½	78½	77	78	5 2 7	,, ,,	78	77½
£2,993,560	Stock	5/0	Do. Deferred	6¾	7¼	6½	7	..	..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 16 1	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	11¼	11¾	11¼	11¾	5 10 8	Mar., June, Oct., Dec.	11 3/16	11 1/16
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	109	113	109	113	4 8 11	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	140	150	147	152	4 12 1	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	19½	20½	19½	20½	4 17 7	,, ,,	—	..
12,931	5	1/8	Direct Spanish (fully paid)	4	4½	4	4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9½	10	9½	10	5 0 0	,, ,,	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8½	9	8½	9	6 0 0	Jan., Apr., July, Oct.	9	8¾
400,000	10	2/6	Eastern	16¼	16⅝	16¼	16⅝	3 19 6	,, ,,	16¾	16 7/16
70,000	10	6%	Do. 6 per Cent. Preference	17	17½	17	17½	3 8 7	,, ,,	17⅝	17½
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	121	124	122	125	3 4 0	May and November	..	...
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	110	106	110	4 12 7	February & August	..	..
250,000	10	2/6	Eastern Extension	16⅜	16⅝	16⅜	16⅝	4 4 10	Jan., Apr., July, Oct.	16⅝	16½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	122	125	123	126	3 3 6	February & August	124⅝	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	102	106	102	106	4 14 4	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	102	106	102	106	4 14 4	,, ,,	104¾	—
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106	109	106	109	3 14 7	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	111%	114%	111%	114%	3 10 10	May and November	..	..
180,227	10	1/6	Globe Telegraph and Trust	8¾	9¼	9	9¼	4 6 6	Jan., Apr., July, Oct.	9 3/16	9
180,042	10	6%	Do. 6 per Cent. Preference	16¼	16¾	16½	16¾	3 12 9	,, ,,	16⅝	16 3/16
150,000	10	5 0	Great Northern	21¾	22¼	21¾	22¼	3 17 2	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	..	—
17,000	25	12/6	Indo-European	48	50	50	52	4 16 2	May and November	51½	50½
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	103	107	105	109	5 12 8	March & September	103½	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	104	107	104	107	3 14 11	..	..	—
11,839	8	4/0	Reuter's	2	4	2	4	..	April and October	..	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	114	119	114	119	5 0 10	,, ,,	118	..
15,609	10	5/0	West African Telegraph	3	6	3	6	..	January and July	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	101	104	4 18 0	March & September	104½	103½
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	97	102	98	103	7 15 4	June and December	..	..
88,321	10	6d.	West India and Panama	1	1¼	1	1¼	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	5 6 8	May and November	11 1/16	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 10 4	June and December	..	..
64,242	15	3/0	Western and Brazilian	11	11½	10¾	11¼	4 18 3	May and November	11¼	10 15/16
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	..	6½	6¼
33,129	7½	4/6	Do. 5 per Cent. Deferred	5	5½	4½	5½	..	..	6	4 15/16
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	102	106	103	107	5 14 3	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	102	106	103	107	5 14 3	,, ,,	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115	120	115	120	5 18 2	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	103	104	102	104	5 18 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	—	..	..	..
224,850	10/0	2⅔d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	—
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	¼	⅜	½	⅝	..	Yearly	—	..
484,597	5	3/4	National	5¼	5¾	5¼	5¾	4 10 11	June and December	6½	5 5/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 15 0	,, ,,	15⅝	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	,, ,,	..	..
119,234	5	3/4	Do. 6% Non-Cumulative 3rd Pref.	5⅝	6⅛	5⅝	6⅛	4 1 8	—	6⅛	5¾
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	..		104	106	3 6 0	January and July	105¼	103¾
58,000	5	1/0	United River Plate	1	2	1	2	..	,, ,,	..	—
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	86	91	86	91	5 9 11	,, ,,	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	14	15	14½	15½	..	—	15	..
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15	15½	15¼	15¾	3 16 2	..	15⅝	15¼
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	130	133	132	135	3 11 1	June and December	134	132
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	4½	5½	4½	5½	3 12 9	—	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	—
8,322	£5	..	House-to-House Electric	..		..		—	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		—	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		—	January and July	—	—
45,000	£5	2/0	Liverpool Electric Supply (fully paid)	7	7½	7 5/16	7 7/16	—	—	..	—
111,000	5	..	London Electric Supply	⅜	⅝	⅜	⅝	..	..	..	—
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	9¾	10¼	9¾	10¼	2 8 9	..	10 1/16	..
£150,000	Stock	4½%	* Do. 4½% Debs.	110	119	117	120	3 15 6	June and December	117½	117
6,452	£10	..	Notting Hill Electric	7	7½	7	7½	..	..	7¼	7 1/16
19,980	£5	2/0	St. James and Pall Mall	8	8½	7¾	8¼	..	..	8½	7 11/16
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 15 8	..	9¼	9
59,900	5	2/0	Westminster Electric Supply (fully paid)	7¼	7¾	7½	8	2 16 3	..	7 15/16	7 11/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅝	2⅞	2⅝	2⅞	5 5 3	..	2 13/16	2 11/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2⅜	2⅝	4 11 5	—	2½	2⅜
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	111	114	111	114	4 0 4	March & September	113½	112¼
20,000	5	3/9	Crompton and Co., 7 per Cent. Cumulative Pref.	3	3½	3	3½	—	January and July	..	..
12,139	5	..	Edison and Swan United	—		—		—	—	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		..	—	—	..
120,000	2	..	Electric Construction	¼	½	¼	½	—	—	..	..
12,845	2	2 9¾	Do. 7 per Cent. Cumulative Pref.	1¼	2	1¼	2	..	—	—	..
61,195	2	10/0	Elmore's Patent Copper Depositing	1¼	1½	1¼	1⅜	—	—	1½	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1¼	—	—	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	25½	26½	25½	26½	4 14 1	February & August	26⅜	26
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 7 10	March & September	..	—
15,995	£10	6/4	International Okonite Ordinary	..		..		—	—	..	—
16,000	£10	..	Do. 8 per Cent. Preference	—		—		—	December and June	..	—
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	¾	—	¾	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	41	43	41	43	5 11 0	March and July	43	42
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 13 6	January and July	..	..
37,514	£5	..	Woodhouse and Rawson Ordinary (£3 15s. paid)	—		—		..	—	..	..
41,098	£5	..	Do. Preference (fully paid)	—		—		..	—	..	..
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	9	10	9	10	5 0 0	..	..	..
£30,000	10	..	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1%	City and South London Railway	44	46	44	46	2 3 6	May and November	45½	45½
7,000	10	5%	Do. 5% Perpetual Preference	13¾	14¼	14	15	3 6 8	..	14½	14¾
£67,130	Stock	4%	Do. 4% Perpetual Debenture	125	127	127	129	3 2 0	May and November	127¾	127½
37,500	£10	1%	Liverpool Overhead Railway	8¾	9	8½	8¾	1 3 2	..	—	..
6,295	10	5%	Do. 5% Preference	13	13½	13	13½	3 15 0	..	—	—
125,000	Stock	4%	Do. 4% Debenture	110	112	110	112	3 11 5	January and July	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

THE ELECTRICIAN:

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NOTES.

The meeting of the Royal Society yesterday afternoon was a memorable one in the history of science, and will not be easily forgotten by those who had the privilege of attending. A Paper by Lord Rayleigh and himself upon Argon was read by Prof. Ramsay. The large hall of the London University was crowded to the doors with representatives of every branch of science, who followed with intense interest the lucid account of the discovery of a new element and constituent of the atmosphere. Lord Rayleigh found, some years ago, that the weight of chemically-prepared nitrogen in a certain glass vessel was 230 grains, while the weight of the same bulk of nitrogen prepared from the atmosphere was 231 grains. A long extract was read from Cavendish's works, in which he records that by continual sparking through air in a closed vessel containing dilute alkali, the dephlogisticated air was converted into nitrous acid, but $\frac{1}{120}$th part remained as a residuum. Cavendish had, in fact, anticipated the discovery. It has been suggested that this may be a mere case of dissociation, but continued electrical discharges through the new gas—if we may so speak of a gas which we breathe every day—fail to produce any change. Ozone becomes reconverted into oxygen if allowed to stand, but argon remains unaltered for months.

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There are two principal ways of producing argon, the one already alluded to, and the other the passing of ordinary air over red-hot copper in a combustion tube to get rid of the oxygen, and the passing of the remainder over red-hot magnesium, which absorbs the nitrogen and leaves the argon. Two gas-holders are used, and the air is passed backwards and forwards through the apparatus. Five and a-half litres of atmospheric nitrogen yield three and a-half cubic centimetres of argon. Chemical nitrogen yields about one-fortieth of this quantity, and this is no doubt due to the water used, argon being soluble in water in considerable proportions. The density found by experiment is about 19·8. There are two distinct spectra, one bright red and the other bluish, depending on the pressure and current. Tubes containing rarefied argon were shown to the meeting. The spectrum of the red kind contains lines of longer wave-length than any that have hitherto been observed. The most remarkable chemical feature of this new element is that, so far as is known, it absolutely refuses to enter into any chemical combination with any other element; hence its name, signifying "inactive."

Many important determinations of its boiling point, freezing point, and specific gravity, have been determined by Prof. Olszewski, of Cracow, the acknowledged highest authority on the physical characteristics of gases at extremely low temperatures. Another feature, perhaps even more remarkable than its refusal to form chemical compounds, is the true theoretical value of the ratio of its specific heats. As determined by Kundt's method, with lycopodium dust in glass tubes, the velocity of sound in it gave this ratio as exactly $1\frac{2}{3}$. Hence it is argued that there can be no internal expenditure of energy in the molecule, and it must either consist of a single atom, or two so tightly locked that they can never be parted. A few months ago we observed that a seat would soon have to be found for it at Mendeljeef's table, but it now appears that there is great difficulty in assigning any place to argon, and it is this perhaps as much as anything else that causes chemists to accept the new element with hesitation. The discoverers propose for it the symbol A_1.

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Following Prof. Ramsay, Prof. Crookes described his researches on the spectra of argon. He commented on the enormous difficulties of the research, the high rank which such discoveries take in science when they result, as did this, from a prediction, and, amid loud applause, he asserted that in the annals of science it could be equalled only by the discovery of Uranus by Adams. Prof. Armstrong, as President of the Chemical Society, suggested a formidable number of grounds for future criticism; but Prof. Rücker, as President of the Physical Society, the most fluent and attractive speaker of English men of science, welcomed the brilliant discovery which puts beyond all question and makes it absolutely certain that we have now a new constituent of the atmosphere and a new element; Mendeljeef's table was after all empirical, and great confidence could be placed in Kundt's method, especially when carried out by such men as Rayleigh and Ramsay. Prof. Roberts Austen broke the spell of the purely scientific interest and glorious uselessness of the subject by suggesting that about 1,000 cubic feet of argon are passed into a Bessemer converter during a charge, and that some of the properties of Bessemer steel may be due to it. Lord Rayleigh made a few remarks on the monatomicity of the element, and observed that the ratio of the specific heats shows that there cannot even be rotational energy in the molecule. The eventful meeting was brought to a close by a few remarks from Lord Kelvin, who thought that molecules of a gas, the ratio of whose specific heats was exactly $1\frac{2}{3}$, could not even be spheres, but must be Boschovich points endowed with inertia and mutual attraction.

One of the first occasions on which a student of algebra has to exercise his ingenuity is in the solution of equations containing "two unknowns." A very serious problem of this character has been brought before electrical engineers. One of the unknowns is a gas, and the other is a flame or spark. Taken separately, the difficulty is considerably reduced. Thanks to the services of a jointer at Eastbourne, who applied the flame of a spirit lamp to a "road box," the cover of a neighbouring box, weighing over half a hundredweight, was successfully "blown high into the air, and descended in a score of fragments"; and the audience was, no doubt, perfectly satisfied that the mains of the gas company were leaky, that the iron pipes and boxes of the electric company were not gas proof, that the jointer must have had a cold, and that something ought to be done. We have no perfect cure to propose, but we venture to make a very commonplace suggestion.

Mere ventilating holes and pipes may or may not afford adequate protection, sufficient experience with such appliances has not yet been gained, though we have not yet heard of the explosion in a box which was provided with such an attempt at ventilation. Should the pipes become blocked, an explosion might occur after all. It seems possible to construct a cover which should both afford free diffusion of gas, and yet, in the event of explosion within a conduit at a distance from the box, should allow the explosion to take place without serious result. Cast iron is not the ideal material, but strips of wrought iron set on edge, and either straight, gridiron fashion, or corrugated like strips cut from the end of a corrugated sheet would be excellent. Such a cover would offer but little obstacle to the outrush of air in case of a distant explosion. The grating thus formed should be a few inches narrower each way than the inside of the box, if possible five or six inches. About four or five inches below it there should be a plate to catch the rain, and to throw it into a trough running round the inside of the box, and thence into the drain. Between the trough, the plate, and the grating there would be ample space for the circulation of air—say three or four inches, at least—but no direct way either for passage of rain or of walking-sticks. Of course the trough must be occasionally cleaned from mud, as the grid would act as a foot scraper. Such a box might be kept fairly dry, but would be more expensive than one with a solid lid. It is only an ideal.

Exactly what it was that the recent deputation of the Municipal Corporation Association set out to complain about in connection with the much anathematised and anatomised Draft Agreement between the Postmaster-General and the National Telephone Company was not very apparent from the brief reports published in the daily papers. Our detailed report of the interview, which appears elsewhere in the present issue, makes the matter plainer. Statutory powers, it was quite rightly argued by the Deputy Town Clerk of Liverpool, should be tempered by statutory obligations. When, however, we recall the fact that under Section 5, Sub-section 2, paragraph *b*, of the Telegraph Act of 1892, local authorities have conferred upon them an absolute veto of the exercise by the National Telephone Company of the statutory powers which may be delegated to it by the Postmaster-General, the advantage gained by the Company would seem in danger of altogether vanishing. Local authorities have of late shown themselves to be keen bargainers, unrestrained by any false delicacy or dignity, and with the grant of statutory powers thus subject to the higgling of the municipal market, there surely need be no fear that the National Telephone Company will not be made to give an adequate *quid pro quo* in the shape of low rentals, metallic circuits, modern switching arrangements, and a telephone to any and every one prepared to sign an agreement.

The suggested alternative to the Draft Agreement is a General Act forcing the National Company to adopt a sliding scale and a maximum rental. This alternative, as Mr. Morley pointed out, is unpractical, if not impracticable. A rental which would be moderate as a maximum for London would scarcely suit the pockets of the Little Peddlingtonians. A company possessing a Government licence which does not finally run out until 1912 is not tactically altogether at the mercy of Parliament, and ethically still less so. It can more or less dictate its own terms, since it can only be bought out at its own price, except on the expiry of its licence, or on the expiry of any septennial period intervening between 1890 and 1912.

As an offset to such ineptitudes it is encouraging to find that the municipal mind has at last awakened to the fact that insecurity of tenure is not conducive to cheap and efficient service. The suggestion that the National Company should be given a licence of indefinite duration upon the condition of being bought up at the end, say, of any decade at *n* years' purchase is worthy of consideration; it would let that Company know exactly what to expect, and thus obviate the necessity of piling up a huge reserve fund against the unknown. As the deputation made no reply to the Postmaster-General's lucid statement of the case, and was eager to clear itself from any suspicion of wishing to unduly hamper telephonic development, it may be expected that it will bring its influence to bear upon those who have done all that noise and nagging could do to make Parliament go back upon its word. We have never disguised our dislike of the policy set forth in the Treasury Minute of May, 1892, believing State purchase to be inevitable; but a policy sanctioned by the legislature in August, 1892, should not be reversed in January, 1895, before even so much as a day's trial has been given to it.

As affording some indication of the evolution of American electric light and power stations from the old fashioned geared type to the direct-driven type, we publish this week an abstract of an article by Mr. J. B. Cahoon, which recently appeared in the *Electrical World* of New York. We mean nothing discourteous when we affirm that America is behind this country and general European practice. Doubtless the conditions are not the same as they are on this side of the Atlantic. Nevertheless, our American friends are finding out that engines and dynamos driven by ropes or belts are not the best thing even for their purpose. They have two instructors to teach them newer practice, and it seems that they are learning a little from one and a little from the other. On the one hand, they have the example of Continental practice, with its large direct-driven slow-speed sets; and on the other hand they have the English practice, which is best illustrated by the high-speed direct-coupled Willans engines and dynamos. The general tendency in America seems to be towards the former of these two systems; but there are not wanting examples of the latter. In this country the vertical slow-speed engine coupled to two separate dynamos, one on either side, has not found favour; but we suppose there must be some virtue in the plan, since it commends itself to the practical eye of the American engineer. We must point out that Mr. CAHOON does not make it as clear as he should that he is describing only one among many types of American station dynamos.

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SOME little time ago we announced, on the strength of a paragraph in one of our French technical contemporaries, that the Compagnie des Chemins de Fer de l'Ouest, satisfied with the performance of the first Heilmann electric locomotive, had ordered two more, which were to embody all the improvements suggested by experience, one of these suggested improvements being the adoption of the Willans engine in place of the home-made horizontal compound engine with cylinders on opposite sides of the crank shaft used on the "Fusée Electrique No. 1." From a long circular sent out to the shareholders of the Société de Traction Électrique and published recently in the columns of *L'Energie Electrique*, it would appear that the so-called additional order of the railway company is merely a leasing by the traction syndicate to the company of two improved locomotives—a somewhat different thing. The fate of locomotive No. 1 is instructive. It is proposed to employ the plant and the platform on which it stands as an electric generating station of the ordinary fixed type; the bogies and motors being made use of in connection with some overhead-trolley railway system. As we pointed out just a year ago, the advantages to be derived by the Heilmann combination are a diminution of the rail wear due to unbalanced parts, and an increased adhesion due to the more regular rotatory effort of the driving wheel. But until the railway company gives a *bonâ-fide* order for, say, half-a dozen Heilmann locomotives, engineers may be pardoned for being somewhat incredulous as to the net balance of the *pros* and *cons* working out in favour of the boiler, stationary engine, dynamo, motor arrangement.

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THE *penchant* exhibited by our neighbours across the Channel, and by other Continentalists, for roundabout ways of arriving at a given result has always been a source of amused wonder to us unsophisticated insulars. A characteristic example of this fondness for devious paths was recently afforded by a very *bizarre* Parisian electrical contemporary. Like most other journals it had a column set apart for announcements relating to *matériel d'occasion*, or, to put it in vulgar English, second-hand plant. But, unlike most other journals, it did not make any charge for these announcements; nothing so crude and straightforward was thought of for one moment! Was virtue to be voluntarily its own reward in this instance, as it is perforce in most? No, not exactly. Our contemporary's "sole remuneration" was to be a small commission paid to it by owners of any *matériel d'occasion* sold by its means. Nothing, as is rightly remarked, could be more legitimate, and, we may add, more absolutely academically correct. Unfortunately, the *matériel d'occasion* once safely sold, there was no more occasion for our contemporary's good services, and, as it had no wish to promote the pecuniary welfare of "*les huissiers et toute la gent tracassière*," in one instance only did it receive the fruits of its labours. Henceforth the no-cure-no-pay system is to be abolished, and the "*débiteurs de mauvaise foi*" will no longer be able to do business in this, to them, highly satisfactory style.

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Electrical Utilisation of Water-Power.—The Portland Cement Works at Heidelberg purpose utilising the Neckar, and hope to obtain 3,000 H.P. from it electrically.

Insufficiently Protected Arc Lamps.—At the harbour of Geestemünde, recently, about 100 bales of wool were destroyed by fire, caused by glowing pieces of the carbons falling on to them.

Accumulator Cars in Vienna.—On the 15th inst. the regular working of the Westbahnhof-Hütteldorf portion of the tramway line in Vienna, by means of the Waddell-Entz copper-zinc accumulators, was commenced.

Interurban Telephonic Communication in Russia.—An interurban telephone line has recently been established between Sebastopol and Simferopol, in South Russia. Communication is also being established between Kieff and Sebastopol.

The Telegraph in Mashonaland.—The total number of miles of telegraphs—exclusive of railway service lines—worked and owned by the Chartered Company south of the Zambesi is now 1,225, and on the completion of the proposed extensions it will represent a mileage of 1,551.

Erratum.—£81 per kilowatt, not £81 per 100 kilowatts, as stated in his biography last week, was the estimate made in 1888 by Mr. Crompton for the cost of plant for a supply station.

Wolverhampton.—The new electric supply station of the Wolverhampton Corporation was opened on Wednesday last by Lord Kelvin, who was also the principal guest at a banquet which was given in the evening to commemorate the event.

Electric Traction in Japan.—Among the electric traction schemes at present under consideration in Japan is one for a line between Oita and Beppu. Another one is a line about 20 miles long from Shinagawa, Tokyo, to Yokohama.

Electric Traction in Germany.—The municipal authorities of Elberfeld have just finally decided to grant a 11 years' concession to Messrs. Schuckert and Co., of Nuremburg, for the establishment and operation of an electric tramway between Elberfeld, Neviges, and Velbert, with a branch to Langenburg.

Interurban Telephonic Communication in Germany.—Over 250 towns and villages are now in telephonic communication with Berlin. So much use is made of the telephone between Berlin and Hamburg, and *vice versâ*, that the two lines in use have been found to be insufficient, and a third one has recently been completed.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
Gibraltar—Tangier	Jan. 14, 1895.	Jan 30, 1895.
Latakia—Cyprus	Nov. 27, 1894.	—
Cadiz—Teneriffe	Dec. 26, 1894.	
Hongkong—Macao	Dec. 31, 1894.	—
Pernambuco—Ceara	Jan. 12, 1895.	—
Gibraltar—Cadiz	Jan. 14, 1895.	—
San Thome—Loanda	Jan. 24, 1895.	—

Electric Lighting in Paris.—It has been decided to light the Place Carrousel, the Tuilleries gardens, and the Rue des Tuilleries by electricity. The Questor's office of the Chambre des Deputés, at the Palais Bourbon, are inviting tenders, until March 31st next, for the carrying out of an installation in the Chambre des Deputés.

The Telephone in America.—There are now in operation in the United States alone, says a writer in *Cassier's Magazine*, more than half a million miles of telephone line, bringing into speaking relations over 250,000 telephonic subscribers, and employing in daily service over 600,000 telephones, by means of which 600,000,000 messages are transmitted annually. In both New York and Chicago about 10,000 subscribers have telephonic communication.

Rural Trolley Roads in New Jersey.—According to the *Electrical Engineer*, of New York, the State Road Commissioner of New Jersey has laid down certain rules which he regards as vital to protect the public interest. His main point is that the grants of right of way should require the track to conform to the width of vehicles generally in use on the highways; that the rails shall have at least 4in. flange, and that wherever the tracks are laid upon public roads the space between the rails and for at least 15in. outside of them shall be either paved or macadamised so as to secure a good road-bed.

Obituary.—We regret to announce the death of Mr. John Tasker, at the age of 76, who was well known at Sheffield as the pioneer of the telephone and electric lighting industries in that town.——We also regret to announce the death (by suicide) of Mr. Carl Thomas B. Brain, of Helsby, who was well known in electrical circles in connection with his system of electric traction, at which he had been working very hard for many years to the injury of his health. Mr. Brain was greatly respected, and his death comes as a sad shock to his many friends in the South as well as in the North.——The death is also recorded of Mr. Thomas Bird, late manager of the General Electrolytic Company's works at Farnworth.——On Saturday last Mr. T. B. Grant, of the firm of Bourne and Grant, died at his London residence from typhoid fever. Mr. Grant was only thirty-three years of age.

The Association for the Improvement of Geometrical Teaching.—The twenty-first general meeting of the Association for the Improvement of Geometrical Teaching was held on the 19th inst., Dr. R. Wormell, the President, in the chair. The report of the Council, proposing the continuation of the *Mathematical Gazette*, and the treasurer's report were read and adopted. Dr. Larmor (St. John's College, Cambridge) was elected President in the place of Dr. Wormell, who retires, the other members of the Council, including the hon. secs., R. Holmes, M.A. (The Avenue, St. Margaret's, Twickenham) and C. Pendlebury, M.A. (53, Gunterstone-road, West Kensington), were re-elected. Miss M. E. Rickett, Messrs. G. H. Bryan, F. J. Butt, W. Gallatly, J. H. Hooker, T. H. Kirby, R. F. Muirhead, and T. W. Palmer were elected members of the Association. After the elections Mr. E. M. Langley gave some geometrical notes, and Mr. G. E. Heppel read a Paper on "Algebra in Schools." After an adjournment, Dr. Larmor took the chair, and Papers were read by Rev. C. Taylor, D.D. ("The A.I.G.T. Syllabus of Geometrical Conics") and Rev. J. J. Milne ("The Conics of Apollonius"), and Prof. Lodge gave some notes on Mensuration. Interesting discussions followed these. All communications with respect to the *Mathematical Gazette* should be addressed to the Editor, 16, Adelaide-square, Bedford.

Accidents.—On Friday last there were explosions at Eastbourne and Rochester. At Eastbourne a large iron cover, weighing over half a hundredweight, was blown into the air. As to the cause of the accident, it is stated that one of the men of the Electric Light Company was engaged in testing a piece of cable. A jointer was using a spirit lamp at one end for the purpose of drying the cable ends before testing, when the explosion occurred. With the report a black smoke issued from the box for a few seconds, and there was a strong smell of gas. On the evening of the same day an explosion occurred in front of the Guildhall at Rochester, followed by the lifting up and scattering of the stones of the street pavements.—Major Cardew made an inspection, on Wednesday, of the scene of the explosion, in the presence of Mr. Hurrell, electrical engineer and Managing Director of the Chatham and Rochester Electric Light Company. The statement of Mr. Hurrell is to the effect that the explosion occurred at No. 7 sub-station. A spark had been found playing on a brick, which had fallen on to the high-tension terminal, and on to the iron tube of the low-tension main. He attributed the explosion to a faulty gas main, the gas coming into contact with this electric arc—Yesterday morning an explosion occurred at Dover in an electric light chamber.—Mr. Edward Evans-Lloyd writes to *The Times*, under date Bordeaux, January 25th: "It is hardly necessary to insist on the dangers incident to electric currents; but, having been a witness of the fatal results of a careless manipulation of the machinery in connection with the electric tramway here, I venture to send you a short account of what happened in Bordeaux yesterday afternoon. It seems that the telephone wires run overhead parallel with those of the tramway, and that during certain repairs to the former wires they broke, and, in their fall, became entangled with a horse which was drawing a carriage in one direction, and with another horse in a cart going the opposite course. The result was that both horses were killed instantaneously, as well as four unfortunate dogs happening at the same moment to be in the street. The driver of the carriage received an alarming shock, and was for some minutes riveted to his seat, though after a time he recovered. I shall not soon forget the pitiful sight of the two dead horses lying at the side of the Route du Medoc, the victims of this new form of electrocution."

Acetylene.—Our esteemed contemporary the *Journal of Gas Lighting* takes exception to our criticisms last week with regard to the premature importance which is being attached, both here and in America, to the electrical manufacture of acetylene. We print below the remarks of our contemporary upon which our own criticisms of it were based :—

> The event of the past week for the gas industry was the introduction of commercial acetylene as a carburetting material by Prof. Vivian B. Lewes, in a Society of Arts Paper, read before an intensely interested and appreciative audience on Wednesday evening. Whatever may be the future of this novelty, its appearance in working dress is something to note in these columns. We report the Paper and the discussion, and comment upon the subject at length elsewhere, so that it is unnecessary to say much about it here. That omnipresent personage, the "practical man," will, of course, have a good many questions to ask concerning acetylene as an enricher of gas—such as whether the estimate of its cost is correct, what it is capable of effecting for a particular make of common coal gas, whether it is safe to handle, and what not. Time will reveal the truth in regard to these and all the other practical points that suggest themselves. For the present, the only correct attitude to be taken with respect to Prof. Lewes's Paper and the subject dealt with therein is that of high and warm appreciation. Nobody can see to the end of the applications of commercial acetylene; but it must be freely conceded to have made its bow in England in admirable style under the skilful chaperonage of unimpeachable scientific authority. Acetylene, if—or rather, we should say, when—it becomes an article of commerce, may be expected to interest a far wider circle than that of the followers of the gas industry. There is a great fascination about the remarkable substance, carbide of calcium, from which it is produced in a state of almost perfect purity by the simple addition of water. First prepared as one of the innumerable products of experimental chemistry which, according to the witty American doctor, "are not good for anything, and smell abominably," it has awaited its time to be born again in the fiery matrix of the electrical furnace, and now bids fair to find a place among the accessories of modern industrial life. Such is the way of man's gropings into the secrets laid up for him in the mighty scheme of things which we call our world. First the toy, then the tool. First the seeming aimless curiosity of the searcher, then the organised labour of the technician, and the directing, economising control of the man of business. And the result is always the same; that is to say, when the ways and means have been rightly chosen and used, there is a more or less perceptible addition to the "unearned increment" of comfort and cheapness experienced by the community, hardly anybody knows how or why.

Our contemporary also has a lengthy article entitled "Gas of 240-Candle-Power A Sensation !" under which startling title it deals more fully with this acetylene question. This article is too lengthy to reprint in full, but the following quotation from it may serve to indicate its nature :—

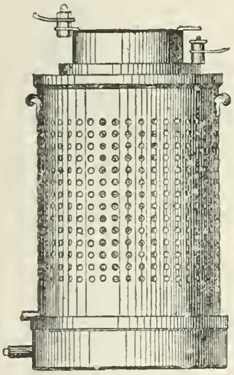
> It was a dramatic *dénouement* of Prof. Lewes's little plot when he applied a light first to a single open flat-flame burner, and then to a group of five similar burners, and people saw for the first time, in a public place, the intensely brilliant, white, and solid-looking flame of burning pure acetylene. It is indeed a flame to wonder at. Nothing like it ever before came within the ken of a gas manager, or dazzled the vision of a photometrist.

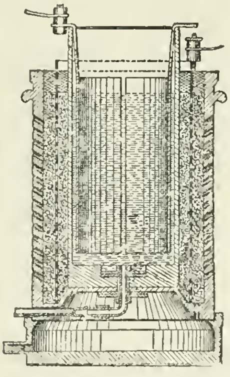
THE WALKER-WILKINS BATTERY, AND OTHERS.

BY W. R. COOPER, M.A.

The public are occasionally awakened by the daily press to a sense of the great advances made by science, and are given a glimpse of some invention, or discovery, which is to revolutionise all our present ill-advised methods, and there is opened up to the imaginative a vista which, though perhaps not terminating in perpetual motion, contains a few problems more or less closely allied to it. According to the *Birmingham Post* we are just at present on the eve of such a revolution. A battery, using far cheaper chemicals than hitherto, has been invented, which will be welcomed by those requiring motors up to two or three horse-power, which will transform the lighter trades, and bring about a vast change in domestic lighting. But most of us are destined to be disappointed.

It is, then, with some interest that we turn to Prof. Jamieson's report on the Walker-Wilkins Patent Non-Polarising Voltaic Battery, to which the above refers. The figure reproduced gives some idea of the construction of the cell. A split cylinder of zinc, in a solution of caustic potash, is supported in a porous pot, and this is contained in an outer perforated vessel. The space between the two is occupied by a perforated nickel cylinder forming the negative plate, which is packed on the inner side with powdered carbon, and on the outer with granular. The potash, after passing through the porous pot, permeates through the carbon and drains off into the earthenware stand, the internal circuit being completed by the moistened carbon. The E.M.F. is about 1·4 volts, and the internal resistance is low.


Outside View.


Vertical Section.

If any cell is to be used for the supply of current, it should be more or less free from polarisation and local action of high E.M.F., of low internal resistance, simple, compact and cheap. This cell certainly does not appear to suffer much from polarisation; but it is not so free from it as the well-known Edison-Lalande battery, consisting of zinc, caustic potash, and copper oxide, the last acting in the double capacity of negative plate and depolariser. In the Walker-Wilkins cell no mention is made of manganese peroxide, or other oxidising body of that nature, depolarisation being effected simply by atmospheric oxygen. The use of the atmosphere for this purpose is no new principle. It was employed in a cell (described in *The Electrician*, Vol. I., 1878), which consists of a porous pot containing zinc in caustic potash, the negative plate being merely silver wire wound round the outside of the pot and freely exposed to the air. In the present cell such free exposure appears to be very much reduced. Probably the depolarisation is largely due to air previously absorbed by the carbon, and it would, therefore, be expected that polarisation would increase after the first charge or two had been exhausted. If a Leclanché cell is short-circuited by a resistance of 10 ohms until the current falls to half its original value, and is then recharged, it will be found to polarise far more rapidly; not necessarily from exhaustion of the manganese peroxide, but from accumulation of free hydrogen in the carbon, where there is little remaining with which it can readily combine. It is easy to see that this may take place with some solid depolarisers. Referring to Prof. Jamieson's tests, it may be observed that the cell considered, when once polarised, does not recover very readily, a result which might be anticipated.

Two conditions should be fulfilled by a depolariser in order that it may be efficient. These are: (1) the surface exposed to action should be large; (2) its chemical activity should be considerable. The first condition is here well complied with, whereas in the ordinary forms of Leclanché cell the carbon and manganese peroxide are much more restricted.

Passing on to the second condition, we see that the chemical action should be such that energy is thereby added to the circuit. This is clearly seen to be the case in the Daniell cell, the E.M.F. of which is higher than that of the simple zinc-copper couple. In both cases zinc sulphate is formed, but in the one copper sulphate has to be broken up, and in the other sulphuric acid in the final reaction; but, as the former is the more readily broken up, the E.M.F. is increased by an amount corresponding to the difference in the heats of formation of these two bodies. If an ordinary Leclanché cell be filled up with a solution of caustic potash, instead of sal ammoniac, an E.M.F. of about 1·4 volts is obtained; but if copper oxide is substituted for the negative plate, as in the Edison-Lalande, the E.M.F. is only about 0·75 volt. This is another instance of the effect of a depolariser. Manganese peroxide gives up its oxygen more readily than copper oxide, and hence more energy is available in the circuit. If there were such a body as peroxide of copper that could be used in place of the cupric oxide, the E.M.F. of the Edison-Lalande would be greater. A depolariser should, if possible, be of an endothermic nature.

The local action in the Walker-Wilkins cell is, of course, very small, as it always is where potash is employed as the electrolyte. It is, therefore, in many ways suitable as a source of electricity. But the cell is by no means as simple in construction as could be wished, and the use of nickel as the negative plate must materially increase the cost of a cell which in any case would not be a cheap form. The only corresponding advantage appears to be a much higher E.M.F. than that of the Edison-Lalande.

At the conclusion of the report the opinion is expressed that the cell "will prove very serviceable for driving electro-motors, for electric lighting, and for electro-deposition of metals"; but this is followed by the limitation—"where engines and dynamos are not available." Owing to the somewhat wide distribution of the latter, it appears doubtful whether this cell will achieve much greater success than its predecessors.

THE HAGEN ACCUMULATOR LINE.[*]

On January 7, 1895, the electrical tramway at Hagen (Westphalia), worked by copper-zinc accumulators, was opened in a driving snowstorm. The opening trial, run on a portion of the line full of curves and inclines, came off in a most satisfactory manner, although the speed, on account of the unfavourable condition of the rails and weather, hardly reached more than 8—9 kilometres (5—5½ miles) an hour. The normal speed at which the cars should run on that portion of the line now completed, the "Kückelhausen-Markt-Hagen" portion, which is 3·125 kilometres (two miles) in length, is 12 kilometres (7½ miles) an hour; the greatest speed allowed by the authorities is 15 kilometres (9·3 miles) an hour. The gauge of the line is 1m. (3·28ft.), the sharpest curve has a radius of 15m., and the steepest incline is 4 per cent.

Of the five cars already finished, one is to be run on the "Hagen-Eckesey" portion of the line, which is to be opened on April 1st. The cars are constructed to carry 26 passengers (12 sitting and 14 standing). Each car has one motor of 15 H.P. maximum output, and carries 88 cells under the seats.

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[*] Abstract of an article by C. P. Feldmann, in the *Elektrotechnische Zeitschrif*

The accumulators are of the well-known Waddell-Entz type; each cell has seven negatives and six positives, measuring 205mm. (8·07in.) by 110mm. (4·33in.) and 320mm. (12·6in.) high; the total weight of each cell empty is about 7 kilogrammes (15·4lb.) and full about 14 kilogrammes (30 8lb.). The negatives consist of a fine iron lace network, which serves to carry the zinc separated by charging from the solution of the zinc salt. These plates have on each side small glass pipes which serve as insulation between the plates of different polarity. The positives consist of double-wound spirals of copper wire covered with finely-divided copper by means of a special process, and then sewn up in separate woollen bags.

The accumulators, therefore, resemble in many points those of Commelin and Desmazures. They differ, however, materially and advantageously from these, because the voltage at the terminals falls very slightly when using a strong current. The E.M.F. of each cell is 0·85 to 0·88 volts. The normal capacity is 250, and the maximum is 300 ampere-hours. The efficiency is independent of the degree of the discharging current.

At my request, says Herr Feldmann, one of the patentees, Herr Entz, short-circuited three cells, which had already done one journey, in series through an ampere-meter, by means of two copper wires of 3mm. diameter in parallel. After the wires had obtained their final temperature the deflection on the ampere-meter remained almost constant. The discharge current was 400 amperes for 40 minutes. The voltage at the terminal of one cell was still 0·5 after 20 minutes, and the E.M.F. immediately after disconnecting rose again to 0·85 (measured by a Weston voltmeter).

In Hagen one battery charge should be sufficient for 33 car-kilometres. The weight of a battery, inclusive of the wooden box, is 1·4 tons, and that of a loaded car about 7 tons.

The motors only act on one axle, the other running free. The transmission takes place by one set of tooth wheels, whose ratio is 5 to 1. The motors are shunt-wound, the shunt winding being run off 12 cells. The five 12-c.p. lamps for the cars (two in front, and three inside) are supplied from this small battery, so that the lighting is not influenced by the speed of the car.

The remaining 76 cells are joined in four parallels for starting, and are then connected, first in two parallel series, then all in series. This is effected by an eight-stop regulating switch. On starting, the driver moves the switch from the position 0 to 2, when we have four rows in parallel, then gradually to 3 (two series in parallel), and to 4 (four rows in series). Position 4 is for normal speed. In positions 5 and 6 resistances are put into the shunt circuit. Position 1 is to put the brake on the car, which works extraordinarily well, as the momentum of the car is used to charge the accumulators. Braking was done several times in half to one length of the car, without the reserve chain brake or sand scatterer being used. The action of the electrical brake allows of running down the inclines in Hagen without the speed exceeding 15 per cent. of the normal. The charging current, however, goes up to from 200 300 amperes, and experience must show if electrical braking is in accord with the precautions otherwise necessary in charging the cells.

The charging station is erected on ground belonging to the Akkumulatorenfabrik. On one wall there is the switchboard, and on the opposite wall the rails for the five cars already finished. In front of the switchboard, at the same level as the floor of the cars, stands the battery to be charged, each set of 44 cells in a wooden box. Under them are arranged coils of warm-water pipes. The charging commences with a voltage of about 0·9 volts per cell, and must be considered finished at 1 volt. In order to ensure good circulation of the electrolyte they are heated up to about 50 C.

In front of the charging table is a stage which can be moved at right angles to the side walls, and provided with hauling and loading apparatus, which can be worked by hand. The car which is to be unloaded and reloaded is brought on to the last rail, then the movable table of the stage is brought up to the platform of the car by turning a handle, so that the guiding angle irons of the latter is on a level with the lower corner of the battery. Then, by turning a second handle, the connecting chain lying between the guiding angle irons moves away from the car and drags the discharged battery, which is fastened to it by a hook, with it. In a similar manner the charged battery is placed under the seats of the car.

AN AMERICAN CENTRAL STATION DYNAMO.

BY C. B. CAHOON.

The many changes that have been going on in the electrical field incident to the development of electric lighting have included the remodelling of lighting stations in the larger cities, and the substitution of large direct-driven generators for the old bi-polar belt-driven type. As such a change involves a large expense, we naturally are led to believe that the direct-driven unit must possess commercial as well as technical advantages over the old-style machine. The very high speeds that have been common with bi-polar generators have given rise to serious losses of energy in belts, to expense in belt maintenance, to trouble with bearings, and other additional features tending to cause the cost of maintenance and operation to assume a relatively large figure. In addition to this, the belt-driven generator takes up a great deal of room, and in large cities space is exceedingly valuable. In many cases where the plant is already established, the purchase of additional land to keep pace with the growth of the plant is practically out of the question, on account of the excessive cost involved. The direct-driven unit occupies comparatively little space when coupled to engines of the vertical type. Another advantage is that, by the introduction of the direct-driven generator, larger units may be employed, and a consequent lessening of the number of dynamo tenders. The general rule governing the size of the unit is that they should be as large as possible, and so divided that the stopping of any one of them will not prevent the balance from giving the normal output of the station. The general practice in the use of these large units is to couple a generator on each end of the shaft of a vertical triple expansion engine, which is driven at a speed varying from 172 revolutions for the 100-kilowatt to 90 revolutions for the 800-kilowatt generator. The number of poles in the generator varies from eight in the smaller size to 16 in the larger size.

A 400-kilowatt generator is the favourite unit with many of the managers of large central stations. An average sized engine for driving two of these generators, one on each end of the shaft, is about 1,300 I.H.P., thus leaving a small surplus power over what is actually required to drive the generators at full load.

The general features of construction followed in all sizes of this style machine are—

First. The frames and pole pieces are cast from a special grade of soft steel, possessing the highest magnetic permeability.

Second. The armatures are so constructed that currents of air constantly circulate through core and windings, providing thorough ventilation for the purpose of keeping down the temperature of the armature to as low a point as possible, the machines in general being designed for a very small rise in temperature when operated at full load, the limit on standard machines being 40°C. rise above the surrounding air after a continuous run of ten hours.

Third. The winding of the armature consists of straight copper bars connected directly to the commutator bars, which are situated on the two ends of the armature. In other words, a portion of the winding itself is used for the commutator.

In order that the general reader may get a fair idea of this type of machine, we give a more detailed description of the 400-kilowatt machine, as follows:—

The Frame.—This is made of a special grade of cast steel, and for convenience in handling is cast in halves; on the lower half are cast projecting lugs, or feet, for supporting the frame on the foundation.

The pole pieces, twelve in number, are cast separately from the frame, and both they and the latter are carefully faced where they are to be bolted together, so as to ensure as nearly a perfect contact as possible. The field spools are made up separately from the pole pieces, being wound on a shell in much the same manner as thread is wound on a spool, and is slipped over the pole piece before the latter is bolted on to the frame. After being placed in position these windings are all connected together in such a manner as to cause the pole pieces to become alternately north and south poles. All these machines for central station work are what are known as shunt machines, no attempt being made to make them self-regulating, as it has been found in actual practice that managers of central stations prefer to have the machines so that they can only be regulated by hand. Brushes are carried by a large yoke, which is supported, in the 400-kilowatt machine, by lugs fastened on the frame, and proper mechanism is attached so that the yoke may be rotated to permit of simultaneously adjusting the brushes at the neutral points. When assembled in position the floor space occupied is 37in. lengthwise by 181in. in width, the diameter of the frame itself being 154in, and the height above the floor-line 107in., and its approximate weight is 54,400lb., while its output is 2,960 amperes at 135 volts. The diameter of the engine shaft where it carries the armature is 14in. The armature is forced on to the shaft, the core of the armature being just enough smaller to make a good forcing fit, and after it is home in place it is keyed up so as to practically become an integral part of the shaft.

The Armature.—The hub of the armature is made of a fine quality of cast iron, on the exterior periphery of which is mounted the spider proper of the armature, which is made of non-magnetic metal, and has twelve arms which dovetail into the core, this latter being made up of thin sheet-iron discs carefully insulated one from another, and separated every three or four inches by an air space of about half-an-inch, for the purpose of permitting the air to circulate through the windings and core for keeping down the temperature. The armature in motion acts something like a centrifugal fan, causing the air to be forced from the interior towards the exterior through these ventilating ducts. Were it not for this feature the output of the armature would necessarily be considerably reduced, owing to the rise in temperature. The windings are made up of heavy copper bars, which are increased in depth on the ends of the armature to form what are known as face commutators, and are spaced about one-eighth of an inch apart by means of wooden spacing blocks, so as to admit of a circulation of air, while the bars forming the commutator are carefully insulated from each other by mica. The body of the armature is very carefully insulated with alternate layers of mica and tough paper to a thickness of about one-eighth of an inch, and the bars themselves are very carefully insulated before being placed in position, so that double insulation is provided throughout. After the winding of the armature is completed, it is then carefully bound with heavy German silver wire so as to hold the windings in position; then the commutator faces are turned off true and smooth and the armature is ready to be tested. The test through which one of these large machines has to go is very elaborate. Careful note is taken of the temperature of fields and armature during and after a ten hours' run, and again after a 24 hours' run, and readings taken of the voltage and ampere output of the machine every few minutes, as also readings of the amount of current it takes to excite the fields. Should any fault develop during the test, the machine is stopped, and the fault remedied and the test started over again, and is continued until the machine meets the specifications in every particular. The manufacturers of electrical apparatus are continually striving to perfect their methods of manufacture so as to produce a machine which shall be free from both mechanical and electrical defects, and one in which the purchaser can put the utmost confidence. Particularly is this the case with large units, because, if anything should happen to one of these while running in a large central station, it would be known to many and would do much to injure the reputation of the manufacturer.

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* Abstract from the *Electrical World* of New York.

Last, though not least, of what may be said in favour of the use of these large units, is the much better appearance which a station has that is equipped with these over one having a multitude of small machines running from a counter shaft with the attendant noise and confusion incident to such a system. We have not entered, to any extent, on technical reasons for the adoption of these large units, mainly because technicalities only appeal to the engineer. The question as to whether or not a station should adopt such units comes down largely to a matter of dollars and common sense, and, as both of these are on the side of the large direct-driven unit, we may feel fairly safe in assuming that now that their introduction has begun, and they have found favour with the public, it is only a question of time when all of our large stations will adopt them.

SOME CONTINENTAL ELECTRIC SUPPLY STATIONS.*

My three weeks' holiday on the Continent and my visits to several central stations both in Belgium and Germany have not only been of the greatest interest, but the information I obtained and the many departures from English practice I saw must necessarily be of the greatest importance to me. The sameness and repetitions of the various plants that one meets in English central stations cannot be said of those I visited abroad, everyone of which has some special feature of its own and entirely different systems. Their design and general arrangement is so absolutely different to anything one sees at home that new ideas and principles are to be picked up at every electrical works. Every German manufacturer of electrical plant appears to be represented by a central station, which gives him ample opportunity of exhibiting his plant and sundries to his own good advantage and that of intending customers; in fact the station is a permanent exhibition for the contractors, who are constantly adding their latest improvement, and thus keep the stations up to date.

But in all the stations the same principle of slow speed engines, low tension current, water tube boilers, jet condensers, and no automatic stokers was very marked, the very reverse of English practice, with high-speed engines, high voltages, and high-pressure steam. Only at Cologne did the dynamos generate a higher pressure than 200 volts, and this was the one station I visited running on the high-tension alternating system, although the remainder had just as large areas to supply, and which in England would be fed from a generating station with 1,000, 2,000, or even 10,000 volts.

The worst feature of Continental electrical work is undoubtedly the house wiring and street lamp connections. It is a common thing to see the wires in houses fixed by iron staples, or, if the work is supposed to be done extra well, silk-covered flexible wire is used and twisted round small porcelain insulators screwed into the walls and ceilings. Telephones, bell and electric light wires hang round columns and porticos like spider webs, mixed up and twisted together. The result is that it is a common occurrence to see large sparks issue from a bell push.

The leading-in wires to the street arc lamp posts hang about in most cases like festoons in a most unsightly way, the only feature (and an important one) in their favour being that the lamps can be lowered for trimming. In narrow streets the lamps are hung in the centre of chains which are attached to two houses on opposite sides of the street, and in one case I noticed a large market-place about 150ft. square, lit by two arc lamps, which were suspended from a steel wire rope, stretched across the square and fastened on one end to the platform round the tower of the municipal buildings and on the other end to the top floor of an hotel, the span being at least 200ft. The lamps hung in the middle of the steel wire on a pulley, and to trim them the leading-in wires were used for hauling the lamps into the hotel. In Brussels, opposite the railway station, there are eight arc lamps about 30ft. from the ground, illuminating a large square. The lamp-posts are hinged in the middle, and, by drawing a bolt, the top part of the post falls over to a position rather less than a right angle to the base of the post for trimming purposes. These and many other instances tend to prove that practicability is more the rule than sightliness. Earth leakages must abound, and the absence of a body like our County ever Council is taken advantage of; in fact, I did not hear of wiring being done to fire office rules. And yet the stations were running splendidly, and had been doing so for several years, in one case for 10 years, without any serious breakdowns resulting therefrom. A short description of those I was able to visit may be of interest.

Antwerp.—The station proper is one for generating a high pressure water supply, which is distributed in a suitable manner at a pressure of 700lb., to feed turbines in the sub-stations. These drive continuous-current low-tension dynamos direct, and buildings in the centre of the road, similar to our cab shelters, indicate the position of sub-stations. They are started up as the load demands, and are in themselves fitted up as small central stations. During light loads, the current is distributed from accumulator sub-stations into one network of mains. The exhaust water from the turbines flushes the sewers. I was not able to obtain any figures as to the cost of working this system, but to judge from the apparently flourishing state of affairs and the general appearance of the plant, it cannot be a failure. At Frankfort-on-Main a similar station was started some years ago; but owing to its small dimensions and the scarcity of water, as compared to Antwerp, it was replaced by a steam plant.

At the Exhibition there was nothing of very great interest or novelty to be seen as regards electrical matters, everything being on the usual Exhibition style. The machinery department was well filled, and some fine and also very extraordinary plant was on show. All power transmission was done by electricity.

Brussels.—English engineers greeted us at the works, the Silvertown Company being the contractors. The distribution of current is on the three-wire system with accumulators. Slow-speed compound engines, driving moderate-speed dynamos by ropes in such a way that one engine drives the two dynamos necessary for the three-wire system. The accumulators supply the current required for light loads.

In this town I also had the opportunity of seeing traction by electricity. The current is sent into the overhead wires at a pressure of 500 volts, and an earth return is used. The cars run at a speed of 12 miles an hour, chiefly in the direction of Waterloo, but as soon as they leave the town proper a speed of 16 miles per hour is allowed. A six-mile drive on the electric trains after one is accustomed to horse trams is quite delightful.

Cologne.—This is the only station I visited the working of which was similar to our English stations. The water works and electric light works occupy one site, and practically one staff works them both. Each has their own set of boilers, but only one battery is used at a time, which is sufficient to run both works. The other battery of 10 water tube boilers is, therefore, spare.

The water works gives her neighbour water for condensing purposes, which is filtered after being used, and sent into the water mains for drinking purposes. The pumps are worked by huge beam engines, magnificent specimens of engineering work; but small work, especially fitting shop tools, are driven by alternating-current motors, and by the current borrowed from the electric works.

Briefly, the two concerns work hand in hand. The engine house of the Cologne Electric Works is very fine indeed, the slow-speed engines of 500 H.P. (of which there are four) coupled direct to alternators doing their work so quietly at a speed of 95 revolutions per minute. Money has evidently been no object in the erection of these works, the fittings and general arrangements being of the finest, and spare plant galore. Any one of the four engines would run their present top load, viz.; 400 kilowatts (about 13,000 8-c.p. lamps) at a pinch, and then, besides this, they have a complete spare battery of boilers, as already mentioned. About 20 H.P. is taken up in small motors (Brown-Boveri type), but they are not a success, as they will not start with any load. I tried this on their fitting shop motor, which refused to move unless the belt was on the loose pulley.

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* Report presented to the Directors by Mr. G. F. Metzger, electrical engineer to the Bath Electric Lighting and Engineering Company.

The secondary current in the houses is arranged at a pressure of 72 volts, the idea being to be able to run two arc lamps in series off this pressure, as German arc lamps work theoretically at 36 volts. I could not discover how the arrangement worked in practice. The contractors evidently reap the chief benefit, as they practically have the monopoly for supplying the transformers. The transformer losses work out at 35 per cent. per annum worse than our Bath record. The only figure I could obtain as regards the cost of coal per unit was that it amounted to almost half the total expense for generating a unit. This applies also to the remainder of the stations I saw. I left Cologne greatly impressed with the magnificence of the central station, and ventured to hope that the quantity of spare plant was not due to non-reliability of the working. They were certainly on the safe side.

Dusseldorf.—Here I saw another continuous-current station, but worked on entirely different lines, also with the object of being on the safe side. Slow-speed engines were coupled direct to the dynamos, which charged accumulators in various sub-stations in the town. No lighting whatever is done direct from the machines but from the accumulators. The station is situated about two miles from the town, and to light up the engine room when the engines are shut down the current is brought back from a sub-station through the cables used for charging. The station and plant is beautifully got up and a regular German Corporation job.

Frankfort.—We arrived here after a drenching trip up the Rhine, and immediately went for the central station. This is still building, and no admission was granted. The Corporation have been considering the electric light question too long, and the result is that there are about eight central stations driven by gas engines, all of the "Otto" type. As the authorities will not allow anybody but themselves to lay electric cables in the streets the public were obliged to confine themselves to small districts for supplying themselves and their neighbours with current. Thus the thicket centres have their own supply on the low-tension and accumulator system, and as the stations are very nicely fitted up and with a look about them that they have come to stay, the Corporation have a poor look out for the supply of current to the best quarters, and those likely to be the largest and best consumers.

I was told that the Corporation station will eclipse all other German stations, and all manner of new things will be introduced to the electrical world. We then made our way to a suburb of Frankfort called

Bockenheim, which abounds in factories. Pleasure resorts, large shops or places of amusement, are altogether unknown there, so that the supply of electricity for lighting purposes was a minor consideration when a central station was contemplated, but a cheap and simple system of current for electromotor work was an absolute necessity if a station was to be built at all. Ordinary low tension or three-wire system was out of the question, on account of a space for the station within the township being unavailable. The site of the station is outside the town, and Lahmeyer and Co.'s combined multiphase continuous-current system overcame the difficulties, and united the local conditions and requirements admirably. The multiphase current is generated at a pressure of 80 volts, and passes then into the step-up transformers placed in the engine room. In these the pressure is increased to 660 volts, and the current is distributed to the various factories at that pressure. The multiphase motors start at full load from 4 H.P. to 20 H.P. Altogether, the factories of Bockenheim are taking 300 E.H.P. of multiphase current from the station, and have shut down their own steam plants.

But the station is also equipped with a low-tension continuous-current plant, which supplies the small amount of lighting required, and also the small motor work below 4 H.P., charges the large accumulators during the day time, and also excites the field magnets of the multiphase machines. The streets are lit electrically by arcs and incandescents, and small sub-stations are provided with continuous-current step-up transformers to make up the drop in pressure. At 11 p.m. the station is shut down and all lighting is done off the accumulators until the factories commence working. The station is extremely compact, and the system an admirable one for the class of supply it has to meet. After a stay of a day or two in Frankfort we made our way to

Berlin.—The town swarms with electric lamps, and although the five central stations are owned by a company, which, however, has to pay the Corporation 10 per cent. of its profits, electric lighting has undoubtedly the monopoly. No builder thinks of laying gas pipes in his new houses, and it is self-understood that the tenant will want electric light. The electric light company is practically the Allegemeine Elektricitats-Gesellschaft, and was started in 1884. They have been going ahead to such an extent that at the present moment 205,000 16 c.p. lamps are connected to the main, besides 1,500 H.P. in electromotors. They pay a dividend of 10 per cent. per annum, and I was led to believe that any earnings above that amount go to the Corporation. As this body already receives 10 per cent. the remainder of the profit is given to the staff as extra salaries or bonuses. Everything is on a huge scale, especially the arc lighting of the well-known street leading to the Imperial Palace, and called "Unter den Linden."

This is a boulevard, and three rows of arc lamps in parallel with about 150 lamps in each row give a wonderfully fine effect, especially when viewed from the Friedrichstrasse, which is about the centre of Unter den Linden. All these arcs are run two in series, each lamp taking 20 amperes, so one can imagine the size of the cables. All the central stations are on the same principles, have the same type of plant, and feed into one network of mains. The aggregate horse-power of the whole of the station is 15,370.

We visited the station in the Mauerstrasse, where there are four engines driving eight dynamos, each dynamo giving 3,000 amperes. The dynamos are the well-known Siemens machines, with commutators of several hundred segments 6ft. 6in. in diameter, and which act as flywheels. I witnessed the switching in parallel of two machines, and the whole process, with one engine standing idle, running her up to full speed and switching in the dynamos only took 20 seconds. The switching arrangements are perfect, and altogether the station is the finest I ever had the pleasure of seeing. We also visited the works of the Allgemeine Elektricitäts-Gesellschaft, where 3,500 hands are employed, and where everything of an electrical nature, from a fuse to a 3,000-ampere dynamo, is manufactured. We saw dynamo-building, cable-making, incandescent and arc-lamp manufacture, instrument-making from a detector to the most delicate dynamometer, "Stabilit" iron and brass casting, testing, &c., which was of the highest interest. The day we stayed in the factory was, indeed, well spent. We left Berlin with the impression that one can never leave off learning in the engineering profession, and wended our way as happier and wiser men to

Hanover, which boasts of a very compact central station, designed and constructed by Messrs. Schuckert and Co., of Nurnberg. Two 350 and one 550-H.P. triple-expansion slow-speed vertical marine engines drive three very large continuous-current machines direct at a speed of 120 revolutions per minute. The distribution of current into the town is on the three-wire system; but, unlike other stations of this kind, one dynamo only is required to feed the three wires. The machine pressure is 200 volts, and the current from the dynamos is fed into the two outer conductors only, whilst the pressure and current in the middle or central wire is balanced and fed from accumulators, which are also large enough to supply the current to all wires during light loads. Like other parts of Germany, water is very abundant here, it being found at only a few feet from the ground surface. Jet condensers are in use, and the water is purified before entering the boilers by a very elaborate water-softening process. Anthracite coal is used in the boiler furnaces, but I could not discover with what results.

FLEURIAIS' ELECTRIC LOG.*

Much has been heard of late with regard to the electric log devised by Rear-Admiral Fleuriais, and the following description may be of interest. Admiral Fleuriais will have nothing to do with logs actuated by means of propeller-like screws; the indications of these, he says, change enormously for inappreciable deformations of the screw-blades, which, moreover, it is almost impossible to restore to their original shape. Again, in the case of a screw, the angle of impact of the water being very oblique, the motion of the particles is very rapid, and the result is that the slightest variation of the passive resistances has a great effect upon the speed of rotation of the log. For this reason Admiral Fleuriais has adopted the anemometer type of vane. Recollecting that Mr. Robinson had experimental proof from locomotive trials that the speed of translation of the centre of the cups is always sensibly proportional to the speed of the wind, Admiral Fleuriais thought it possible that this law would remain true in water, and to this end he carried out experiments on board the "Magicienne," and accurately verified the fact. Admiral Fleuriais also gave up the idea of placing the moving and electrical parts of his apparatus inside water tight boxes.

In the first type of log the mill M (Fig. 1) carried a split roller one-half of it being copper, and the other half insulating; the insulating material used being either bone, ivory, or lignum-vitæ. A spring R, lared at the end pressed on this wheel, and as the mill rotated was successively in contact with the copper and the insulator. The spring R was connected by means of an insulated wire F to the negative pole of a battery and to a bell on the ship; the return circuit being viâ the hull and the water. When the log was thrown overboard a current passed; but owing to the small conducting surface exposed to the sea water as long as the spring R was in contact with the insulator the resistance of the circuit was so high that the current was very small. When, however, the spring R pressed upon the copper conductor C the whole of the metal frame of the log was in circuit, the resistance was greatly reduced, and a larger current flowed, ringing the bell on board ship, each revolution of the mill causing the bell to make one stroke, and by means of a sand glass these strokes were counted. In the first type of log the time taken by the sand glass to empty was almost precisely equal to the time taken by the mill to make ten turns when the ship was going at the rate of one knot, so that if 84 strokes were made by the bell the speed of the ship was 8·4 knots, and so on. The tow rope consists of a four-strand cable, one consisting of an insulated electric conductor, which contained seven thin wires. The perfect insulation of the electric cable is, it will be seen, in a log of this pattern of the utmost importance.

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* From *L'Electricien*.

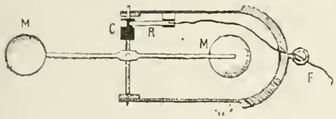

Fig. 1.—Fleuriais Electric Log. Early Pattern.

The difficulties of counting the bell strokes, however, foreseen by the inventor, became even graver than he had anticipated when high speeds were attained. Above 12 knots it was impossible to count even approximately the number of strokes. This led Admiral Fleuriais to gradually modify his device. In order to make the apparatus more powerful he doubled the number of vanes, using eight cups instead of four, as shown in Fig. 2. The central portion of the axis A B of the mill M is provided, it will be seen, with a worm which engages with a 72-tooth wheel, which carries on its axis a contact maker, D, provided with three conducting pieces, upon which presses the silver tip of the spring R, which is along its entire length well coated with Chatterton. The end of the spring is connected to a conductor which is contained in the interior of a rectangular tube, and connected to an insulated cable. The mechanism of this type of log is enclosed in a bronze box with holes in it so that the water can get in, but sheltering the mechanism from damage by contact with marine flotsam and jetsam. By the advice of M. de Maupeou, Director of Naval Construction, two bent flukes, L, were affixed to the log to cause it to sink. In this form of log there is one bell stroke per turn of the mill, and a speed of 20 knots can be registered with ease. The log has been tried on several warships, the "Roland," the "Wattignies," the "Dupuy de Lôme," the "Davoust," &c., &c. The results have been so good that Admiral Fleuriais is in hopes that his electric log will render unnecessary the recourse to measured-mile trips for the purpose of ascertaining contract speed. It must be mentioned, however, that with the speeds now attained by cruisers and torpedo boats—that is to say, 18 knots and more—the log comes too much to the surface; so much so, indeed, that the cups of the mill are often out of water. It would, of course, be possible to put a snout at the end of the log so as to insure a constant immersion; but in practical navigation such a course would have many inconveniences. Admiral Fleuriais is still at work perfecting his apparatus.

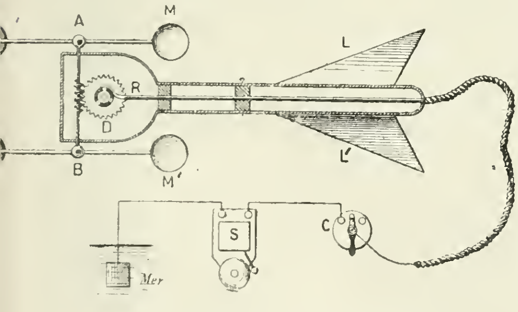

Fig. 2.—Fleuriais Electric Log. Latest Pattern.

THE MUNICIPAL CORPORATIONS ASSOCIATION AND THE DRAFT AGREEMENT.

DEPUTATION TO THE POSTMASTER-GENERAL.

On Thursday last week the Postmaster-General received a deputation from the Association of Municipal Corporations in reference to the draft agreement with the National Telephone Company. The Postmaster-General was accompanied by Mr. Spencer Walpole, Secretary of the Post Office; Mr. J. C. Lamb, C.B., C.M.G., of the telegraph branch; Sir Robert Hunter, solicitor; and Mr. A. M. Ogilvie and Mr. Burrell, private secretaries. The deputation consisted of representatives of the following corporations: Dover, Liverpool, Leeds, Norwich, Nottingham, St. Helens, Salford, Southport, Wolverhampton, and York.

Sir SAMUEL JOHNSON (Town Clerk of Nottingham) said that Nottingham had a very ample instalment of telephones, the National Telephone Company having been established there for many years, and having now about 1,200 or 1,300 instruments working. The system had worked admirably in Nottingham, and they had no complaints whatever to make against the Company.

Mr. HARCOURT CLARE (Deputy Town Clerk of Liverpool) said that their primary object was to offer on behalf of the Corporations of England a respectful protest against the Post Office entering into the contemplated agreement with the National Telephone Company, by which that Company would be enabled to go to each corporation individually and ask that corporation to give its sanction to the exercise by the Company of compulsory powers over property and over streets. Those powers ought not to be conferred on any company except accompanied by statutory obligations with regard to the conditions under which they should be exercised, and with full statutory protection to owners of property and the public against the oppressive exercise of the powers. The particular paragraph to which he referred was No. 11 of the Draft Agreement, which stated that:—"The Postmaster-General will from time to time, at the request of the Company, authorise the Company to exercise within any exchange area specified by the Company all such powers of executing works (other than works under, in, upon, over, along, or across any railway or canal) as are conferred upon the Postmaster-General by the Telegraph Acts of 1863 and 1878; and by Section 2 (but not by any other section) of the Telegraph Act, 1892." When the late Postmaster-General, Sir James Ferguson, introduced the Bill of 1892, the Council of the Association passed a resolution to the effect that no legislation should be sanctioned which proposed to authorise the exercise of statutory powers by the licensees of the Post Office until the conditions under which the works were to be constructed and maintained and the obligations with regard to supplying telephonic facilities to the public had been defined by statute. They had maintained that principle up to the present time, and they still thought it the right one to follow. Unfortunately, the Corporations gave way to the pressure that was put upon them not to oppose the Bill of 1892, on the conditions that the corporations should have an absolute veto against the exercise of any powers within their area, and that if they did give their sanction to the exercise of such powers it should be subject to such conditions as they might think fit to impose. The Association, in their communications on that Bill, gave the department, he thought, very clearly to understand that they strongly objected to clauses 5 and 6 of the Act of 1892, and that they only consented to withdraw their opposition provided that they had what they considered the power of rendering the Act, if it passed, a dead letter, so far as they were concerned.

The POSTMASTER-GENERAL said that was not the view of all the corporations, for he understood from Sir Samuel Johnson that there had been cordial co-operation between the Corporation of Nottingham and the Company.

Sir SAMUEL JOHNSON said that the arrangements between the Corporation and the Company were most satisfactory, and there had not been a single complaint; but the Corporation were acting under a private Act of a most stringent character.

Mr. HARCOURT CLARE said he was not suggesting that they had had any difficulties, in Liverpool for instance, with the Company: he was simply referring to the principle of the Act and its effect, if enforced, throughout the country. After the Act was passed they became aware that negotiations were going on with a view to the acquisition of the trunk lines by the Post Office, and they had good reason to suppose that the Company placed considerable importance upon obtaining authority to exercise the powers under the Act of 1892. They therefore asked for an interview with the Postmaster-General in order to explain their strong objection to the Act; but, unfortunately, his engagements prohibited him from affording them an interview, and accordingly the special committee had made a report in which occurred the following paragraph:—"Your Committee are strongly of opinion that it will be most unsatisfactory to the corporations and the public generally if the Telephone Company acquire any statutory powers under the Act of 1892, and they recommend that no consents be given by the municipal corporations under that Act. If it should ultimately become necessary to confer further powers on the telephone companies, then your Committee recommend that the whole of the powers to be granted and the restrictions and obligations to be imposed should be embodied in an Act of Parliament." Unfortunately, as he understood the agreement, so far as the draft was concerned, had been finally settled, and it was now a little late, perhaps, to discuss the question, but he wished to point out that this had not been the fault of the corporations. The Act provided that the Postmaster-General could empower the licensees to exercise the power of the Telegraph Acts of 1863 and 1878; but that, so far as the areas of the corporations were concerned, they must first of all obtain the consent of the corporations, and that that assent could be withheld or given on such conditions as the corporations might think fit to impose. It might be asked why, if they could withhold their consent, or give it upon such conditions as they thought fit to impose, had they such a strong objection to the Act? He would reply that if the powers under the Act were conferred on the Company, the Company then would be placed in the position of approaching each corporation individually, and the effect would be that, supposing a corporation withheld its consent, either because it was not in a position to form an opinion as to what conditions ought to be imposed, or because, if it did attempt to impose them, they could not practically be enforced, then the Company would, no doubt, use its influence to agitate the public mind against the corporation, and individuals who wanted to have the telephone supplied would be told that the corporation stood in the way. So that the public mind would be worked up to compel the corporation to give their consent, although the corporation with their fuller knowledge of the details would, if left to their judgment, withhold it. The corporations would be in an unfair position as compared with the Company in negotiating the terms. The Company have a complete knowledge of the whole subject; but, on the other hand, the corporations could only have a very limited knowledge, and they had no power of getting a more detailed knowledge except through the Company, which would give them just such information as they thought fit, and no more. He would take two points of the greatest importance which ought to be imposed upon the Company if these powers were granted; one was that the maximum charges should be fixed, and the other that the maximum dividends should also be fixed, subject possibly to an upward sliding scale for dividends proportionate to a downward sliding scale for charges.

The POSTMASTER-GENERAL: Would that maximum scale apply to all over the country?

Mr. HARCOURT CLARE said it would not necessarily apply throughout the country. The question of what the maximum charges and maximum dividends should be, could only be ascertained by a Committee of the House empowered to inquire into the whole subject, and to take evidence from all parts of the country. The maximum charges and the maximum dividends could not be fixed without having regard to the financial position of the Company, the cost they were put to for way-leaves, and the construction of works, and so on. That ought to be laid down by some general Act of Parliament, and could not be settled by each corporation individually. Suppose, for instance, that Liverpool fixed the maximum dividend at 5 per cent., Birmingham at 6, Manchester at 4, and somebody else at 4½, how could the thing be carried out by those separate agreements? Then there should be provisions putting the Company under the same obligations to supply as gas and water companies are put under. Such conditions, if made by a corporation, would be very difficult to enforce, and the individual who felt himself damnified because the Company had not complied with any of them, would not be able to proceed against the Company himself, but would have to come to the corporation, which would have to act as a sort of intermediary between him and the Company. This was a position that corporations ought not to be placed in; it gave them work that they ought not to have to do, and rendered them liable to expense which they ought not to incur.

The POSTMASTER-GENERAL asked whether there might not be provisions in the agreement giving an aggrieved individual facilities for approaching the Company direct.

Mr. HARCOURT CLARE said that he did not think an agreement between the corporation and the Company with regard to these matters would be capable of being enforced by an individual with the same facility as if conditions were imposed by statute. The deputation admitted that further powers ought to be conferred on the Company if the Government were not going to take over the undertaking themselves. They had no desire as Corporations to hamper the development of the telephone undertaking, which they recognised was an integral part of the commercial life of this country: their desire was to see it developed and constructed under the most favourable circumstances, in order that it might be supplied at the cheapest possible rate. They agreed that it was necessary to confer powers on the Company to enable them, amongst other things, to avoid the blackmailing for way-leaves which they were now subject to; but they thought that the statute conferring those powers should clearly define the concessions which the Company were to make in return. The Company, which had only 19 years or so to exist, must, for its own protection, include in its charges a calculation which would enable them to put by a reserve fund. If they had not to do that they might be able to make a very considerable reduction in their charges; but, under present circumstances, towards the termination of the period the Company could not afford to spend additional capital in further developing the telephones. He suggested whether a statute might not be passed giving the Company all the powers they wanted, and, subject to the conditions he had already pointed out, and giving them practically a continuous existence in the same way as a gas company, with a provision that the Government should have power at any time, upon notice, to buy the whole undertaking as a going concern on paying something like 25 years' purchase of the Company's *bona fide* income. If the Postmaster General could see his way to deal with the matter under a general statute, he could assure him that he would have the hearty support of all the corporations of England in endeavouring to make an Act which would both improve the telephone system and give ample protection to the public.

Mr. ALDERMAN HUGHES (of Liverpool) said they had not very much to complain of the Telephone Company, except as to charges. Under the Draft Agreement by which the trunk lines were to pass into the hands of the Government, and all communication between one city and another could only be made through the local post office, it was certain that there would be much delay by reason of the increased connections that would have to take place before one customer was in communication with the other, although the delay, as the service was now conducted, was almost at times such as to make it impossible to make use of the telephone in any satisfactory manner. It looked on the face of it as though there were to be some attempt to increase the charge, because, so far as they could read between the lines the Government were anxious to get hold of some portion of the revenue accruing from the service. That was only natural perhaps; but if that extra charge was to fall upon the traders of the country, it would lead to a very serious agitation.

The POSTMASTER-GENERAL, in reply, said: I am afraid there was a misapprehension as to the postponement of this deputation, which was referred to by Mr. Clare, the only reason for the postponement being that I wanted the corporations to have full information before they came to lay their views before the Department. Mr. Clare seems to infer that in the meantime an agreement has been come to; but the agreement was made in July, 1892. It was an agreement signed by Sir James Fergusson on behalf of the then Government, and by the Chairman of the two great Telephone Companies, the National and the New. It was necessary to embody the heads of arrangement into a formal legal document, which is the document I laid upon the Table of the House at the end of last session, and which probably will come up for discussion, I hope, in the early part of the coming session. There have been one or two references to the question of the purchase by the State. I think we who are connected with the Post Office must consider that a compliment to us, because it is evidently the opinion of gentlemen of great commercial experience like yourselves that if the Post Office had the management of the telephone service, it would probably be more satisfactory than it is under a Company. I should be the last to dispute that proposition, but I am bound to say, with the experience of the purchase of the telegraphs, the Government is not prepared to enter into the compulsory purchase of the telephone system from the companies, who—rightly or wrongly, and upon that I express no opinion—have been created the licensees of the Post Office for the purpose of carrying on telephonic work. I cordially agree with the remark that the question should be viewed from an imperial and not from a local point of view. I think that the fact that the telephone is after all, part of the telegraphic service of the country, and has been so settled by the courts of law, alone proves that this matter ought to be—in the interest of the commercial classes—looked at from the broad point of view of the whole country and not from the local point of view of any particular town or district. But I am afraid there is some misapprehension with regard to one or two points which I think this deputation, and the discussion which we may have, may have the effect of removing. In the first place, we are not now dealing with a new licence. These companies were licensed many years ago, and the proposal which was considered, and the arrangement which was entered into in 1892, was not to take away a licence which had already been given, but was to make a new arrangement, which was the result of negotiation between the companies and the department; and it is not, strictly speaking, a new licence which would be given them under the agreements. That is one misapprehension because the gentlemen who have spoken, with great ability and knowledge of the subject, appeared to think that we were beginning a new arrangement with the Company, and that we could impose what terms we liked. The companies have those licences, which are continuing licences for 17 years; and it would be contrary to the public policy of this country to revoke a licence which has been granted until it expires by the effluxion of time; and we have no right and no power, and I venture to think that Parliament would hesitate before it imposed upon a company to whom the Government have granted a licence, conditions, against their will, which were not in the licence when it was originally granted. And, therefore, we have no power to impose conditions upon the National or New Companies (or for shortness I may mention only the National Company) with regard to either maximum charges, or the equality of charge without their full consent during the continuance of this licence. Then I know Mr. Clare would say, "If you are going to confer new powers upon them you can make it a condition that they should agree to certain proposals such as those of maximum charges and of equality of treatment." But it is late in the lay for us to discuss that question, and it would have been late in the day if the deputation had come up to see me in the course of 1894, when they first proposed, because the agreement was actually entered into in the year 1892, before I had any connection with the department; that is to say, before the general election of 1892 in the month of July. Now, I want to put before you one or two points with regard to these proposed agreements. What is the policy which was decided upon in July, 1892? The policy was that the Post Office should take over the trunk wires of the country, not merely because it was thought that the policy would facilitate the carrying on of the telephonic work, which up to that time had been practically confined to the existing companies, but because it was intended (and that was part of the arrangement submitted to Parliament) that the department should extend the system of trunk wires, probably at a much more rapid rate than the companies would have been willing to do had the whole work been left in their hands. Therefore, I think you gentlemen who have spoken of the great advantage of the telephone system to the commercial world will recognise that that part, at all events, of the agreement will be of substantial advantage to commercial men, because it undoubtedly will lead to a development of the trunk wire system, and therefore to the granting of fresh facilities to the telephone using public. That was one part of the agreement, and that necessarily led to the curtailment of the areas—the restriction of the areas—in which the companies carried on their business. These matters were the subjects of a very long discussion between the companies and the department; and, as I say, the Government had no power to carry out, and I venture to think Parliament would have hesitated to have carried out such an arrangement against the will of the companies to whom the licences had been granted, licences which extended to the whole country. The result of those negotiations was that upon certain terms—first with regard to price.

secondly, with regard to those increased powers which the companies were anxious to obtain the companies agreed to hand over to the Post Office the whole of the trunk wire system of the country. Now, what is the objection to the granting of those powers which are now possessed by the Postmaster-General, and which under the agreements will be possessed by the companies. The objection, or the suggested objection, is that the corporations of this country will not be able to make satisfactory terms with the companies, and they would prefer that Parliament should intervene and settle the matter by a Committee of the House of Commons. If the Government had proposed in 1892 that Parliament should settle this matter, I confess I should not have been surprised if the corporations had come up and protested against Parliament taking out of the hands of the local authorities the right to settle in each area what they considered was necessary from the point of view of the people who resided in that particular area; but that the corporations should object to our giving full and ample powers to the corporations; that they shall have the absolute power of settling this question according to their own needs, I confess, astonishes me very much indeed. I am a great believer in corporations, and I am confident that Sir Samuel Johnson does not agree with that view, that the Corporation of Nottingham, at all events, would not be thoroughly competent and able to deal with this question, and to extract from the National Telephone Company and from the Post Office also, if they came into a controversy with the Post Office—fair and seasonable terms upon this or any other matter that might be in conflict between those two bodies. If the corporations and municipal authorities in the country consider the question from this point of view, I believe they will come to the conclusion that after all the decision which was arrived at in 1892 was a wise decision. The words of the Act are—"Notwithstanding anything in the Telegraph Act, 1878, a licensee shall not exercise any powers under the said enactments without the consent in London of the County Council, and in any urban sanitary district outside London of the Urban Sanitary Authority, and elsewhere of the County Council, and shall be subject to any terms and conditions which the County Council or Urban Sanitary Authority may attach to any consent, and shall comply with any regulations of such Council or Authority from time to time in force in relation to telegraphic lines." Though the Postmaster-General would have an appeal, the power which he confers upon the Company is absolutely subject to the veto of the Local Authority, and the Company would have no appeal from its decision.

Mr. HARCOURT CLARE said he agreed with the Postmaster-General's construction of the Act; but his point was that they were not in a position to formulate the conditions, and that if they did formulate them they could not enforce them.

The POSTMASTER-GENERAL: I think the objection of the Town Clerk of Norwich is not a substantial one. There is no appeal from the veto of the corporation, and, therefore, I understand that he withdraws his objection to the scheme which is now before Parliament.

Mr. KENNETT said that was quite right. They had no objection whatever to the proceedings of the National Telephone Company. Up to the present time they had been very satisfactory: but they wanted to protect themselves from further difficulties hereafter.

The POSTMASTER-GENERAL: To go back to the point mentioned at first, this is not a new start which we are making. We have got to deal with a Company which has still a life of nearly 17 years, and we have got to make the best of a very difficult position. Whether the licence should be extended, whether terms should be imposed with regard to extension, may be a matter for consideration; whether ultimately (and that, I think, is the solution which probably will be the outcome, at some time or other, of this business) the State should take over the whole matter, that again, I say is a matter which ought to be very carefully considered. At the same time, and in view of what took place in 1870, when the telegraphs were bought, as I say, the Government are not prepared to consider even the question of compulsory purchase. We have got to make the best of the present position, and my own belief is that in the interests of the municipalities these agreements, when they are in operation, will prove, by the extension and stimulus they will give to telephone business throughout the country, to be a very considerable step in advance. We are already engaged in a very considerable extension of telephone trunk lines throughout the country, some of which are nearing completion, and others are in various stages of operation. If these agreements from any cause are not carried into effect we revert to the present system, or rather we shall continue the present system under which the National Telephone Company carries on the telephone business both in the municipalities and also in the rural districts. I cannot help thinking that it would be a retrograde step after the decision which Parliament came to in 1892. The policy was then very carefully considered. As I understand from Mr. Clare, the corporations in 1892 gave way if their absolute right of veto was retained. That has been loyally carried out by Parliament in the section which I have quoted, and I think the corporations would be acting unwisely if, in face of the decision which they arrived at that time, they were to give other than a friendly approval to the proposals, which, as I say, are not my proposals, but which were proposals of the late Government, which were agreed upon between the two parties, and which received the sanction of the House of Commons, both in the House itself and in the Committee to which it was referred.

Sir SAMUEL JOHNSON thanked the right hon. gentleman for his courtesy, and for the explanations which he had given, many of which he hoped the deputation would consider extremely satisfactory. At all events, they now understood better than before the exact position in which the Government stood with regard to the telephone companies, and especially with regard to the National Telephone Company. What had been said by the Postmaster-General with regard to the corporations undertaking the local work themselves deserved very serious consideration, which he trusted it would receive.

The deputation then withdrew.

THE ORIGIN AND DEVELOPMENT OF THE TELEPHONE SWITCHBOARD.*

BY J. E. KINGSBURY, ASSOCIATE.

The telephone itself has been the subject of various Papers read before this Institution; but the same remark does not apply to apparatus which has become allied with the telephone in its commercial applications. The most important of such apparatus is the switchboard used in exchange service. It is because this subject does not appear among your records that I have treated it in the manner indicated by the title of this Paper. To those who have been long engaged in telephone work such a title will not raise expectations of novel information, or suggest exhaustive treatment. To those who are not so engaged I can only hope that it may be of interest to the same extent that it is of interest to trace the development of any enterprise or apparatus.

The switchboard has been described as the brain of the telephone system. In seeking anatomical similes I hardly know whether to choose the brain, the heart, or the backbone. It is the brain, in so far that it is the nerve centre, all communications going through it; it is the heart, in that it is the life of the telephone system as we know it to-day; and it is certainly the backbone—of the exchange business.

The telephone, itself a marvel of simplicity, has become involved in a network of considerable complexity known as an "exchange system"—a means of inter-communication of which the switchboard is the centre piece. The exchange system seems necessarily identified with the telephone, but it existed before the telephone was invented.

I am indebted to American sources for the information that the first idea of exchange working is to be found in a British patent granted to an inventor bearing a French name. Mr. T. D. Lockwood says: "The first idea of exchange work which, to my knowledge, occurs in history, is found in a British patent, issued as far back as February 7, 1851, to F. M. A. Dumont. This clearly describes an exchange system of dial telegraph instruments, connecting by short lines with branch central stations, which branch stations were provided with trunk lines connecting them with a principal station." Mr. Lockwood remarks that "the idea was far ahead of the times."—(Tel. Con. Rep., 1887, p. 50.)

At Newcastle the Post Office arranged a system of connecting subscribers provided with Wheatstone A.B.C. instruments. In New York such a system was introduced in 1874 or 1875. The founder of that system was not aware that inter-communicating exchanges had previously existed. He had observed the success attending the telegraphing of stock quotations to subscribers, who each received identical information despatched from a central office, and he assumed that a like success might be obtained by furnishing information to legal firms as to the course of proceedings in the Courts. The legal firms did not take kindly to the idea, but one of them offered an alternative suggestion, intimating that a system which would enable lawyers to communicate with each other by telegraph would be worth paying for. Confirmation of this idea was obtained from others, and the result was the establishment of a telegraph exchange. As the exchange was exclusively used by legal firms, the company was called the "Law Telegraph Company." Telegraph instruments were subsequently replaced by telephones, and the particular system adopted for working the exchange became known as the "Law" system.

Notwithstanding that this telegraph exchange was already in existence at the time of the invention of the telephone in 1876, it was not until January, 1878, that the first commercial telephone exchange was started. In the meantime Bell's invention had been greatly improved, and shortly afterwards the introduction on a commercial scale of the Edison carbon transmitter and the Blake microphone placed telephony upon such a practical basis that its progress became assured. It was the microphonic era when was commenced that activity in telephone exchange work which necessitated attention being given to switching mechanism.

In addition to the public exchange system every large telegraph office was the centre of numerous lines which were connected together as required by means of a switchboard. Part of a well-known telegraph switchboard is illustrated here.† It consists of vertical and horizontal bars, the vertical bars being the lines, the horizontal bars providing the means of connecting any one vertical line with another by inserting plugs. The vertical lines terminate in springs resting on contacts. A telegraph instrument can be looped into circuit by a double-contact plug inserted between the spring and its contact. These springs were known to telegraphists as "spring-jacks." Those who started telephone exchanges, like all other founders of new industries, adopted, in the first instance, that which already existed, so far as it was, within their knowledge, available for their purpose. All the first telephone switchboards have been traced by competent hands to a telegraphic origin. Hence the origin of the telephone switchboard is the telegraph switchboard, with the addition of indicators already in use for signalling purposes.

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* Paper read before the Institution of Electrical Engineers.

† [Illustration not available.—Ed. *E.*]

It will be remembered that telephone exchange business was started almost simultaneously in London by two different organisations—the Bell and the Edison Companies. The Edison Company had an experimental exchange at No. 6, Lombard-street. It was publicly opened on September 4, 1879, with 10 subscribers connected. The switchboard then used formed the subject of the first specification for a telephone switchboard in the English Patent Office (No. 3,794, September 20, 1879). The drawings attached to that specification are here reproduced. The switchboard used by the Bell Company in their first exchange at 36, Coleman-street, was of a different character. The sketch shown is made from a photograph in my possession.* It is a rather curious circumstance that these two drawings, in addition to showing the first switchboards used simultaneously in English telephone exchanges, are also examples of two types of board, viz., plug boards and cord boards, of which there were several varieties. The "Edison board"—as it is called here, because it was used by the Edison Company is the upper part of the telegraph switchboard. The vertical strips are continuations of subscribers' lines; the horizontal strips are normally insulated from the vertical strips; but any vertical strip may be placed in electrical contact with any horizontal strip by placing a metal plug in the hole which is drilled at the point of intersection. Another plug similarly applied will place the same horizontal line into electrical connection with any other vertical line. Thus two subscribers' lines are connected together by means of a cross-bar and two metal plugs. There are no flexible cords whatever; even the speaking instrument is connected to a rigid bar. A different method is followed in the board used by the Bell Company, and consequently called here the "Bell board." The cross-bars remain, but the vertical bars are dispensed with. The subscribers' lines end in a spring-jack like the lower part of the telegraph switchboard, connections being made by means of flexible conducting cords having suitable plugs at each extremity. The one, therefore, is a plug board, the other a cord board; and for a while these two types provided the necessary material for the holding of opposite views amongst practical telephonists. The plug board was preferred because it was free from the liabilty of broken cords, had its construction and circuits readily traceable, and also, perhaps, because it was generally more in accordance with previous practice in switches. The cord board, however, had greater flexibility and possibilities of concentration.

Numerous varieties of plug board were made, differing considerably in appearance, but having exactly the same method of working. It is not possible for me, in the time at my disposal, to describe in detail the various differences. It will suffice to say that the general idea was the same; the differences were either in construction or in the method of connecting the vertical with the horizontal bars. In some the plugs were loose, as in the one shown; in others—as in those originally used, I believe, in Manchester and Sheffield—the connecting plugs slid over a rod with notches for each horizontal bar, and were held in place by a spring clip fitting into the notch. These are differences of detail, and need not now be considered. It is of more importance to trace the methods of operation.

In the Edison board it will be noticed that, whilst the majority of horizontal bars are free for use as connecting strips, two of them are appropriated for specific purposes. The seventh bar is connected to the operator's telephone, the twelfth bar to the earth. In order that each subscriber's line may be complete, so that the exchange may be called, the plug must be normally in contact with the earth bar. Where the fall of the indicator shutter shows that a subscriber is calling, the plug has to be taken out of the earth bar and set into the instrument bar. When the number of the subscriber required has been ascertained, the peg has to be again removed from the seventh, or instrument, bar and set into one of the other horizontal bars which may be unoccupied. The peg of the called subscriber is also removed from the earth bar and placed in contact with the horizontal bar already selected. The two subscribers' lines are then connected. No provision being made for ringing from the exchange, one subscriber calls the other. This act throws down both indicators, which the operator must replace.

In the Bell board, the work is divided between two operators. One does the switching, the other the talking with the subscriber. The switching operator connects the subscriber with the table of the talking operator, who, upon learning the number required, instructs the switching operator to make the necessary connections,

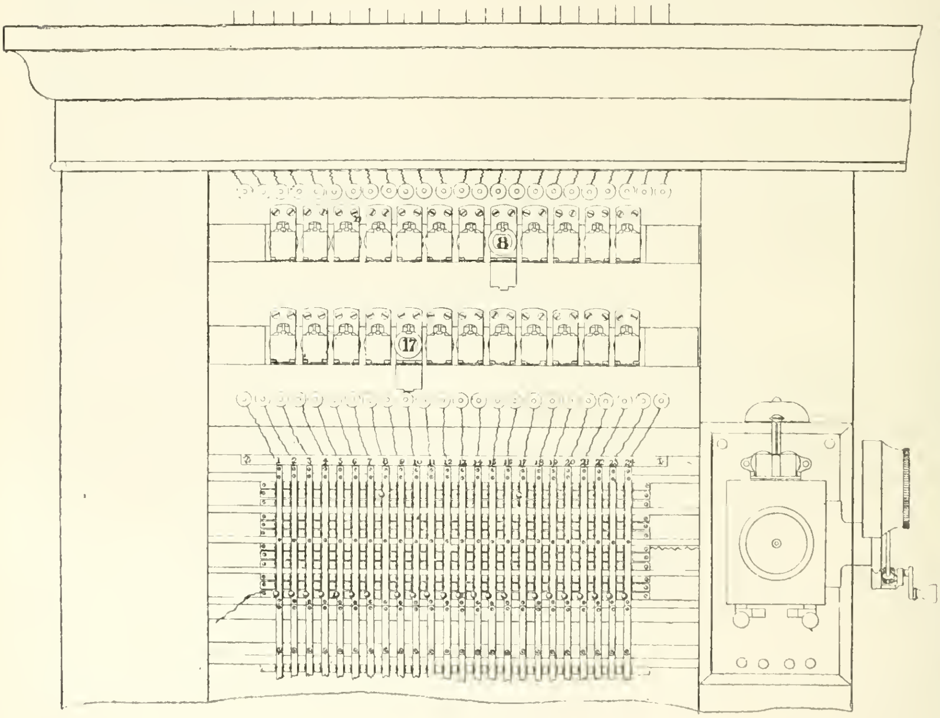

FIG. 1.

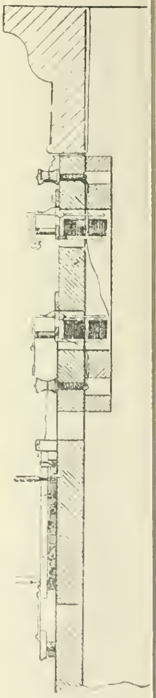

FIG. 2.

[* Illustration not available.—Ed. E.]

which he does with the flexible cords. Without detailing the various movements, it will suffice to draw attention to one point. The subscriber's line comes to a spring, and the spring rests on a contact. The contact is the earth. The plug with which connection is made removes the line from the earth, and that is one step in advance of the Edison board. A line needed to be broken and diverted. These requirements were separately met in the Edison board, whilst in the other case they were combined. In the development of telephone switchboards that is equivalent to making two blades of grass grow where one grew before.

The cord board offered facilities in this direction which the peg board did not. According to the Telephone Convention Report for 1883 (p. 33), plug boards were the most popular in 1881; there being amongst the companies reporting to the association 11,904 subscribers on plug boards, and 8,893 subscribers on cord boards. By 1882 the conditions were changed, cord boards having 16,799 subscribers, and plug boards 12,755. By 1883 the change was shown to have some substantial foundation, the figures being 21,432 for cord boards and 12,763 for plug boards. These figures do not refer to the identical boards illustrated here, but to all varieties of their respective types. They show that the intervening period was sufficiently active and exacting to have had some influence in deciding which was the fittest type of board for survival. That type was the cord board, and it may be desirable now to trace briefly the development of the most generally used form of cord board for small exchanges.

For this purpose it is necessary to call your attention to a patent specification which I think may be called a classic in this branch of invention. It is dated November 29, 1879, numbered 4,903, and granted to C. E. Scribner. In Fig. 1 is represented a board known as the "universal jack-knife switch." There are the indicators and the individual connecting springs for the lines as in the Bell board, but arranged in distinct groups, and there are the horizontal connecting bars also. Although there are these points of similarity, there are improvements over each. In the Bell board the line comes to the indicator first, then through the spring jack to earth. Inserting a plug into the spring jack cuts off the earth, but the indicator remains in circuit. Scribner cuts off both drop and earth in one operation by the simple device of putting the drop the earth side of the jack, so that both subscribers' indicators are cut out of circuit instead of both remaining in. This is another step forward. The horizontal connecting strip is also improved by being turned round when engaged.

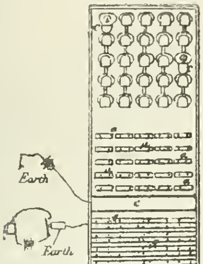

Fig. 1.

In connecting the two subscribers' lines together, two cords were used, as in the Bell board, each cord having a plug at either end, and the calling subscriber's line was connected to the revolving bar by one cord, and the same revolving bar connected to the called subscriber's line by the other cord. But, as both subscribers' indicators were cut out, some provision must be made for the reception of a disconnection signal. This switchboard brings us one more step forward in the inclusion of signalling apparatus in the connecting cords or bars at the central office. And I would invite particular attention to the way this was done, because I think that it has been overlooked by some writers on telephone subjects. To each bar an indicator was connected in derivation, one end of the coil being connected to the bar, and the other to earth. The specification says :—"The earth connection of the coupling bar being through the coils of a magnet in no way interferes with the telephonic conversation"; which remark you will apply to the lines then prevalent with the electromagnet then used. The clearing-out drop, as illustrated, was not mounted on the switchboard—there was a relay operating an audible signal; but a complete indicator is allowed for in the description. Although a clearing-out drop was connected to the central office circuit, the operator's telephone was still at the extremity of a separate cord, and needed to be plugged into or out of a spring-jack in order to be brought into or out of the subscriber's line circuit.

The circuit made up by the operator for the purpose of joining two subscribers' lines consisted of two cords and a bar. There were the operations of putting two plugs into spring-jacks and two plugs into a bar. If the two cords were permanently attached to the bar, a part of the work would be saved. If, further, the operator's telephone were to be switched into or out of the line by a key, the operations required would be more quickly performed.

(To be continued.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

TO-DAY) FRIDAY, February 1st.

Institution of Mechanical Engineers.

7:30 p.m. Annual General Meeting at 25, Great George-street. The following Paper will be read: "Comparison between Governing by Throttling and by Variable Expansion," by Capt. H. Riall Sankey.

MONDAY, February 4th.

Royal Institution.

5 p.m. General Monthly Meeting.

Society of Engineers.

7:30 p.m. Ordinary Meeting at the Westminster Palace Hotel. Presentation of Premiums. Presidential Address by W. G. Peirce.

TUESDAY, February 5th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. Monthly Ballot. The following Paper will be read: "The Mechanical and Electrical Regulation of Steam Engines," by John Richardson.

Society of Arts.

8 p.m. Applied Art Section. The following Paper will be read: "Drawing for Process Reproduction," by Gleeson White.

FRIDAY, February 8th.

Physical Society.

5 p.m. Annual General Meeting. Exhibition of Simple Apparatus by W. B. Croft. The following Paper will be read: "The Tin Chromic Chloride Cell," by S. Skinner.

Institution of Electrical Engineers.

8 p.m. Students' Meeting at 28, Victoria-street. The following Paper will be read: "The Magnetic Condition of Matter, with Experiments," by C. E. S. Phillips.

Institution of Civil Engineers.

8 p.m. Students' Meeting. The following Paper will be read: "The Construction and Maintenance of Roads," by Chas. H. Godfrey.

⁂ Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

Three-phase Transmission Plant in America.—The Pelzer Manufacturing Company, of Pelzer, S.C., has contracted with the General Electric Company of America for a three-phase electric transmission plant that will be exceptionally large and interesting. At the generating station, three miles from the cotton mills owned by the Company, says the *Western Electrician*, there will be three slow-speed generators of 750 kilowatts each directly coupled to water wheels. These dynamos will generate current at a potential of 3,300 volts, and the current will be fed directly to the transmission wires at this pressure. The transmission line will consist of eighteen No. 00 wires, this size having been selected in preference to larger wire to reduce the line induction as much as possible under the existing conditions. At one mill will be located a 400-H.P. synchronous motor, receiving current directly from the wires. There will be, in addition, more than twenty induction motors in various rooms. Of these, fourteen will be 110-H.P. motors, and the others will be of various sizes, from 5 to 75 H.P. In a sub-station will be located nine 160-kilowatt transformers for the motors and for 1,200 incandescent lights for the mills. Two electrically operated blowers of 3 H.P. each will be used for cooling the ransformers.

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A MEMORABLE SILVER WEDDING.

The commemorative banquet given at the Hôtel Métropole, on Monday evening last, the twenty-fifth anniversary of the taking over of the telegraphs by the State, was in most respects worthy of the occasion, and must have been in every way gratifying to its promoters. We can scarcely be mistaken if we say that the promoters were officials of the Post Office Department, and that the high compliments paid to the administrative triumphs of the past twenty-five years were not only intended for, but accepted by them as their due. And assuredly no one will grudge them in the least the merit of an achievement which, at its original inception and during its subsequent completion, reflects the greatest credit on the enterprise, courage, and devotion of the postal officials. It is not too much to say that, without the existence of a trained body of organisers and administrators, which the Post Office provided ready to hand, and has never failed to maintain, the transfer of the telegraphs to the State would have been scarcely possible, and its satisfactory management equally so. Thanks to them, the telegraph service of this country is now one of the best conducted and most efficient of our State Departments, surpassing in all essentials that of any other country in the world. The speeches delivered last Monday night in the Whitehall Rooms bore testimony to these facts in no sparing terms, and most of the two hundred and fifty guests were, no doubt, proportionately gratified. They had got up the entertainment to celebrate their handiwork, and they had their reward.

Most of the guests; but perhaps not all. A silver wedding with the wife's relations left out would not unfittingly describe the actual programme. Our natural interest in the telegraphs may prejudice our judgment as to a gathering of this particular kind; but, making all the allowance we can for departmental etiquette, and for the exigencies of political life, we confess to being disappointed. On second thoughts we acquit the Department of all blame; for, with the exception of Mr. Spencer Walpole, who made a most admirable after-dinner speech, and Mr. Lamb, whose able defence of telegraph finance was a necessary feature of the proceedings, the official element may be said to have been altogether absent, whether postal or telegraphic. But the political element was there in great numbers if not in great strength—so numerous indeed as to exclude everybody else who could have spoken as the occasion seemed to demand, and so manifestly irrelevant to the special object of the commemoration that their remarks were listened to in respectful, though somewhat wondering, silence. Lord Kimberley's essay would have been equally appropriate at a dinner on board the cableship "Mirror" or the "Faraday": and his complaint as to the vexatious importunities of the wire is one that is echoed in every merchant's office from New York to Singapore. The Marquis of Ripon is, no doubt, an imposing figure-head as a politician, but he is no authority on telegraph matters. Of the Earl of Jersey and of other speakers the same may be said without the least disrespect to their rank or intelligence. One idea of the telegraph seems to be that it was designed in the order of Providence for the purpose of informing the Democracy in these latter days of what is going on in the people's Parliament; and another speaker cited the success of the telegraphs under State management as an argument for State socialism generally, including, it may be argued, the management of his own broad acres. A settled gloom spread over the faces of the postal officials at the prospective contingencies here foreshadowed, and the telegraph officials indulged in a furtive snigger. But what can you expect when a social gathering of essentially national character falls into the hands of a group of party men all of one colour? They too had their reward; their speeches were meagrely reported, and no London newspaper contained any leading notice of the event.

It is due to Mr. Shaw Lefevre to except him from this sweeping criticism. His speech was not only appropriate, but instructive. For one thing, he let fall a remark which evoked a quick and hearty response among at least a section of his auditors, and which deserves greater publicity than the newspaper reports of the proceedings have afforded it. Speaking of the popularly accepted notion that the State telegraph does not pay its way, he said, "The distinction between postal and telegraph revenue is a highly artificial one, it being practically impossible to determine what is Post Office and what is telegraph receipts and expenditure." Mr. Lamb, following on some time later, expressed himself satisfied, as, indeed, he has a right to be, with the financial results of the enterprise, claiming that there are items of inestimable value to be set to the account besides those expressed in Arabic figures. No doubt there are; but probably there was no telegraph official present who would not have accepted the Arabic figures by themselves if they had been forthcoming. Postal officials have just cause to be proud of the alliance which they contracted twenty-five years ago; but it would be a subject of still greater pride if, having come into possession of a marriage portion of great potential value, they could show that it has been fruitful in their hands, instead of apologising for its being a gradually vanishing quantity. We could have wished to hear what the telegraph officials themselves had to say on this and other matters pertaining to their transfer to the State. But they were not in the programme; and it was reserved for Sir John Pender, in the brief moments allowed him, to make the one, and almost only, gracious reference to the important services rendered to the country by electricians and telegraph engineers, both previous to and since the acquisition of the telegraphs by the State. With one other encomium pronounced earlier in the evening, we gladly coincide, and have pleasure in recording it to Mr. Bryce's credit. He spoke of the "unfailing honour" with which the service is conducted. That is, undoubtedly, a great and a well merited compliment, and although we have felt constrained to speak regretfully of some features of the evening's entertainment, we are proud to believe that the service it commemorated is still absolutely free from influences that would shake the public confidence which it now so fully enjoys.

OBITUARY.

PROF. CAYLEY.

By the death of Prof. Arthur Cayley, England has lost one of her greatest mathematicians. Prof. Cayley, says *The Times*, was born at Richmond, on August 16, 1821. After some years at a school at Blackheath and at King's College, London, Cayley was sent to Cambridge at the age of 17. In mathematics he carried all before him, and in 1842 he came out as a Senior Wrangler and First Smith's Prizeman. It is of interest to note that Sir Gabriel Stokes was the Senior Wrangler of the previous year, and Prof. Adams of the year following. Soon after taking his degree, he became a pupil of the eminent conveyancer, Mr. Christie, and after he was called to the Bar (at Lincoln's Inn, in 1849), Mr. Christie put abundance of work in his way. But his first love, mathematics, never lost its hold over him; indeed, during the whole of his active career as a barrister he was constantly busy with mathematical work, contributing to many periodicals and societies at home and abroad. It was in 1863 that he married and returned to Cambridge to fill the newly-instituted Sadlerian Professorship of Mathematics. Previous to that date we find the titles of some 300 Papers by him in the Royal Society list, which gives some indication of his unceasing activity. It would seem that it was only in 1852 that he made his first contribution to the Royal Society, and in the same year he was elected a Fellow. The Royal Society list contains the titles of 724 Papers and memoirs by Prof. Cayley down to 1883, and since then he must have brought the number up to considerably over 800. These are being collected into a series of ten volumes quarto by the University of Cambridge. Absorbed as he was in mathematics, Prof. Cayley in various ways showed his sympathy with human life and interests, and especially with education. He was an early member of the Alpine Club. He was familiar with many European languages. In 1882 he was invited by the Johns Hopkins University, Baltimore, to give a series of lectures, and this he did in the winter session of that year. He was President of the Southport meeting of the British Association in 1883. From the Royal Society he received both the Royal and the Copley Medals. He was, in 1890, made an officer of the Legion of Honour by the President of the French Republic, and he was an honorary member of many learned societies at home and abroad.

THE ELECTRIC ARC.

BY HERTHA AYRTON.

(Continued from p. 368).

At the conclusion of the last article I said, "It appears, then, that the diameter of the crater does *not* vary directly as the current, as has been stated, for example, by Prof. S. P. Thompson in his 'Cantor Lectures,' January 14, 1895." Dr. Thompson, however, tells me that at that lecture he spoke, or at any rate intended to speak, of the *area*, and not of the diameter of the crater, as being proportional to the current, when the current was not very small, or the arc in an unstable condition.

The discrepancy, therefore, between Dr. Thompson's views on this point and the result of my own experiments is not as great as at first sight appeared. The area of the circle passing through the edge of the crater could, of course, be obtained from the results given in the last article, for, since I have found that D, the diameter of the crater with a silent arc, may be expressed with considerable accuracy by

$$D = a + b\,A,$$

where A is the current, it follows that a, the area of the circle passing through the edge of the crater, is expressed approximately by

$$a = \frac{\pi}{4}\left(a^2 + 2\,a\,b\,A + b^2\,A^2\right).$$

This area is not, however, the true area of the crater, for the crater is a curved surface, and I am at present engaged in attempts to actually measure the area of this small curved surface, under different circumstances, by using a special form of planimeter, which I devised and had constructed last year for this purpose. When the areas of the craters have thus been accurately found out, it will be possible to say how far it is correct to conclude that the area of the crater is really directly proportional to the current.

Fig. 15, given on page 368 of *The Electrician* for Jan. 25th, is too small to enable sufficiently accurate measurements to be made of the diameters of the craters for the purpose of testing the accuracy of the linear law connecting diameter and current which is stated in the last article. I therefore append the following table, which gives the results of the actual measurements made of the diameters, for each current, with the 2mm. and 4mm. arcs, side by side with the diameters calculated from the formulæ

$$D = 3{\cdot}2 + 0{\cdot}162\ A, \text{ for the 2mm. arc,}$$
$$D = 3{\cdot}2 + 0{\cdot}172\ A, \text{ for the 4mm. arc,}$$

D being the diameter of the crater in millimetres, and A the current in amperes. The coefficients given here of A are somewhat higher than those stated in the last article ; but those, I find, were a little too small to produce the best agreement between the formulæ and the results obtained experimentally.

Table V.

Carbons : Positive, 13mm. cored. Negative, 11mm. solid. Length of arc, 2mm. silent.

Current in amperes.	Measured diameter of crater in mm.	Calculated diameter of crater in mm.
4	3·8	3·85
7	4·2	4·33
10	4·75	4·82
15	5·6	5·63
20	6·45	6·44
25	7·25	7·25

Length of arc, 4mm. silent.

Current in amperes.	Measured diameter of crater in mm.	Calculated diameter of crater in mm.
7	4·4	4·404
10	4 9	4·92
15	5·8	5·78
20	6·6	6 64
25	7 6	7·5

For all currents, therefore, between a comparatively small one and the largest that will give a silent arc the *diameter* of the crater may be expressed with surprising accuracy as a linear function of the current.

In Figs. 7, 8 and 9 (p. 338 *The Electrician*, January 18th) curves were given connecting potential difference with length of *silent* arc for various constant currents with each of the three pairs of carbons. If, however, we proceed to draw such curves for *hissing* arcs, then, in consequence of the curve connecting, potential difference with current for each length of *hissing* arc being practically a horizontal straight line (Fig. 5, p. 337, *The Electrician*, January 18), we obtain only *one* curve connecting potential difference with length of arc. For this curve is the same for any current which causes the arc to hiss. In other words, all the curves in any one of Figs. 7, 8, or 9, which refer to *silent* arcs close up into a single curve for *hissing* arcs. The values of the abscissæ and ordinates of this curve when the positive carbon is 9mm. cored and the negative 8mm. solid, are given in Table No. VI.

Table VI.—*Hissing Arcs.*

Carbons : Positive, 9mm. cored. Negative, 8mm. solid. For any current that causes hissing.

Length of arc in millimetres.	Potential difference between the carbons in volts.	Length of arc in millimetres.	Potential difference between the carbons in volts.
0·0	29·8	3·0	37·5
0·5	32·0	4·0	40·0
1·0	34 0	5·0	41·5
2·0	36·0	8·0	49·0

On plotting these numbers we obtain a curve something like that for 15 amperes in Fig. 9, but flattened out and lowered considerably.

The curves in Figs. 4, 5, and 6 for the three pairs of carbons may be employed to ascertain what must be the resistance of the extra coil used with an arc lamp, and what is the potential difference necessary to be maintained between the mains, in order to produce a *silent* arc of given length with a given current. For example, let an arc lamp, fitted with a 13mm. positive carbon and an 11mm. negative carbon, be used on a constant-pressure circuit, between the mains of which a potential difference of V volts is maintained. Let it be desired that the lamp shall use 15 amperes, and that the feeding mechanism shall keep the arc 2mm. long. Also suppose the electromagnetic feeding mechanism is such that it begins to work when the current, passing through the regulating solenoid, falls by one ampere, and we desire that the feeding of the carbons shall begin whenever the arc is too long by 0·5mm.

From Fig. 5, page 337 (*The Electrician*, January 18th), we see that when a current of 15 amperes is flowing through a 2 mm. silent arc with the carbons in question, the potential difference between the carbons must be 43 volts; therefore, if x is the resistance in ohms of the regulating solenoid and of the extra coil inserted in the lamp

$$43 + 15\,x = V.$$

Now let the carbons burn away until the arc is 2·5 mm. long, and the current falls to 14 amperes ; then, from an examination of the curves in Fig. 5, we see that the potential difference between the carbons must be about 44·1 volts, therefore

$$44{\cdot}1 + 14\,x = V.$$

Solving these two equations for x and V, we have

$$x = 1{\cdot}1$$
$$V = 59{\cdot}5,$$

or the resistance of the regulative solenoid, and the added coil together must be 1·1 ohms, and the constant potential difference maintained between the lamp terminals must be 59 5 volts.

Next let the same arc lamp be used on a 100-volt constant pressure circuit, and, as before, let it be desired that the regulating mechanism shall keep the arc at 2 mm. long, and pass a current of 15 amperes. If, as before, the regulating solenoid starts the feeding when the current falls by one ampere, then what must be the joint resistance of the regulating solenoid and added coil, and how long will the arc become before the feeding commences?

Let x be the required resistance, then

$$43 + 15\,x = 100,$$
$$\text{or } x = 3{\cdot}8 \text{ ohms.}$$

Let v be the potential difference between the carbons when the feeding starts ; then

$$v + 14 \times 3{\cdot}8 = 100\,;$$
$$\therefore\quad v = 46{\cdot}8\,;$$

and from an examination of the curves in Fig. 5 it is clear that a potential difference of 46.8 volts between the carbons sends a current of 14 amperes through the arc when the arc is about 3 8 mm. long.

Hence, in this case, the joint resistance of the solenoid and the added coil must be 3·8 ohms, and the feeding will commence when the carbons have burnt away, so that the length of the arc is 3·8 mm.; that is, has become 1·8 mm. too long. If this variation in length be more than is desired, then the regulating solenoid must be constructed to start the feeding mechanism with less than one ampere drop into the current.

From the curves in Fig. 5 we see that the resistance added to an arc lamp on a constant-pressure circuit fulfils two objects. It not only prevents the current becoming very large when the carbons are in contact before the arc is struck, but it fulfils another very important function in making it possible for a solenoid to regulate the length of the arc, and keep the current passing through the arc approximately constant, by causing the feeding mechanism to approach the carbons when the current falls below the required value.

For if there were no added resistance coil, and the only resistance in the lamp, beyond that of the arc itself, were the very small resistance of the regulating solenoid, the potential difference between the carbons would be practically constant when the lamp was attached to constant-pressure mains. In that case we see from the curves in Fig. 5 that if the arc were, say, 3 mm. long, and the current were, say, 13 amperes, the burning of the carbons would *increase* the current, so that the regulating solenoid would have to start the feeding mechanism when the current became too *large*, and not when it became too small, as with the regulating solenoid of an ordinary arc lamp.

But even if the regulating solenoid were constructed so as to start the feeding mechanism when the current became too large, such a lamp could not be satisfactorily used with a constant potential difference between the carbons—that is, without an added resistance on a constant-pressure circuit. For a length of arc of about 1·8 mm. is not uncommon in arc lamps, and at about this length, as seen from the curves in Fig. 8 (*The Electrician*, January 18th, p. 338), a small increase in the length of the arc may cause either a great increase or a great diminution in the current for a constant potential difference between the carbons, depending on whether the length of the arc is greater than, or less than, the length corresponding with the point of intersection of the curves.

For example, with a constant potential difference of 43·7 volts between a 13 mm. cored positive carbon, and an 11 mm. negative one, the increase in the length of the arc from 2 to 2·4 mm. *raises* the current from about 10 to about 25 amperes. Whereas, with a constant potential difference of 42 volts between the same pair of carbons, the increase in the length of the arc from 1 to 1·4 mm. causes the current to *drop* from about 25 to about 5 amperes.

Hence, as the length of arc frequently employed with arc lamps is about that corresponding with the point of intersection of the curves in Figs. 7, 8 and 9, the addition of a resistance to an arc lamp on a constant-pressure circuit is necessary to make it possible for an electromagnetic mechanism to regulate the distance between the carbons. This explains the curious fact noticed by Prof. Ayrton when giving the lecture on "The Storage of Energy" at the London Institution on March 2, 1882. A Foucault-Dubosq arc lamp, which regulated perfectly well when supplied with current from Grove's cells without any interposed resistance, refused entirely to regulate when the Grove cells were replaced by a battery of Faure accumulators, although the number of accumulators was chosen to set up the same potential difference between the lamp terminals as was produced by the Grove's cells. He had, in fact, replaced a circuit of constant E.M.F. by one supplying constant pressure, and with the latter the distance between the carbons oscillated backwards and forwards between two wide limits, the regulating mechanism, which both approaches and recedes the carbons in a Foucault-Dubosq lamp, vainly trying to find a position of stability. The length of the excursion up and down of the carbons in such a case can be calculated from the curves which will accompany the next article.

(*To be continued.*)

TWENTY-FIFTH ANNIVERSARY OF THE GOVERNMENT TELEGRAPHS.

COMMEMORATION DINNER.

A large and distinguished company, representing nearly every department in the State, assembled on Monday night in the Whitehall Rooms of the Hotel Métropôle, London, the occasion being a banquet held to commemorate the 25th anniversary of the taking over by the Government of the telegraphic system of this country. Mr. Arnold Morley, M.P., the Postmaster-General, presided over the gathering, which, besides being attended by several members of Her Majesty's Government, was representative, in particular, of every branch of the postal service. Prominent amongst those present were the Earl of Kimberley, the Marquis of Ripon, the Earl of Jersey, Sir Robert Reid, M.P. (the Attorney-General), Sir Frank Lockwood, M.P. (the Solicitor-General), Sir John Pender, M.P., Mr. James Bryce, M.P. (President of the Board of Trade), Mr. G. J. Shaw-Lefevre, M.P. (President of the Local Government Board), Sir Donald Currie, M.P., Sir Henry Oakley, Sir F. Mowatt, Mr. Spencer Walpole (Secretary to the Post Office), Sir Stuart Knill, Sir T. Sutherland, M.P., Sir Robert Hunter, Sir Myles Fenton, Mr. Alderman and Sheriff Samuel, Mr. Sheriff Hand, Mr. S. R. French (Postmaster-General, Cape Colony), Major-General Webber, Mr. Algernon Turner, Sir Francis Evans, Col. Du Plat Taylor, Sir J. Robinson, Mr. H. C. Fischer (Controller of the Central Telegraph Office), Mr. H. L. Creswell (Secretary Post Office, Ireland), Mr. W. H. Preece, C.B., F.R.S. (Engineer-in-Chief), Mr. W. E. Lewin Hill, Mr. J. Ardron, Col. J. P. MacGregor, Col. John Mitford, and Mr. J. C. Lamb, C.B. (the deputy chairman), Mr. F. E. Baines was unable to attend, as was also Mr. R. W. Johnston, both through failing health. Besides Messrs. Preece and Fischer above named, the old telegraph service was represented by Messrs. Askins, T. Barlow (Assistant-Controller, Central Office), Benton, Cooper, Cordeaux, Culley, Douglas (Postmaster, Tunbridge Wells), A. E. Eames, J. W. Eames, H. Eaton (late Metropolitan Superintending Engineer), Fleetwood, Gavey, Gibson, Hartnell, Heaviside, J. T. Hill, J. Hookey (Assistant-Engineer-in-Chief), Prof. Hughes, Messrs. J. Jenkin, C. H. Kerry (Postmaster of Warrington), J. Laister (Postmaster, Northern District), W. Langdon, T. Mason, E. May (Assistant-Controller, Central Office), H. J. J. Melsom (Postmaster of Canterbury), C. A. Morgan, C. E. Stuart, H. J. Vose, W. Whight, J. W. Wilmot, and A. C. Woodward. Amongst the representatives of submarine telegraphy, Sir John Pender at the head, may be named Messrs. J. D. Pender, Alex. Siemens, Von Chauvin, G. Draper, C. Gerhardi, O. P. Moll, Bullock, and Hibberdine. Amongst several of the late senior officers of the original telegraph companies who were present were Messrs. W. T. Ansell, C. V. Boys, C. Curtoys, C. E. Spagnoletti, H. Schutz Wilson, and Frank Webb, of the Electric and International Company, and Mr. W. Andrews, of the United Kingdom Company, which Company was practically the pioneer of an uniform and cheap tariff for messages. We believe that Mr. C. W. Earle, who was present, is the only surviving Director of any of the original telegraph companies.

A pleasing impression was created by the presence in the entrance hall of a guard of honour composed of Post Office telegraph messengers, belonging to the S.W. District, who, attired in their familiar neat uniforms, shouldering their rifles, presented an exceedingly smart appearance. With them was the drum and fife band. On the arrival of the Postmaster-General, the lads presented arms, while the band struck up the strains of the National Anthem. It may be interesting to record that every guest, on taking his seat, was presented with a souvenir of the occasion in the shape of a card, on which were medallion portraits of the Postmasters-General who have held office since January 29, 1870, the day on which the transfer of the system to the State was formally effected. Portraits of Mr. Scudamore, Mr. Patey and Mr. Baines appropriately filled up the series at the foot. In other respects, the card was symbolical of the telegraphic service in this country, while in the centre were given a number of figures illustrative of the progress and development of the system in the past quarter of a century. From these it appeared that, whereas in 1869 the number of telegrams, inland, press, and foreign, despatched in the United Kingdom was 6,830,812, the total reached last year was 71,165,380. In the former year the mileage of line amounted to 14,776, and in the latter to 32,881, its wire mileage having increased from 59,430 to 206,304; cables had increased in number from 20 to 136, and their mileage from 177 to 2,463, and their mileage of wire from 679 to 8,500. Before the telegraphs were purchased by Government the instruments in use numbered 4,045, as against 26,764 at the present day, while the number of words per minute capable of being sent on the fastest form of instrument prior to 1870 was about 70 against 600 now reached. It was further recorded that, whereas in 1869 there were 2,932 telegraph offices in this country, they now numbered 9,637. Finally, the average charge for telegrrms had been reduced from 2s. 2d. to 7¾d. As the guests arrived they were cordially received by Mr. Arnold Morley, the Postmaster-General, and Mr. Spencer Walpole, the secretary. Shortly before the announcement of dinner, the Reception Hall was crowded, and presented a most animated appearance. Such greeting and hand-shaking are seldom seen on occasions like these. Although some 250 persons were present, there was hardly a stranger amongst them, and evidently many of them met now for the first time after a long separation, the requirements of the service having drifted them far apart.

After the usual loyal toasts had been proposed by the Postmaster-General, and duly honoured, Mr. SPENCER WALPOLE proposed "The Houses of Parliament."

The Earl of KIMBERLEY, in replying, said, holding the high office he did, he was naturally deeply interested in the extension of telegraphic communication throughout the world. There were some great and obvious advantages in this great facility of communication. It enabled them to prevent misunderstandings which might grow into serious difficulties. But, on the other hand, there was not the slightest doubt that the extreme centralisation of government which resulted from the facility of communication tended somewhat to weaken the responsibility of their agents throughout the world, and it was a doubtful advantage that there should be thrown (as there was now to some extent) upon one man the complete direction of our foreign policy throughout the world in almost every detail. It was necessary that general principles should be left to such direction, but it was essential that their agents throughout the world should continue to feel their personal responsibility, and should not every moment look to him who might occupy the supreme office, but to some extent act upon their own opinion. On the whole, however, he thought that the advantages of improved communication were enormously in excess of the disadvantages. If they were to knit the various parts of their empire more closely together, it would be largely by means of the admirable system of communication which now existed, and if they managed their political force wisely they might look forward to the time when the whole empire might act for one great purpose as one body, and might exercise an influence in the world which had probably been never experienced in its history.

Mr. BRYCE, in responding for the House of Commons, said that members of that Assembly owed it to the telegraphic service that they had been able to rise to the magnitude of those functions which the growth of democracy had thrown upon the Representative House. It was the function of the telegraph to convey all over the country the record of proceedings in the House of Commons, and to enable the country to express its approval or censure of what the Legislature was doing, and in that way the telegraphic service had succeeded in bringing Parliament back to its original position—which it still held in legal fiction—that it was the nation assembled. They recognised how great was the obligation which the development of science had placed them under in enabling them to realise a system of popular government, of which their ancestors had not ventured to dream; and in thanking them he would express the gratitude which Members of the House of Commons felt for the promptitude, accuracy, and, above all, the unfailing honour, with which their duty to the country was always discharged.

Mr. SHAW LEFEVRE, in submitting the toast of "The Telegraph Department," said he presumed that the honour of so doing had been entrusted to him by reason of the fact that he was one of those who had held the office of Postmaster-General since the event they were celebrating. His own memory nearly went back to the inception of the telegraphic system. He remembered Prof. Wheatstone visiting his father's house and explaining his invention, and telling him that he (Mr. Shaw Lefevre) might hope to see the day when the system would envelop the whole world. That was a great prophecy, and it had been amply fulfilled. Mr. Shaw Lefevre traced the history of the movement which culminated in the transfer of the telegraphs to the State. He was glad to think that it was to the credit of the Post Office that one of its chief officers first made a distinct proposal in this direction. It was so far back as 1856 that Mr. Baines made for the first time a distinct proposal that the State should undertake the charge of the telegraphs. He then proposed that the companies should be bought out, that a uniform system should be established, and that the minimum charge for a message should be reduced to sixpence. It was 14 years later when the country awoke to the necessity for the change while 14 years more passed before the charge was reduced to sixpence. It had cost £11,000,000 to purchase the telegraphs, but even at that price the companies were a good riddance, and he thought that the transaction had been justified by the results. The number of telegrams had increased from 7,000,000 in 1870 to 70,000,000 in 1894; the average charge for a message had been reduced 2s. 2d. to 7½d.; instead of there being 3,000 stations there were 10.000, and it was not too much to say that the telegraph was brought within the reach of every single village in the country: and the average time in sending a message had been reduced from two to three hours to ten or fifteen minutes. These figures were evidence of the great success of the transfer. It was an unfortunate fact that the telegraph service did not do more than meet its expenses; but it was impossible to strictly distinguish postal from telegraph receipts and expenditure, and he had always held that the two services of post office and telegraphs must be looked at together. The surplus revenue of the two services was now £2,750.000, and he thought that was enough to satisfy the most grasping Chancellor of the Exchequer. The present management of the telegraphic service afforded every security that the means afforded by advancing science would be adopted as soon as possible, and that the service would be maintained at its present high level.

The Earl of JERSEY submitted "The Trade Communications of the Empire," Sir John Pender, M.P., and Sir Thomas Sutherland, M.P., responding, the former paying a warm tribute of praise to the promoters and administrators of the telegraphs previous to their acquisition by the State.

Mr. ALGERNON TURNOR proposed "The Guests," for whom the ATTORNEY-GENERAL replied.

The "Health of the Chairman," proposed by the SOLICITOR-GENERAL, brought the proceedings to a close.

THE LONDON COUNTY COUNCIL AND THE TROLLEY SYSTEM.

At the meeting of the London County Council, on Tuesday, the Highways Committee said they had considered the application made by a company called the London United Tramways (Limited), which had acquired the undertaking of the West Metropolitan Tramways Company, for the Council's consent under the latter Company's order of 1887 to the use of electricity by means of overhead wires as the motive power for working so much of the tramway in Uxbridge-road between Shepherd's Bush-green and Acton as was within the county of London. The system involved the placing in the centre of the thoroughfares of columns with brackets with bare copper wire stretched between them; and, bearing in mind the very decided opinion expressed by the Council some time since against the proposal to adopt the road, the Company was, the Committee thought, not likely to find favour with the Council. Having regard to the policy which the Council had always adopted with respect to overhead wires, the Committee thought it most unadvisable that it should consent to the adoption in any part of London of a system involving the use of overhead electric wires for working tramways. Should the Council consent to the adoption of such a system for tramway purposes, there would probably arise immediately a demand on the part of electric lighting companies to be allowed to place their wires overhead also, especially as no reason could be alleged against the adoption of that course which would not apply with equal force to the tramway wires. They recommended against the request.

Mr. BEACHCROFT expressed the hope that the Council would not, off hand, say that they would not permit the experiment of the overhead tramway system to be tried. He moved that the Company should have the consent of the Council to use electricity by means of overhead wires as the motive power for working the tramway experimentally.

The Rev. FLEMING WILLIAMS, in seconding the amendment, said he hoped the fanatical cry for the beautification of London would not be carried to simple absurdity. The first thing to be done for the beautification of London was to clear the slums, and as that was done fresh means of locomotion would be required to carry the people dislodged into the suburbs.

Mr. J. WILLIAMS BENN, M.P., was surprised that the rev. alderman should have seconded this motion, as he was one of those who believed that the land of London had been stolen from the people in past times. Now he was seconding a motion to deprive the people of the blue sky above. He could not imagine anyone who had seen the American trams, on the same system as now proposed, desiring to have the same kind of monstrosity in London. Under this system the centre of the street became a sort of metallic cobweb, and from the roof of each car there projected a sort of iron fishing rod connected with the wires above. The opponents of this scheme were by no means opposed to the application of electricity to tramways; but they did object to the streets being disfigured by these wires and posts.

Mr. JOHN BURNS, M.P., said the only effect of the adoption of this system of locomotion would be to impair and generally destroy the beauty of the district. There was no necessity to go to America to see what the system was like, as they had it in Leeds, and the result was a hideous network of wires. Wherever this system had been adopted the value of the surrounding property had greatly depreciated. Another reason against its adoption in London was that it would obstruct the passage of their fire escapes. He believed that if the Council allowed this scheme to be adopted the people of London would pull it down, and he regarded it as the first attempt on the part of a private company to subordinate the people of London to the making of a dividend.

The amendment was rejected, and the recommendation of the Committee approved.

At a largely attended meeting of Acton tradesmen and residents held on Monday a resolution approving of the scheme was unanimously passed. A deputation was also appointed to wait upon the District Council and present a petition bearing over 1,100 signatures in its favour. At the meeting of the Hammersmith Vestry a resolution in favour of the scheme, so far as it affects the portion of the line east of Acton parish, was unanimously passed.

LONDON COUNTY COUNCIL AND ELECTRIC LIGHTING LOANS.

At the usual weekly meeting of the London County Council, held on Tuesday, the Finance Committee reported as follows :—

Loan to the Vestry of St. Pancras for Electric Lighting.

We have again had under consideration the application of the Vestry of St. Pancras for a loan of £14,600 for the purposes of electric lighting. We reported on this subject on July 17th last, and recommended, consequent on the Council having granted 42 years to the Vestry of Hampstead for the repayment of a similar loan, that sanction should be given to the Vestry of St. Pancras borrowing £14,300, and that 42 years should be allowed for repayment. On the Treasury being notified that the Council proposed to advance the money to the Vestry, and to spread the repayment over 42 years, exception was taken to that period as being disproportionate to the life of the works. Consequent on such objection, communications took place with the Treasury, and eventually an agreement was come to with the Treasury that the periods for repayment of all loans for the initial cost of electric lighting undertakings should be limited as follows :—For land, buildings, culverts, bare copper mains, and royalty licenses relating to such purpurposes 50 years, and for all other purposes 20 years. This agreement and the letters on the subject were fully set out in our report to the Council on November 20, 1894, when the Council confirmed the agreement as applicable to all future loans for electric lighting, and we have assumed that the Council does not wish to again re-open the question. Applying these terms to the loans for electric lighting purposes made to St. Pancras Vestry, it is necessary to restrict the period for repayment of this loan (14,300) to 20 years, as the previous loans have been for longer periods. The Vestry of St. Pancras having been so informed, now ask that if the Council will not lend the money for 42 years, it will sanction the Vestry borrowing it elsewhere for that period. The Vestry do not seem to have realised that the agreement referred to above applies not only to loans to be advanced by the Council, but to all loans which the Council sanctions in pursuance of its statutory duty, and that the Council has taken great trouble to obtain the best possible terms for the local authorities in regard to loans for electric lighting purposes. Having carefully considered all the representations made to us by the Vestry of St. Pancras on the subject, we are unable to see our way to suggest any other course than that the Council should adhere to the principle embodied in the agreement with the Treasury, and sanction the borrowing by the Vestry of the sum of £14,300 at $3\frac{1}{4}$ per cent., for a term not exceeding 20 years. We recommend—

(*a*) That the seal of the Council be affixed to an order sanctioning the borrowing by the Vestry of St. Pancras of the sum of £14,300 towards defraying the cost of electric lighting works at the rate of interest not exceeding £3. 5s. per cent. per annum, such sum being repaid by such equal half-yearly or annual payments as will repay the amount borrowed within a period of 20 years from the date of the loan, and the interest also within the same period.

(*b*) That the Vestry of St. Pancras be informed that the Council will be prepared, should they desire it, to advance the sum of £14,300 on loan at $3\frac{1}{4}$ per cent., repayable in 20 years.

Loan to the Vestry of Islington for Electric Lighting.

We have considered an application from the Vestry of Islington for a loan of £51,000 for electric lighting purposes. Of this amount, the sum of £18,000 is to be applied towards defraying the cost of erecting a central station at the rear of Eden-grove, Holloway, for which contracts have been entered into for £23,792. 12s. 7d., and the sum of £33,000 is to provide the necessary boilers, engines, dynamos, fittings, switchboards, mains, pipes and lamps, estimated by the Vestry to cost £34,269, and by the Council's engineer, £32,844. The Council has already granted a loan of £9,000 for 55 years to purchase the site. Consequent on the agreement with the Treasury (as to the periods over which loans for the initial cost of electric light installations should be spread), as confirmed by the Council's resolution of November 20, 1894, the Vestry was informed that under that resolution we were prepared to recommend the Council to sanction a loan of £18,000 for 50 years, and £33,000 for 20 years. The Vestry has taken exception to our decision, and contend that the same treatment should be meted out to them as to St. Pancras and Hampstead, by granting them 42 years for repayment ; and that if the Council itself is not prepared to lend the money for that period, the Council should sanction, unconditionally, the Vestry borrowing the amount, leaving them to make the best terms they can with some financial corporation as to the rate of interest and the period for repayment, subejct only to the restrictions imposed by the Metropolis Management Act of 1855, which provides (sec. 190) for the repayment of any moneys borrowed by a sinking fund of not less than 2 per cent. of the amount borrowed, the Vestry regarding this as equivalent to repayment within 50 years.

It is hardly necessary to point out again that the consents in the St. Pancras and Hampstead cases were given before the agreement arrived at with the Treasury, and before the Council's resolution of November 20th last, according to which all loans for electric lighting purposes will for the future be sanctioned. The vestry of Islington, like St. Pancras, does not seem to appreciate the Council's position in reference to giving its consent to the borrowing of money, or to realise the impropriety of the Council consenting to the Vestry borrowing elsewhere for a period of years for which the Council cannot itself properly lend, and thereby rendering nugatory the agreement with the Treasury, a position which we submit it is quite impossible for the Council to adopt. We think that the same course should be adopted in this case as recommended in the case of St. Pancras, and we accordingly recommend—

(*a*) That the seal of the Council be affixed to the order presented herewith, whereby the Council sanctions the borrowing by the Vestry of Islington of the sum of £51,000 towards defraying the cost of erecting a station and other works in connection with an electric light installation in the parish, at a rate of interest not exceeding £3. 5s. per cent. per annum, such sum being repaid by such equal half-yearly or annual payments as will repay the amount borrowed, as to £18,000 for the erection of the station within a period of 50 years, and as to £33,000 for plant and works within 20 years from the date of the loan, and the interest also within the same periods.

(*b*) That the Vestry of Islington be informed that the Council will be prepared, should they desire it, to advance the sum of £51,000 on loan, at $3\frac{1}{4}$ per cent., repayable as to £18,000 in 50 years, and £33,000 in 20 years.

Mr. WESTACOTT said that he had given notice of an amendment that 42 be substituted for 20 years in respect to the loan to St. Pancras. Mr. Harben, however, was going to make a statement, and if Mr. Spicer (the Chairman of the Committee) would take the report back after hearing that statement, he would not move his amendment.

Mr. HARBEN said he merely wished to make a statement in reference to the opinion of, perhaps, the greatest electrical engineer of the day, Mr. Preece, the electrician to the Post Office, who had more to do with electricity than any other man in the kingdom. Mr. Preece wrote to him as follows : "I don't mind your saying my views are in favour of 42 years, and that I consider 20 years applies only to boilers. Every other part of the system must be kept up to date. It is always under renewal, and at the end of 20 years it must be in good order, and must always be maintained so. In fact, every electrical appliance is always kept up in perfect working order, and maintenance means renewal." After such an opinion as that he thought the matter should be taken back for further consideration.

Mr. CAMPBELL opposed the postponement of the matter on the ground that posterity would not only have to pay their quota for the old engines, but would also have to pay for new engines if the time was extended.

Mr. SPICER said that in reference to those electrical lighting loans he was sorry they were so often before the Council ; but as far as that report went with reference to St. Pancras, the evidence which the Finance Committee had at the present moment would certainly not allow them to recommend a longer period than that proposed, and, as regarded the Treasury, they could not go back upon the arrangements. But if he was told that there was further evidence from a gentleman like Mr. Preece, and if the Treasury were wrong in their surmises, and they could have some strong evidence brought before them that the time should be lengthened, he would take the report back to be brought up at a future date, and in the meantime they would confer with the Treasury in reference to it. But he thought it should be clearly understood that if they could not obtain the Treasury's consent the Finance Committee could in no way withdraw from the position they had taken up. He would withdraw the report with reference to Islington at the same time.

Lieut.-Col. FORD thought the action of the Committee in taking the matter back most unreasonable ; and he could not understand their weakness. The matter had been thrashed out over and over again, and surely the Treasury were not such dummies as not to know what they were doing. He did not think it should be taken up because Mr. Harben brought up a letter from an obscure official in the Post Office. He supposed it would be only a fair compliment to the Government to suppose if they did not consult that obscure person they consulted someone else.

Mr. COHEN, M.P., said that with regard to Col. Ford's remarks he differed altogether from him in describing Mr. Preece as an obscure official, and although he was not at all sanguine that the Treasury would recede from the position they had taken up, yet they would hold the opinion of one of the greatest experts it its employment to be a very governing opinion. He thought the Chairman of the Committee exercised a wise discretion in re-considering the matter.

Mr. ELLIOTT thought that as the Council in their Money Bill of 1893 specially provided that for electric lighting purposes the repayment of loans should extend over 50 years, they had been guilty of a breach of confidence in departing from it.

The report was then taken back.

THE ELECTRIC LOCOMOTIVES FOR THE BALTIMORE AND OHIO RAILROAD.

The following particulars with regard to the mechanical and electrical details of the much-talked-of electric locomotives building for the Baltimore and Ohio Railway Company for use on their "Belt" line tunnel have been communicated to the American technical press :—

The trucks are of forged iron, each resting upon four driving wheels of cast steel, 62in. in diameter. Flexibly supported upon each of these trucks are two 6-pole gearless motors, one for each axle, transmitting their motion from the armatures to the wheels by means of a specially designed flexible coupling. The method of spring suspension has been carefully modified to allow of the immediate adjustment of the wheels to the irregularities of the tracks, and thus effect a diminution in the wear both to the motors and the track. The armatures are of the iron-clad type. A hollow shaft serves to carry the armature, and through this passes the wheel axle, to which it is connected by the universal coupling already mentioned, which allows of freedom of movement in any direction.

The complete motors are the largest railway motors in the world, and, while ponderous in appearance, are by no means so bulky as might be expected from the heavy duty they will be called upon to perform. They are so set on the truck that they will be easy of access under all circumstances, whether the locomotive is at a standstill or in motion.

The cab, which will be spring-supported on the truck frame, will be of sheet iron and wood, and will have windows on all sides in order that the occupants may have an unobstructed view in all directions. Within the cab will be set up the series parallel controller, by means of which the movements of the locomotive will be at the command of the driver, and the air brake pump, operated by a small electric motor. Compressed air will be used for the whistle. The locomotive will be also equipped with bells, safety devices, &c., and will have a Janney automatic coupler at each end.

The finished locomotive will be an imposing piece of electrical machinery. It will weigh in its completed state 95 tons, will be 14ft. 3in. long, 9ft. 6¾in. wide, and will be of standard gauge. The maximum speed of the motor will be 50 miles an hour. With a load of half the maximum pull of the draw-bar a speed of 30 miles an hour will be made, while 15 miles an hour can be made with the maximum load. The average speed of the loaded train will be about 30 miles an hour. This locomotive is designed for heavy work, and will be called upon to handle trains as heavy as those now handled by the heaviest steam locomotives.

A test of one of the completed trucks was recently made upon the tracks at the Schenectady Works. In order to obtain the necessary load a New York Central heavy six-wheel engine was made use of and the electric locomotive truck coupled to it. The machines were then sent sent in opposite directions and tugged at the connecting coupling as in a tug of war. The electric locomotive had a slight advantage over the steam engine in weight on the driving wheels, and pulled it up along the track with apparent ease. For the same weight upon the drivers it was shown that the electric locomotive will start a greater load than the steam locomotive, the pull being constant throughout the entire revolution of the wheel, the difficulty of variation of pull coincident with the changes in the crank angles of the steam locomotive being eliminated. The test also proved that not only were the motors sufficiently powerful, but that the driving mechanism and armature couplings are amply strong to transit the torque of the armature to the axle.

Adelaide.—A curious mode of settling the question of lighting the streets of Adelaide by electricity or by gas has been adopted in that southern city, the matter being put to the vote of the ratepayers. Either the citizens of Adelaide are not aware of the superior advantages of arc lighting, or gas there has advantages which it does not possess elsewhere, for they voted in a small majority for gas.

LIGHT RAILWAYS.

REPORT OF COMMITTEE OF CONFERENCE.

The following is the report presented by its Committee to the Conference on Light Railways, called together by the Board of Trade. A full account of the discussion which arose on the report will appear in our next issue.

Your Committee have considered the subject referred to them, namely :

1. How far the usual requirements of the Board of Trade as to constructing and working new railways may fairly be relaxed, especially in the case of lines built through sparsely populated and agricultural districts?

2. Whether additional legal facilities for obtaining powers to construct tramroads and light railways are necessary or desirable ?

They have given special attention to the case of light railways in agricultural districts, and they have also considered tramways and tramroads, as well in rural districts as in urban districts not of the first magnitude, but under this head they have not considered the circumstances of main lines of railway or tramway, on which the traffic may be expected to be of great volume. For their guidance they obtained from the Board of Trade the Acts of Parliament and the existing regulations bearing upon the subject, and they consulted with its officers as to the practical effects both of the Acts of Parliament and the regulations upon railway construction and working. They were also furnished by the officers of the Board, by the Foreign Office, and by members of the Committee, with information upon the subject from abroad.

In compliance with a request made to him, Sir Joseph Crowe, K.C.M.G., C.B., has sent them an account of the law and practice in France, under which land is acquired compulsorily for railways of local interest in that country. The Committee consulted those of their number who are acquainted with special divisions of the subject. The information given by Mr. Jackson as to the views of the existing railway companies was supplemented by valuable evidence from Sir Henry Oakley, the honorary secretary to the Railway Association. Upon the information thus acquired, the Committee submit the following report :—

They find that the existing law in Great Britain specially affecting the construction and working of light railways is mainly contained in the Acts of 1864 and 1868, and the law specially affecting tramways in the Act of 1870.* In the case of tramways the law necessitates a confirming Act, even where no compulsory powers of taking land are demanded. Tramroads as distinguished from tramways, are only dealt with in a Standing Order of the Houses of Parliament.

Practically no light railways have been constructed under the general Acts of 1864 and 1868, owing, in part, it is alleged, to the consent of all landowners and other parties beneficially interested, and the absence of opposition from any railway or canal company, being necessary before the Act can be made use of. The mileage of such lines constructed under special Acts has also been inconsiderable.

This lack of progress in rural districts has also been in great measure due to the want of latitude left to the Board of Trade by law, and in other cases by the conditions which the Board considered it their duty to impose for the public safety. It has also been stated that obstacles have arisen in the case of tramways and tramroads in consequence of the local authorities requiring conditions which were considered too onerous by the promoters of new schemes.

The Committee believe that the impediments to construction may be greatly diminished, and that on a large proportion of such lines as are contemplated by their inquiry, the regulations which have been enforced with a view to public safety may be considerably relaxed.

In the case of lines of small traffic, having few trains in the day and working at a moderate speed, there is little risk compared with that occurring on great trunk lines having numerous sidings and branches, and carrying, at high and varying speeds, a complicated traffic of passengers, merchandise, minerals, and cattle, at all hours of the day and night. It seems reasonable that details as to route, width of gauge, fencing, level crossings, bridges, gates, the use of public roads, stations and station requirements, signals, continuous brakes, and many similar matters—unnecessary expenditure on which, taken together, adds greatly to the cost—should differ in different parts of the country, depending in each case upon the nature of the country, and the traffic to be conveyed. The same remarks apply to limitation of speed and regulations for ensuring reasonable safety in working. There are several other items involving expenditure, such as the provision for deposit of security, the lodging of plans, advertisements, &c., in which there is room for considerable economy.

The Committee think that it is not reasonable that undertakings of limited scope, when they are approved of by the locality they are intended to serve, should be forced, as they are now, to have recourse to the expensive tribunal of a parliamentary inquiry.

The Committee are of opinion that the recent creation of popular local authorities of various degrees throughout Great Britain opens the door to an escape from the great cost attending applications to Parliament, by enabling powers and responsibilities with reference to the authorisation and control of light lines to be conferred on those bodies, and that the time has arrived for Parliament to consider whether this should not be done, an ultimate appellate jurisdiction being reserved to the Government Department charged with the inspection of railways, which, it may be assumed, would be exercised with due regard to the existence of such local control and responsibility.

If this were done the initial cost of construction, and the expenses of working, could be so greatly reduced that many light railways and tramways, promoted either by independent companies, or by the existing lines of railway and tramway, could be undertaken to the great advantage of districts and especially agricultural districts, at present without satisfactory means of transport.

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* Railway Construction Facilities Act, 1864, 27 & 28 Vict. c. 121, Regulation of Railways Act, 1868, 31 & 32 Vict. c. 119, Part V., and the Tramways Act, 1870, 33 & 34 Vict. c. 78.

The Committee suggest that proposals for the construction and working of such lines should be submitted in the first instance to the County Council (with exceptional provisions as to large municipalities) subject to precautions ensuring that the interests of those directly affected are duly safeguarded. In all cases a majority of assents in number and value of owners and frontagers should be required, and in cases of compulsory acquisition of land there should be a power of appeal to the Board of Trade. If any doubt should arise as to whether a proposed line is a light railway to be dealt with locally, or is a scheme which, on account of its magnitude, or otherwise, should properly be dealt with Parliament, the Committee think that the Board of Trade should determine the question. The Committee are doubtful whether it would be within the terms of the reference to them, and they refrain from giving an opinion as to whether, and if so, on what conditions, it is desirable that local authorities should be empowered to contribute funds towards, or otherwise take part in, undertakings of this character.

(Signed) B. Samuelson (Chairman of the Committee), W. M. Acworth, B. Baker, M. E. Hicks-Beach, R. Melvill Beachcroft (subject to Appendix A), Cathcart, F. A. Channing (subject to Appendices B and E), Andrew Clarke, Edmond Fitzmaurice, Claud J. Hamilton, Alfred Hickman (subject to Appendix C), Henry Hobhouse, A. C. Humphreys-Owen (subject to Appendix D), W. L. Jackson, Wm. Thos. Makins, P. Walter Meik, A. M. Rendel, Albert K. Rollit (subject to Appendix G), Alex. Siemens, Samuel Storey (subject to Appendix E), Sutherland, Thring (subject to Appendix F). T. C. Farrer (Secretary to the Committee), 23rd January, 1895.

APPENDIX A.

MEMORANDUM BY MR. BEACHCROFT.

I have signed the above report agreeing generally with the suggestions so far as they go. I dissent, however, to the exclusion from the report of all reference to the case of tramways and tramroads in urban districts of the first magnitude, believing that even if all the suggestions referred to are adopted they will have little or no effect in solving the second of the two problems set before the Conference by the President of the Board of Trade, namely, that relating to congested populations.

The relief of the congestion of great cities, such as London, can only, as the President stated, be obtained "by providing for a better transportation of workmen to their work from suburban areas" or by enabling industries which "are now conducted in the large cities to be transferred to suburban or rural districts, by providing easier and cheaper modes of transportation from the places in which these industries would be established."

By limiting the object of the reference to the Committee, as is practically done by the Report, to the case of agricultural and small urban districts, the Committee is, I submit, shelving a responsibility which, if not undertaken now, must be undertaken before Parliament can be asked to deal with the general question.

The conditions affecting the construction and working of tramways and tramroads, whether as to safety of the public or otherwise, in the outskirts of London, differ only in degree from those applicable to such places as (say) Weston-super-Mare or Stoney Stratford—at all events, the evidence given to the Committee raised no serious distinction—in either case the main hindrances to development would apply equally; these are (1) the cost of acquiring the land where main roads are not available, and (2) the financial difficulty attending new enterprises in view of their being, to start with, almost necessarily of a profitless character.

A revision, by Parliament, of the provisions of the Lands Clauses Consolidation Act on the one hand, and the establishment of some system of guarantee on the other, are the points which seem most pressing for consideration, and I can only express the hope that the Conference itself will not rest satisfied without a further report on this important branch of the subject.

APPENDIX B.

MEMORANDUM BY MR. CHANNING.

While concurring generally in the Report, I wish to add the following notes on several points of importance which, in my opinion, are dealt with inadequately in the Report.

(1) The requirements of the Board of Trade as regards the equipment and safe working of railways are a less hindrance to the carrying out of light railways than the heavy and uncertain expenditure involved in opposed proceedings before Parliament, and in the cumbrous and costly machinery for the purchase of land.

The evidence shows that some of the requirements of the Board of Trade are recognised as indispensable by engineer experts interested in the promotion of light railways, as well as by the inspectors of the Board. It is, therefore, desirable to distinguish clearly between such requirements and other requirements which, however necessary on ordinary railways with heavy traffic and worked at high speed are practically unnecessary on light railways worked at low speed and under wholly different conditions, both as regards goods and passenger traffic. It would appear from the evidence that in most parts of this country efficient continuous brakes, at least on engines and passenger carriages, fencing, gates at level crossings, and some mechanical regulation of speed, will generally be indispensable, and that the speed should be restricted to a maximum of 25 miles an hour in the open country down to eight miles an hour or less in urban or suburban districts. In the second place, the weight of rails, the construction of permanent way and of bridges, the use of public roads, and other like matters, must vary considerably, according to the nature of the country traversed, and the character of the traffic provided for. In the third place, there are requirements, such as the provision of and equipment of stations and platforms, safety arrangements as regards signals and block working, &c., which will, in most cases, clearly be unnecessary on light railways of the type contemplated. As to the first of these classes, the Board of Trade will be exceeding what is likely to be sanctioned by public opinion if any substantial modification is made in existing requirements, unless in very exceptional circumstances. As to the second class, the Board of Trade should exercise the widest and fullest discretionary powers, dealing with each case according to the special circumstances. As to requirements of the third class, the Board should release light railways from such expenditure to the utmost, unless some urgent and exceptional state of things renders it indispensable.

(2) I think it is to be regretted that the Committee has made no effort to draw a distinct line between the light railways and tramways and tramroads contemplated by this inquiry and ordinary branch line of railways. As, however, the Committee have agreed to a paragraph which refers to the Board of Trade, the decision "whether a proposed line is, in fact a light railway, or is a scheme which, on account of its magnitude, should properly be dealt with by Parliament," it would, in my opinion, be only reasonable that the Board of Trade in legislating on the questions here considered, should introduce some definition which would serve as a guide to county councils, to promoters, and others.

In some districts it may be most desirable and reasonable that railway companies should extend their new branches in the form of light railways. But in other cases it might be a grave abuse for a railway company to construct or work, on the cheaper and less efficient scale, branch lines which, owing to the population of the district and the nature of the traffic, ought, in the public interest, to be carried out and worked as branch lines are now under the normal standards of railway equipment and working. I am convinced that Parliament and public opinion would rightly resent any attempt to lower the normal standard of ordinary branch lines to be constructed in future, which would result in unfairly sacrificing or restricting the conveniences, and diminishing the precautions for the safety of the public, in the interest of railway directors and shareholders.

(3) Where an independent company is authorised to construct a light railway forming a junction with an existing railway, the Board of Trade should have power to compel, if necessary, the existing railway company to grant facilities, and to make a fair adjustment of the cost of services and of the receipt of charges in respect thereof as between the railway company and the light railway company.

(4) I believe that it would tend to render the provision of light railways and tramways cheaper and more effective, and would also tend to induce county councils and urban authorities to contribute towards the expenditure necessary, or to guarantee such undertakings, if full powers were given to county councils and urban authorities to construct and work light railways on their initiative and responsibility, or to join with other county councils or authorities, or with any railway company or independent company, in constructing or working light railways. Where a county council thus carries out a light railway, it will obviously be necessary that the Board of Trade should be the confirming authority, and that all questions arising, whether of compensation or as to other disputed matters, should be decided by an arbitrator appointed by the Board.

(5) In any legislation as to light railways, tramways, or tramroads, I think the *employés* ought to be included in express terms among the railway servants to whom the Hours of Labour Railway Servants Act, 1894, applies, unless they are already so included.

APPENDIX C.

MEMORANDUM BY SIR ALFRED HICKMAN.

That the compensation to be paid for land taken compulsorily should be fixed by an arbitrator appointed by the Board of Trade, who should be instructed to take into account the value added to the remaining land of the same owner by the improved means of communication.

APPENDIX D.

MEMORANDUM BY MR. HUMPHREYS-OWEN.

While concurring generally in the report, I agree with Mr. Storey and Mr. Channing that powers in relation to light railways should be given to county councils. I think legislation desirable which would enable parts of rural counties to facilitate the construction of light railways, either by providing capital for or guaranteeing interest on the cost of construction of lines serviceable to the locality, but conferring no advantage on the county at large. Precedents for such legislation are to be found in the Lighting and Watching Act 1833, and the Acts relating to Commissioners of Sewers, especially Part II. of the Land Drainage Act 1861.

I think also that the attention of Parliament and of the Board of Trade should be directed to the evils caused by improvident methods of raising money for the construction of railways and tramways. Mr. Sellon mentions this at several points in his evidence (*qq.* 2,141—2,149; 2,305), and even goes so far as to say that it may be regarded as the largest head of expenditure (2,230, 2,231). Sir Henry Oakley lays down as one of the conditions of success for light railways that they should be "made with honest sovereigns" (2,348), and similar views are expressed by Mr. Acworth (1880, 1895), and from French information by Major Addison (1810, 1811). In my opinion unless a line is promoted by a public body or by an existing railway company, securities equal in value to the amount of the authorised share capital should be deposited by the promoters.

APPENDIX E.

MEMORANDUM BY MR. STOREY AND MR. CHANNING.

We are of opinion that it would largely tend to the multiplication of light railways and to their cheaper construction, and therefore to the greater probability of their being worked at a profit, if *at least* equal optional powers to those now possessed by borough councils in the matter of tramways were conferred by Parliament on county councils with respect to light railways and tramroads, with the possible additional power of assisting such projects by some provision of capital or by guarantee, on terms approved by the Local Government Board after a local inquiry.

APPENDIX F.

MEMORANDUM BY LORD THRING.

Highly as I approve of the report in general, I think, perhaps, that in working out the details of a measure it may be found desirable to make some modifications in relation to the intervention of the Board of Trade.

APPENDIX G.

MEMORANDUM BY SIR ALBERT K. ROLLIT.

I assent generally to the terms of the report, but expressly subject to the reservations in my remarks at the opening conference, and to some others in respect of tramways, especially town tramways.

THE CAPITAL INVESTED IN ELECTRIC SUPPLY.

For an industry which only received legislative sanction—encouragement it certainly was not—in 1882, and which only got fairly under way in the early months of 1890, a total capital expenditure of something like 7½ millions sterling is a sufficiently satisfactory record, all things considered. English electrical engineers, at any rate, can claim to have done all that engineering skill and foresight can do to render this capital expenditure remunerative.

Date est'blish'd.	District supplied.	Population.	Owners of Supply Station.	Amount exp'nded to Dec.31, 1894.
				£
1893	**ABERDEEN**	110,173	Local Authority	23.200
1894	**ABERYSTWITH**	6.696	Do.	N
1895	**ALTRINCHAM**	12.424	Altrincham Electric Supply	25 000
—	**†AYR**	24.800	Local Authority	12,000
1889	**BATH**	51.843	City of Bath Electric Lighting Company	46,087
1894	**BEDFORD**	160,704	Local Authority	12,000
1895	**BELFAST**	255.896	Do.	20,000
1890	**BIRMINGHAM**	478,113	Birmingham Electric Supply Company	80 000
	†BLACKBURN	120.064	Local Authority	32.000
1893	**BLACKPOOL**	23.846	Do.	50.000
1894	**BOLTON**	115.002	Do.	22,000
1889	**BOURNEMOUTH**	37.650	Bournemouth and District Electric Supply Company	55,000
1889	**BRADFORD**	216,361	Local Authority	64,500
—	**BRAY**	6.539	Bray Electric Light and Power Company	10.000
1894	**BRIDLINGTON**	8.909	Local Authority	N
1891	**BRIGHTON**	115,402	Do.	113.830
1893	**BRISTOL**	223,592	Do.	90.000
—	**BUCKINGHAM**	171,849	Buckingham Electric Supply Company	N
1893	**BURNLEY**	87.058	Local Authority	23.500
1894	**BURTON-ON TRENT**	46.047	Do.	30.000
1893	**CAMBRIDGE**	185,822	Cambridge Electric Supply Company	31,815
1895	**CARDIFF**	136.181	Local Authority	32,500
1893	**CARLOW**	6,900	Milford Electric Supply Company	1 400
—	**CHAGFORD**	...	Chagford and Devon Electric Light Company	2.000
1890	**CHATHAM**	95.000	Chatham, Rochester and District Electric Light Company	19,450
1890	**CHELMSFORD**	11.003	Chelmsford Electric Lighting Company	15,800
	†CHELTENHAM	42,914	Local Authority	16.000
—	**CHISWICK**	22.000	Do.	N
1894	**COATBRIDGE**	30,033	Scottish House-to-House Electricity Company	N
—	**†COVENTRY**	52,724	Local Authority	20.000
—	**COWPEN**	10.003	Sanderson & Co.	N
1893	**DERBY**	94.146	Local Authority	30.000
1894	**DEWSBURY**	29.847	Do.	25,000
1895	**DOVER**	33.300	Dover Electricity Supply Company	40.000
1892	**DUBLIN**	252.239	Local Authority	*30,000*
1893	**DUNDEE**	142.455	Do.	30.000
1894	**EALING**	24.000	Do.	25.000
1882	**EASTBOURNE**	34,977	Eastbourne Electric Light Company	38.000
—	**†EDINBURGH**	261,261	Local Authority	100.000
1890	**EXETER**	37.580	Exeter Electric Light Company	22.000
1891	**FAREHAM**	6.658	Fareham Electric Company	7.000
1889	**GALWAY**	15.000	Galway Electric Light Company	8.000
1893	**GLASGOW**	789.000	Local Authority	150.000
1894	**HALIFAX**	91.500	Do.	30 000
1894	**HANLEY**	54.946	Do.	21.000
1883	**HASTINGS**	52,340	Hastings and St. Leonard's Electric Light Company	*34,500*
1892	**HOVE**	27,000	Hove Electric Lighting Company	44.000
1893	**HUDDERSFIELD**	95,420	Local Authority	50.000
1893	**HULL**	208,639	Do.	35.000
1893	**KELVINSIDE**	...	Kelvinside Electricity Company	27.000
—	**KESWICK**	3,760	Keswick Electric Light Company	5.000
1893	**KILLARNEY**	5,204	Killarney Electric Lighting Company	5,300
1893	***KINGSTON-UPON-THAMES**	27.059	Local Authority	16.000
1894	**LANCASTER**	31,038	Do.	25,000
—	**LARNE**	6,000	J. E. H. Gordon & Co. (Limited) (in liquidation)	N
1887	**LEAMINGTON SPA**	26,930	Midland Electric Light and Power Company	32,000
1893	**LEEDS**	390,000	Yorkshire House-to-House Electricity Company	56.000
1894	**LEICESTER**	187,000	Local Authority	50,000
1884	**LIVERPOOL**	517,980	Liverpool Electric Supply Company	250,000
	LONDON:—			
1889	**Charing Cross**	...	Charing Cross and Strand Electricity Supply Corporation	215,400
1889	**Chelsea**	...	Chelsea Electricity Supply Company	118,785
1892	**City of London**	...	City of London Electric Lighting Company	900,000
—	**†County of London**	...	County of London and Brush Provincial Company	...
1892	**Crystal Palace**	...	Crystal Palace District Electric Supply Company	69,000
1894	**Hampstead**	...	Local Authority	29.000
1890	**Brompton**	...	House-to-House Electric Supply Company	350.000
—	**†Islington**	...	Local Authority	60.000
1886	**Kensington**	...	Kensington and Knightsbridge Electric Light Company	187,500
1885	**London (S.E. & S.W.)**	...	London Electric Supply Corporation	890,000
1890	**London (W.C., W. & N.W.)**	...	Metropolitan Electric Supply Company	*650,000*
1891	**Notting Hill**	...	Notting Hill Electric Light Company	82.890
1888	**St. James and Pall Mall**	...	St. James and Pall Mall Electric Light Company	223.000
1891	**St. Pancras**	...	Local Authority	150.000
1890	**Westminster**	...	Westminster Electric Supply Corporation	411.130
1893	**Woolwich**	...	Woolwich District Electric Light Company	N
1894	**LONDONDERRY**	33.728	Local Authority	15.000
—	**LYNMOUTH**	1,547	Lynmouth and Lynton Electric Light Company	N
1893	**MANCHESTER**	515,998	Local Authority	150,000
1892	**MORECAMBE**	6.476	Morecambe Electric Light and Power Company	6,752
1892	**NELSON**	22.700	Local Authority	9,305
1890	**NEWCASTLE-ON-TYNE**	197,026	Newcastle-on-Tyne Electric Supply Company	52.000
	Ditto	197.026	Newcastle and District Electric Lighting Company	53.000
—	**†NEWPORT (MON.)**	55.000	Local Authority	30.000
1891	**NORTHAMPTON**	61.778	Northampton Electric Light and Power Company	20.917
1893	**NORWICH**	104.000	Norwich Electricity Company	25 570
1894	**NOTTINGHAM**	220.000	Local Authority	45 000
—	**OGMORE VALLEY**	10,000	Ogmore Valley Electric Light and Power Company	5.000
1891	***OLDHAM**	131,463	Local Authority	24.700
1892	**OXFORD**	45.741	Oxford Electric Company	63,420
1894	**PORTSMOUTH**	159.255	Local Authority	76,385
—	**PRESCOT**	6.419	British Insulated Wire Company	10.000
1892	**PRESTON**	110.225	National Electric Supply Company	73,100
—	**READING**	62.000	Reading Electric Supply Company	30.000
—	**†RICHMOND**	22.500	Richmond Electricity Supply Company	21.000
188[illegible]	**ST. AUSTELL**	3.582	Veale and Co.	4.904
—	**†SALFORD**	198,136	Local Authority	32.000
1893	**SCARBOROUGH**	33,776	Scarboro' Electric Supply Company	25,000
1888	**SHEFFIELD**	334,585	Sheffield Electric Light and Power Company	57,125
1891	**SOUTHAMPTON**	65.325	Southampton Electric Light and Power Company	18.000

Date est'blished.	District supplied.	Population.	Owners of Supply Station.	Amount exp'nded to Dec.31, 1894.
1894	**SOUTHPORT**	43,026	Local Authority	16,000
—	†**SOUTH SHIELDS**	78,391	Do.	**N**
—	†**STAFFORD**	20,270	Do.	15 000
—	†**SUNDERLAND**	134,394	Do.	25,000
1889	***TAUNTON**	18,026	Do.	17 000
—	**THETFORD**	4,250	Thetford Electric Light and Power Company	4,000
—	†**TUNBRIDGE WELLS**	27,895	Local Authority	13,000
—	†**WALSALL**	71,791	Do.	19,000
—	**WEYBRIDGE**	4,000	Weybridge Electric Supply Company	**N**
1893	**WHITEHAVEN**	17,812	Local Authority	19.000
—	**WOKING**	10,000	Woking Electric Supply Company	**N**
1895	**W'LV'RHAMPTON**	82,622	Local Authority	30,000
1894	**WORCESTER**	42,908	Do.	52,000
1894	**YARMOUTH**	49,318	Do.	16,500

N indicates that no information is obtainable, or that the figures would prove unreliable.

Where figures are in italics, the information is obtained from the only available sources, and are put at a minimum.

* Authorised expenditure at *Glasgow*, £200.000 ; at *Oldham*, £27,000 ; at *Taunton*, £20.000. Application is now being made for power to borrow a further £100,000 by *Manchester*, and a further £10,000 by Kingston-upon Thames.

† Not yet in operation.

It will be seen from the above that the amount of capital actually expended is as follows :—

Companies	£1,977,420
Local Authorities	5.422,905
Total	£7,400,325

In addition to this amount, schemes for the establishment of electric supply stations are under consideration by a number of Local Authorities and companies (many of whom have already obtained the necessary Parliamentary powers), involving a large outlay, and a glance at the above list will show the number of stations which have come into operation all over the kingdom, and, therefore, what great progress has been made in the popularisation of electricity for lighting and power purposes since January 1, 1893, at which date only six local authorities and 17 companies were supplying current.

CORRESPONDENCE.

TO PROF. PERRY, AND OTHERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I must ask Prof. Perry to kindly exercise his forbearance for a time. I have reason to believe that I have other readers who have not had so much experience with operators as Prof. Perry. For their sake I do not think it desirable to complicate the subject at an early stage by introducing such advanced mathematical notions as the gamma function and generalised differentiations. As Prof. Perry will see in my last two articles, they are unnecessary in the present stage, and the work is done entirely without them.—Yours, &c.,

OLIVER HEAVISIDE.

"LABOUR-SAVING" APPARATUS AS AN INSTRUMENT OF EDUCATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Discussions are like rivers, they widen as they proceed. The controversy on a student's right to use direct reading ammeters or voltmeters has merged into broader questions of methods of physical laboratory teaching. In its original form the matter at issue was of limited importance; but the more general range which it has since attained makes it one on which most teachers will have some well-defined opinion. At the same time the controversy threatens to become somewhat desultory.

The really interesting question is not so much whether so-called direct-reading instruments shall be accepted as a starting point for a student's exercise, or whether he is to begin by an independent determination of the length of the seconds pendulum before he may use a watch with seconds hand, as the question of the kind of things he is to be taught to do. The student has to make a departure from *some* accepted facts in every piece of experimental work, and if you set him to calibrate his home-made ammeter with a copper voltameter you have to let him assume the received electro-chemical equivalent of copper. If that is not to be allowed he may ultimately find himself compelled to redetermine the length of the arc of a terrestrial meridian, construct a cubic decimetre to be filled with pure water at 4° C., and make a careful observation of the length of the pendulum giving mean solar seconds before he reaches any satisfactory basis for his calibration. The question of the point from which you start him is really to be determined by what you wish him to be able to do after giving to the subject as much time as most students are able to devote to experimental work. If the student is a potential examinee with a science examination in front of him as his goal, and with prospects of having to teach elementary physical science himself, then there is a great deal to be said in favour of making an acquaintance with the chief qualitative effects in physics through the medium of apparatus built up *ab initio* with his own hands, provided he has sufficient dexterity and time; but it is useless to talk of his doing any *exact* quantitative work by these means unless he has immensely more than the average finger craft. Accordingly, he may acquire in this way a good examination paper kind of knowledge of the principles of the science, but he is not trained in becoming an exact observer, and he is or may be as ignorant as a babe of actual and practical forms of instruments as used in the workshop or testing room, although he may be familiar with rough laboratory equivalents of them. Place such a student in the electrical testing room of a cable factory or dynamo builder, and he has to begin his acquaintance with the actual tools of his trade. "Yes, but," say the advocates of the jam-pot battery and home-made ohm, "he has had his mind so much strengthened by his previous training that he very readily assimilates the new knowledge."

I am sometimes tempted to think that we may overdo this cult of mind-strengthening education, and that the chief charge against much teaching is that it begins at the wrong end. The plain fact always remains that for most young people the chief end of education is that they may be enabled, in the first place, to earn a living subsequently, and they can only do that by being able to *do* something which the world wants done. Hence the system of teaching which begins by teaching certain things as an *art*, and afterwards, if there is time, considers them as a *science*, is more effective from a practical point of view than that method taken in the reverse order. We see the result of this latter process in the schoolboy waste of time over German and French language. He is taught, first and erroneously, language as a science. He can translate for you into excellent French, under the guidance of Ollendorf, "The lion was sitting in the house of the washerwoman," and parse every word of it; but he cannot speak the language "as she is spoke," and he cannot understand it when it is spoken. This is because we mostly teach language, which is first and naturally a branch of the great art of mimicry, unnaturally as a science. The moral of all this is that the technical student had better be taught as an art as soon as possible to use the tools of his craft. This does not assume that the teacher should neglect to instruct him in general principles, or that he is to be limited to you-press-the-button-and-we-do-the-rest sort of laboratory exercises; but it does mean that by working from the first with accurate and practical forms of apparatus he may be trained at the same time to gain accuracy in observation and knowledge of the actually used instruments. My experience is that even junior students take more interest in their laboratory work when they know they are working with the real thing, and can, with pains, get good quantitative results, than they do when merely limited to such rough determinations as they can get from the instruments made by themselves. The fact is that the technical student starts with the object of being made into a good user of known tools, and he no more needs to begin by making his galvanometer than he begins by making his lathe or slide rest. . . . If his goal is ultimately the workshop or factory, he has to learn to use the weapons with which he has to fight; and if he has only learnt to make certain little rough models of them he has still everything to learn.

It is impossible to disguise the fact that much educational work would be far better conducted if the abstract were approached through the concrete than *vice versâ*. Why is not trigonometry taught more on the drawing board, with protractor and a table of sines and cosines, and the chief formulæ demonstrated experimentally? Why should not the chief facts of dynamics be more generally taught with a good Atwood's machine, and not, as at present, only by bringing the student to algebraic symbols in a book? Similarly there is every possible advantage to be gained by introducing a laboratory student to quantitative physical work at a very early stage, carried out with good instruments, and getting fairly good results. It is sheer nonsense to say that the work is done for him by the instrument maker. He has to learn to read an instrument accurately first before he can get any results at all.

The fact remains that the character of the teaching must be to a large extent determined by the end in view. The technical student must be taught in a technical manner, and that largely means learning to use certain tools and to acquire certain arts of doing things. If he is properly taught he gains powers of accuracy, observation and acquaintance with exact processes. If he spends too much time in making his apparatus he has no time left in which to learn to use it, and his rough home-made equivalents are but a poor substitute for the real article. At the same time, I think a student not quite a beginner, and who has made the acquaintwith fundamental facts and laws should have opportunity to acquire experience in making up apparatus for special purposes and get an insight into requirements of construction. This, however, should come after, and not before he has proved to himself, as far as possible, the chief quantitative facts in the science he is studying.

I must not trespass more on your space; but my contention generally is that the physical laboratory training of the technical student, at least, should be governed by the principle of bringing the student as soon as possible to use accurate instruments and get quantitative results, and then go back afterwards, if he has time and inclination, and begin the simple instrument-making work.

With regard to the original question, it seems to me that the experiment about which all the dispute began was really wrongly named. It was not a determination of the mechanical equivalent of heat at all but a determination of the electrical equivalent, and the student was really engaged in testing the truth of Joule's law. Only he ought to have completed his work by testing the consistency of his ammeter and voltmeter. – Yours, &c.,

University College, London. J. A. Fleming.

THE BORCHERS BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The interesting Paper read by Dr. Borchers last October before the German Electrochemical Society led us to investigate the subject treated on the lines indicated by him, but with results differing widely from those he obtained.

Copper and carbon were used as electrodes, and as possible current generators, atmospheric air, and instead of pure carbon monoxide, usually coal gas (the results not being affected by this substitution), both gases being freed of carbon dioxide by caustic soda, before being admitted into the element.

The most important results obtained are the following, which, however, are only averages, the voltage being noticeably influenced by the velocity of the admitted gases, and more especially by the unavoidable process of oxidation of the solution.

Solution, gr.	A. Without air.	B. Coal gas and air.	C. Air alone.
200 HCl, 200 H_2O, 40 Cu_2Cl_2	0·012	0·08	0·5
100 NH_3, 300 H_2O, 40 Cu_2Cl_2	0·08	0·12	0·26
450 NaCl conc., 15 Cu_2Cl_2 ...	0·06	0·11	0·16

Resistance = 60 ohms.

The E.M.F. was measured by being compared with the 1·1 volts of a Daniell cell, with the help of a reflecting galvanometer. For the figures under A the solutions could not be kept intact, although prepared in an atmosphere of coal gas, on account of the great avidity with which they absorb oxygen, and therefore are possibly too high. Those of B were read off four minutes after the opening of the gas cocks, and while the current was steadily increasing, for as soon as air was introduced into the inner cell it was, impossible to prevent its rapidly oxidising contents—by regulating the gas supply—from gradually spoiling the remaining solution through the clay partition, cuprous chloride, Cu_2Cl_2, being oxidised, in all probability to copper oxichloride, $Cu_4Cl_2O_3$, the copper plate invariably attacked, and various salts formed. It is impossible to give data expressing the dependence of the current on the corrosion of the plates, as suggested; as the latter, even though almost completely protected from oxygen, were attacked by the solutions used, independently of the production of current.

Finally, no carbon dioxide whatsoever could be detected in the escape gases from any of the elements, nor was any carbonate found in the ammoniacal solution.

In defence of Dr. Borchers it must be said that the poor results obtained when both electrodes are of carbon, are not decisive, as the action of copper might possibly fall under the head of a phenomenon similar to catalysis, and play an important part, without a loss of weight in the plates.

However, the above results point most decidedly to oxygen and copper as sole current generators, and if Dr. Borchers remains silent much longer, it will seem as if he, too, had been forced to give up the ideas originally advanced.—Yours, &c.,

H. H. Barnes, jun.
Laboratory for Technical Chemistry, E. Veesenmeyer.
Polytechnicum, Stuttgart, Jan., 1895.

[The controversy has reached a point at which a reply from Dr. Borchers would be welcome.—Ed. *E.*]

DEATH FROM ELECTRIC SHOCK.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: A death occurred here the other day resulting from a shock, and as the circumstances are, to say the least, unusual, I should be glad to know if any of your readers know of a similar case occurring elsewhere.

A 52-volt 16-c.p. lamp was suspended in a stable, and upon a man attempting to turn it on, he received a shock which resulted in his death. He was at the time standing in his bare feet on the damp ground.

Upon testing the transformer the following morning I found the insulation between the primary and secondary down to 0·17 megohm. The insulation of the feeders and mains the afternoon of the accident was about the same as usual, as it also was the following morning, so that the earthing of the mains was only momentary. We run here at 1,000 volts primary, with overhead wires.

I shall be glad to learn if there is any company who have adopted an earthing device, and if they insist upon its use; and if so, if it has been found satisfactory, and to answer its purpose.

I am sending you a paper containing a full account of the accident and inquest, &c., by this mail.—Yours, &c.,

Georgetown, Demerara, Arthur H. Shaw.
January 10, 1895.

THE FIRST POLYPHASE MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I notice that in the issue of your valuable paper for January 14th, Prof. S. P. Thompsen published under the above heading the description of an apparatus exhibited by Mr. W. Baily before the Physical Society of London on June 28, 1879.

Kindly allow me to point out, in reply to Prof. S. P. Thompson's remarks, that the credit of priority in the invention of the rotary field motor is rightly due to Prof. A. Pacinotti, for having, as early as 1873, advanced in the periodical *Il Nuovo Cimento* the suggestion of a similar but more perfect arrangement than that proposed by Mr. Baily.

Prof. Pacinotti's apparatus consists of a fixed ring-wound armature, divided into 24 sections, and connected with the bars of a commutator in the usual way. By connecting a pair of brushes, movable around the periphery of the commutator, with the poles of a battery, a magnetic field of variable direction arises from the currents in the winding; and if the brushes are made to revolve, their motion is followed exactly by that of a permanent magnet pivoted in the centre of the armature. It was remarked by Prof. Pacinotti that, as neither the armature nor commutator were required to rotate, they might be kept entirely separate, the only connection between them being established by a line of 24 wires.

This instrument, originally intended for transmitting signals in a quadrant telegraph, may be properly considered (so far as I am aware) as the first example of a rotary field motor; it embodies, in a practical form, the advantages which in Mr. Baily's motor could only be secured by greatly increasing the number of magnets.

It should be noticed, however, that, even in Prof. Pacinotti's instrument the field only shifts with discontinuity between successive positions, although the conditions of a continuous rotation are more closely approached than is the case with Mr. Baily's method. Moreover, both instruments are fed, not by alternating, but by continuous currents, periodically reversed in the various parts of the winding by means of a commutator. The principal feature of polyphase motors is, therefore, absent; viz., *the continuous rotation of a magnetic field, obtained by means of alternating currents.* The merit of *that* discovery, however, still remains with Prof. Ferraris.—Yours, &c.,

Rome, January 26, 1895. G. Giorgi.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Prof. Pacinotti's motor of 1873 is quite well known to me. It lacks the essential feature of the polyphase motor—namely, the driving by *induced* currents. In its production by revolving contacts of a successively displaced polarity, it unquestionably anticipated some of the ideas patented in 1888 or 1889; but in this very feature it was itself anticipated by several still earlier forms, as by Wheatstone about 1849. As to the similarity between Baily's motor and the modern two-phase motors with alternate currents, permit me to point out that Baily, not having two alternate currents in quadrature, imitated them artificially by a commutator at the generating end of his lines. His motor works perfectly well when supplied with alternate currents as a two-phase motor. This cannot be said of the Pacinotti motor with its twenty-four line wires.—Yours, &c., Silvanus P. Thompson.

January 29, 1894.

THE ORIGINAL CROMPTON WORKS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have read your leader in the current number of *The Electrician* on Mr. R E. Crompton, this year's President of the Institution of Electrical Engineers, with considerable interest; but think a small addition might be made to fill up the gap between his Indian experiences and what may be called the commencement of his electrical career, as his electrical business did not commence with the manufacture of Bürgin machines and Crompton-Crabb arc lamps, as your article would lead one to suppose. The use of the Gramme machine, and the manufacture of his own first successful arc lamp preceded these. There is an old saying that a successful business often commences with a man and a boy, and this can fairly be applied to Mr. Crompton's electrical business, where Mr. Crompton was emphatically the man and the writer his boy.

The nucleus of the present electrical manufacturing business commenced early in 1879, at the Anchor Iron Works, Chelmsford, in a room about 20ft. by 14ft., and it was here that Mr. Crompton's first successful arc lamp was developed. His lamp afterwards had a share in obtaining at the French International Electrical Exhibition held in Paris, 1881, the first gold medal ever awarded to the firm. This pioneer success has proved the forerunner of a series of "golden" distinctions wherever the firm has exhibited. I cannot help being proud of having been the first man employed in Mr. Crompton's electrical business, which has by his skill and indomitable energy, developed into one of the largest electrical engineering establishments in the United Kingdom.

I have long ceased to be in Mr. Crompton's employ, but since leaving him have had the pleasure of executing many large orders for him and his firm, and have also to thank him for the valuable advice he has rendered me on several occasions. Personally, I am most pleased to find Mr. Crompton's energetic endeavours in the electrical profession are meeting with their just reward, both from his *confrères* and the public generally, and trust that his year of office will be one long remembered in the annals of the Institution.—Yours, &c,

Bradbury Electrical Works, A. P. Lundberg.
Bradbury-street, Kingsland, London, N.,
January 30, 1895.

MR. CROMPTON'S LOAD CURVE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The diagram of the combined output of the electric light companies of London, as given in Mr. Crompton's address, is, of course, very interesting; but it may mislead some persons to whom the following considerations may not occur:—

First.—As the bulk of this supply goes to the west end of London, where clubs, theatres, taverns, and other places of entertainment keep very late hours, the load factor is more favourable than it would be even in other parts of the metropolis.

Second.—The people of London in general keep later hours than the inhabitants of provincial cities and towns.

Third.—The day selected being the shortest in the year shows a load factor the most favourable out of the whole 365, supposing, of course, that no special consumption arises from fog. It would be desirable also to know what was the total delivery on the day in question. Of course, it may be calculated from the diagram, but the small scale of this may lead to error.

I would, therefore, ask Mr. Crompton if he would favour us with similar diagrams for March 22nd, June 22nd, and September 22nd. I am sure Mr. Crompton, or some other electrical engineer, can furnish you with similar diagrams for provincial central stations.

If they are of sufficient interest, I will be happy to send you corresponding diagrams of gas consumption in this city. It will show what the public demand for light is under normal circumstances, as we are scarcely ever troubled with serious fogs in the south of Ireland.—Yours, &c., Denny Lane.

Cork, January 26, 1895.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

SPECIAL NOTICE.—**The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK will be READY ON FEBRUARY 8th. Subscription orders should be sent in immediately. In addition to the old well-known features of the book, which will be brought up to date, a quantity of new and useful matter will be added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Although about 100 pages are added to the book, no addition is made to the price, which is 5s. (by post 5s. 9d., abroad 6s. 4d.) before publication; after publication 7s. 6d, post free 8s. 3d., abroad 8s. 10d.**

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices:—*

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is just out, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

Tenders Invited.—The Ryehope and Silksworth Industrial and Provident Society (Limited), Ryehope, near Newcastle, invite tenders for the installation of the electric light into their trading premises. Tenders have to be in by 2 p.m. to-morrow (Saturday).

——— Our advertisement columns contain a notice that the Weybridge Urban District Council invite tenders for the public lighting of the district on and after September 29th next. Tenders, stating the number of public lights proposed, the illuminating power and price per light, must reach Mr. George Wheeler, the clerk *pro tem.* to the Council, before February 20th.

——— Tenders are invited until February 7th by the French General Direction of Posts and Telegraphs for the supply of 850 tons of galvanised iron wire and 25,100 galvanised iron brackets.

Sale by Auction.—Catalogues are now ready of the valuable modern electric lighting plant, instruments, arc lamps, transformers, cable, stores, &c., which are to be disposed of by Messrs. Wheatley Kirk, Price and Goulty at the central station of the Brighton and Hove Electric Light Company, Gloucester-road, Brighton, on Wednesday next, February 6th, at 10 for 11 o'clock prompt. Included in the sale is a quantity of heavy plant and apparatus in perfect condition, including 50-H.P. nominal compound semi-portable under-type engines with locomotive boilers by Fowler of Leeds, Lowrie-Parker alternating-current dynamos, Lowrie-Hall transformers, switchboards, &c., &c., which may be viewed the day prior to sale, and of which some further particulars are given elsewhere.

New Offices.—Messrs. H. Whitmy Smith and Co. (late Smith Brothers), of Northampton, have opened a head office at 46, Strand, London, W.C., where all correspondence is to be addressed.

Business Notice.—Mr. S. Jevons, who for some years carried on the Midland branch of Woodhouse and Rawson United (Limited) at the Minories, Birmingham, has now purchased the business from the Receiver and Manager. Mr. Jevons proposes to make the principal feature of the business a depot for electrical supplies for contractors and the trade generally.

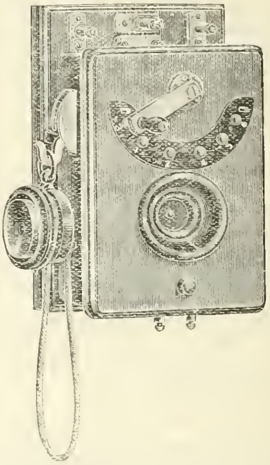
Anti-Friction Bearings.—The Auto-Machinery Company (Limited), of Read-street, Coventry, are manufacturers of the patent anti-friction bearing, constructed for heavy machine shafts, and adaptable to almost any purpose by a slight modification of the bracket. These bearings are being used for dynamos, motors and motor generators, the main spindles of lathes, drilling and milling machines, carriage axles, shafting, &c. It is claimed that they effect a considerable economy of power, a saving in oil and attention, and that they are simple in construction and easy to adjust. In machine tools the thrust is taken without the intervention of collar or pins. These bearings have recently received a very favourable testimonial from Dr. E. Hopkinson.

Cartridge Manufacture.—The Electrical Installation Company have recently introduced a mechanical contrivance worked by a small electromotor, by which important improvements are effected in the final stage in the manufactures of sporting cartridges. It is claimed that this can be economically worked and is extremely accurate, an important feature in cartridge manufacture.

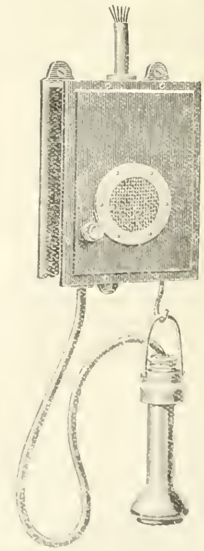
Chloride Accumulators.—We have received a copy of the new catalogue and price list issued by the Chloride Electrical Storage Syndicate (Limited), describing the manufacture and various forms of the chloride storage battery. Numerous illustrations of the forms and arrangement of the plates are given; and there are tables of prices, &c., in which the capacity and charge and discharge rates of the batteries are tabulated. The catalogue should prove useful to engineers and others requiring to specify or erect storage battery plant.

An Improved Duplex Steam Pump.—Messrs. Cole, Marchent and Morley have introduced a new duplex steam pump, which they call the "Prospect." It is claimed to be the only direct-acting pump in the market which can be made to work and use steam expansively, with a consequent saving of steam. This expansion is capable of variation, and it is stated to possible to pump a greater quantity of water than by any other pump of the same size now in rule. For electric light stations it is claimed that the economy of steam obtained by this pump will be of great advantage, without adding to the complication of the installation. The distinctive feature of the Holehouse and Morley duplex pump is, that the steam in each cylinder is distributed in each cylinder by compound motion, each set having part control of its own and its neighbour's valve, enabling the pump to be worked expansively according to the relative proportion of the levers. To enable the engine to be easily started, and to run slowly, hand wheels are provided to give adjustment to the expansion from about [illegible] to full length of the stroke. Each adjustment can be made and be easily seen by an outside indication whilst the engine is in motion. The compound action causes the pump to run nearly as though the cylinders were coupled to cranks at right angles; consequently, as both pumps are always in motion at the same speed, the "Prospect" pump will lift twice what is lifted by an ordinary duplex pump.

Domestic Telephones.—Messrs. Gent and Co., of Leicester, have recently introduced what they term the "Retiring Hook" system of telephones, which is claimed to work for the simplification and cheapening of telephonic communication between the different rooms of large buildings and institutions. The system is named from the method adopted to avoid the frequent annoyances caused in "direct call" systems by the switches being left as last used, either through carelessness, or by the springs which should regulate them failing to act. The instrument used in this system is shown in the illustration. The receiver hook disappears into the instrument as soon as the switch is moved and the receiver is taken off. The operator, therefore, cannot hang up the receiver again until the switch is put "home." The instrument is very simple, effective, and cheap, and, as the firm is well known for its success with intercommunication sets, their experience should be of service to those requiring these instruments.



Mining and Engine-House Telephone.—The accompanying illustration shows the new mining and engine-house telephone which has recently been put on the market by the General Electric Company (Limited) to meet the demand for a serviceable instrument to stand a great amount of rough use, and to be practically impervious to injury from moisture, dust, &c. The containing case



The Mining and Engine House Telephone.

is of cast-iron, with front screwed on, and with india-rubber packing between the sides and front of case. Special precautions are taken that no moisture is admitted through the mouthpiece of transmitter, or at the point through which the switch-hook enters the case. The receiver is made of gun-metal, and is solid and substantial, The flexible cord which connects the receiver with the case is protected by a steel flexible tube, which passes through a stuffing box into the interior of the case at one end, and into the interior of the receiver at the other end. The whole of the movement inside the containing case is mounted on a slab of ebonite, so that the working parts are insulated from the metal case. This instrument will prove serviceable to colliery proprietors and others, who have hitherto been unable to avail themselves of the convenience of the telephone. With this combination the "Hunningscone" transmitter is used. The General Electric Company has recently taken over the Anders Telephone Company's business, and is now selling the Anders Telephone for domestic purposes, under the name of the "Stanley Telephone." This instrument can be readily attached to existing bell wires.

"Blackley" Tape.—Messrs. Connolly Bros. have just introduced this material, intended for the efficient protection of insulated wire joints, leading-in wires, &c. Amongst the advantages claimed is that no insulation is required, and that the tape does not stick to or dirty the fingers. The tape is made of strong cloth, heavily impregnated and coated on both sides with an india-rubber compound of highly insulating and preserving properties, the layers of which stick strongly to one another, and will not unwrap even when exposed to the weather. This result is obtained without the use of naphtha, india-rubber solution, or other solvent. There is no waste, as the tapes are each rolled in separate packages and rolls convenient for storing. A trial of this material is solicited by the makers.

Medical Electrical Institute.—Mr. Justice Kekewich, on the application of a debenture-holder, granted an order for the appointment of a receiver and manager of "the Medical Electrical Institute."

Exhibitions.—An exhibition of agricultural machinery is to be held at Vienna from May 4 to May 7th, and M. Stockinger, Austrian Consul-General, 11, Queen Victoria-street, London, will give all information concerning space. The exhibition will include engines, tools, electrical machinery used in saw-mills, and celluloid factories, &c.

Bordeaux Exhibition.—February 28th is the closing date for applications for space to be lodged with the Société Philomatique de Bordeaux, or with the secretary of the London Chamber of Commerce. The Exhibition opens at the beginning of May next, and closes in November. The society is particularly anxious to have a representative display of electrical plant and apparatus from British electrical firms.

Smart Work.—Messrs. Rashleigh Phipps and Co. received an order on Monday afternoon last to install 200 lights in the Book, News, and Fancy Trades Exhibition at St. Stephen's Hall, Westminster. The work was completed by Tuesday morning.

"The Journal."—The *Journal* of the Institution of Electrical Engineers is now ready, and can be obtained of the publishers, Messrs. E. and F. N. Spon, 125, Strand, W.C., price 5s.

Abercanaid (South Wales). The electric light is in full use at the Plymouth Colliery Works, Abercanaid, and it is proposed to extend the mains to private houses in the neighbourhood. The streets are lighted by electricity, but for private lighting oil is the principal illuminant.

Belfast.—As notified in our last issue, the supply of electric current was switched on on Wednesday last, the Lord Mayor of Belfast and Mr. Alderman Pirrie, together with Mr. McCowan, the borough electrical engineer, participating in the function. In the evening about 2,000 lights were supplied to about 40 subscribers in several of the principal throughfares. In the Theatre Royal, at which an exhibition of the light was given in the evening, the trial proved most satisfactory.

Blackrock (Ireland). At the last meeting of the Town Commissioners a reference was made to the electric lighting question. The Chairman pointed out that no scheme was at present before the Commissioners. It was true they had a certain amount of spare plant, and the Dublin Electric Tramways Company had informed them they could supply current for electric lighting purposes. As, however, this combination of traction and lighting was contrary to his judgment he recommended that the matter be left in abeyance for the present. The Tramway Company had notified that they hoped to begin work on the electric tramways at the beginning of February.

Brighton.—In accordance with an arrangement come to in November last the Mayor of Brighton presented Mr. Alderman Moon, on behalf of the Corporation, on Monday last with a copy of the resolution drafted by his colleagues on the Lighting Commitee in appreciation of his services as chairman of that body. At the banquet the Lord Mayor, the members of the committee, the Town Clerk (Mr. F. J. Tillstone), and Mr. Arthur Wright, the Corporation's electrical engineer, were present. Expression was given by the Mayor to the high sense of the valuable services rendered by Alderman Moon, which was entertained by all the members of the Corporation, and the Brighton public generally, for the most efficient services rendered by that gentleman in connection with the electric lighting of the town.

Bristol.—The Sanitary Committee of the Corporation have been notified by the Electrical Committee that the disused gas lamps in the streets now lighted by electricity may be removed.

Cambridge. Reference was made some time back to the efforts of Mr. Bartholomew to provide the electric light for the skating at Newnham. The ice was opened to the public a few days back, and the addition of the electric light was fully appreciated by a tremendous crowd. The venture may be voted a complete success.

Cowes (Isle of Wight).—The Lighting Committee of the District Council have received an application from Messrs. Reider and Co., electrical engineers, asking the Council's sanction to an application to the Board of Trade for a licence to lay electric lighting mains along the principal thoroughfares of the town. The Committee, however, recommended that if the work was required to be done the Council should themselves carry it out, and give the Committee authority to make careful inquiry as to the cost of plant, maintenance and working. It was agreed to refer the report back to the Committee, in order that they might obtain further information on the subject.

Church Lighting.—The arrangements for lighting St. Thomas's Church, Nottingham, by electricity, are nearly complete. The work is being carried out by Mr. R. S. Blackburn.

Destructive Fire.—On Thursday morning a serious fire broke out at Bournbrook, the electrical depot of the Birmingham Central Tramways and Telegraph Company. The fire appears to have commenced in the switch room and battery house adjoining. The damage was confined to a comparatively small area, but would appear to amount to about £2,000. The battery house and switch room were gutted, and the valuable electrical plant rendered useless. Owing to the fire, the running of the electric cars was suspended on the Bristol-road, but it is hoped that their running will be resumed on Monday next.

Dundalk.—At the last meeting of the Town Commissioners a motion was discussed urging the necessity for steps being taken to carry out the terms of the electric lighting licence, for which a renewal for three years was obtained about 12 months ago. It was urged that if the Commistioners were not prepared to recommend a general lighting scheme on a considerable scale they could at least light the principal open spaces and municipal buildings of the town. A report is to be prepared by the Borough Surveyor as to a scheme best suited for the town for which water power from Ballymahellet may be utilised. It was considered probable that private firms would be willing to tender for lighting the district if they were approached.

Fareham.—A special meeting of the Urban District Council, called to discuss a resolution proposing the rescinding of a motion passed by the late Local Board, has been held, and a resolution was adopted asking the Local Government Board to withhold its sanction to the proposed borrowing of £7,000 for the purpose of paying out the Fareham Electric Lighting Company and the purchase of its undertaking by the Council. This action is taken practically at the instigation of the Local Government Board, as a letter was read at the meeting in which it was stated that the inspector appointed to inquire into the subject was not satisfied that the proposal to purchase the undertaking was in accordance with the general wishes of the ratepayers. The meeting was adjourned until this day (Friday), when a motion will be made that an offer be submitted to the Company to pay them an additional £150 per annum for lighting the town until the termination of the Company's existing contract in September, 1896, subject to certain conditions, the payments under the new arrangement to commence from March 1st next, one of the conditions being that the Company shall withdraw, unconditionally, the *quasi* contract for sale and purchase by the Council. It will be remembered that the Company are under contract to supply the district with electric current to September, 1896, unless the proposed purchase is carried through.

Hackney (London, N.E.). The electric lighting question was discussed at the last meeting of the Vestry. It was stated that the Provisional Order obtained some time ago expired this June, and unless the Vestry took immediate steps the power would most likely be taken out of their hands, and a local company formed to introduce the electric light. It was unanimously decided that the Vestry should keep the matter in their own hands. A new committee was appointed to make full inquiries, with special instructions to consider the question of utilising the dust destructor in connection with any electric lighting scheme. Mr. Charles Button, J.P., is Chairman *ex officio* of the Committee.

Johannesburg.—The satisfactory progress of the public electric lighting scheme at Cape Town is reviving interest in the subject of electric lighting at Johannesburg. The following is from *South Africa* :—"In view of the acquisition by the Sanitary Board of the Johannesburg Lighting Company's plant, the electrical lighting scheme at Cape Town, which is now nearly completed, should have some attention. I mentioned some time ago the unreasonable rates charged here for electrical lighting, and the impossibility of people with limited means availing themselves of a system which is much safer, cleaner, and generally more desirable than the use of gas for lighting purposes. If Cape Town should be able to do all that is anticipated in the electrical system which is being installed, Johannesburg should certainly be able to do the same, or better."

Killarney.—Judge Shaw, it will be remembered, deferred his decision in the action brought by the Killarney Electric Light Company against the Killarney Town Commissioners for the amount of their account for electric lighting. This decision has now been given in favour of the Electric Lighting Company's claim. The defendants' plea was that they were not liable for the supply of electric current, but that the members of the the Town Commissioners who had signed the order were individually liable. There are two parties on the Board—one in favour of gas, and the other in favour of electricity. The Judge's decision does not appear to have given universal satisfaction, and, therefore, notice of appeal was lodged.

Lambeth (London, S.E.)—To discuss the report presented by the clerk in accordance with the instructions of the Vestry, a meeting was held last week, at which, after full consideration, it was decided that a special meeting of the Vestry should be held early in February to further consider the matter, and notice was given of a motion that the Vestry's order shall be unconditionally surrendered. The stronger party on the Vestry, however, are apparently opposed to this course, and favour the retention of powers by the Vestry.

Lancaster.—The District Council, before giving it sanction to the application of the Windermere Company in its application for a Provisional Order, have appointed a small committee to examine the plans of the Company with the view of extending the area proposed to be lighted under the Company's scheme.

Leeds.—On Monday next the Corporation will meet to discuss a further report from the City Engineer on the subject of the proposed electric tramways. The Tramways Committee of the Corporation have unanimously decided in favour of the electric overhead system in preference to that of cable traction. From the report presented to the Committee it was shown that the cost of cable traction would be about £3,000 per mile more than the cost of the electric overhead system, with an annual saving of about £10,000 per annum on the latter over the former. To overcome an objection which has been raised against the electrical system, that the passengers must always ride inside, it is proposed to have double-decked cars, to carry about 50 passengers. The Committee have been brought to favour the electrical system from the fact that the conditions which go to recommend the cable system do not exist in Leeds, where gradients are the exception.

Liverpool.—Notice of motion has been given for a special meeting of the Corporation to be held on the first Wednesday in February to consider the resolution passed at the last meeting of the Electric Lighting Committee with reference to the proposed application for an electric lighting licence. Negotiations are still proceeding between the Corporation and the Liverpool Electric Supply Company as to the terms of purchase of the latter's undertaking, but have not, we understand, arrived at a stage to warrant any public announcement on the subject.

London County Council Projects.—According to an interview reported in the *Echo* of January 29th, the London County Council are examining carefully the draft agreement between the Postmaster-General and the National Telephone Company, with a view to putting before the public a competitive scheme to supply London with a telephone service, which is "to be cheaper and more effective" than the present system. Under the scheme the Council proposes to acquire the entire telephone system for London.

Luton.—No objections have been lodged to the Town Council's proposal to obtain an Electric Lighting Order.

Madrid.—From a foreign source we learn that the customers of the Compañia Madrileña recently held a meeting at Madrid at which demands were made upon the Company (1) for an indemnity against loss incurred by the recent failure of the Company's electric light supply ; (2) for an improvement in the meters used by the Company ; and (3) a reduction in price of 10 per cent. It is stated that, after a lengthy deliberation and correspondence with the head-quarters of the Company in Germany, the demands of the meeting have been complied with. We give this report for what it is worth, and are prepared to learn that there is but little truth in it. We have authority for saying that no such demands have been made by the customers of the Electricity Supply Company for Spain, whose head-quarters are in London.

Manchester.—The report of the Directors of the Athenæum states that the most important matter in connection with the progress of that Institution during the past year has been the installation of the electric light, which has resulted in immense improvement to the lighting and ventilation of the Institution, calculated to reduce future outlays upon painting and cleaning to the smallest limits. The cheerful appearance of the light, combined with the healthiness of the atmosphere, has proved a great attraction to the members.

Newark.—At a general meeting of the Urban Sanitary Authority, on Monday last, the question of the proposed purchase of the gas works was discussed. It would appear that the difference between the price offered by the Corporation and that which the gas company are willing to accept is £12,000, and it was pointed out at the meeting that at present they were paying about £700 per annum for public lighting, whereas for about £10,000 they could build works capable of supplying the electric light, with current to spare for private lighting. The authorities have in their possession a quantity of machinery lying idle which could partly be used for the purpose, and the old water-works building would be suitable for a site for an electrical supply station. The Gas Committee's minutes were approved, and the subject of electric lighting will be further discussed at a future meeting.

Nottingham.—Extensions of the electric lighting mains are being made in this town, several of the leading thoroughfares having been recently added to the lighting area. These include Chapel Bar, Park-row, Regent-street, Oxford-street, North Circus-street, and Derby-road. Additional arc lamps have been erected in the market-place.

Personal.—We are asked to state that Mr. J. Watts has terminated his connection with the firm of Messrs. Ronald A. Scott and Co. (Limited).

Portsmouth.—At the last meeting of the Town Council a resolution was passed as follows : "That all the Corporation and urban sanitary offices, and all the police stations, fire stations, and stables belonging to the Corporation of the Borough of Portsmouth (within reasonable distance of the electric mains), which are at present using gas as an illuminant, be at once provided with the necessary fittings, and supplied with electric current from the Corporation electric supply station." Mr. H. R. Pink, in moving the resolution, said that Portsmouth had the finest electric lighting system in England, and urged that it should be utilised as far as possible. Mr. Alderman Ellis, Chairman of the Electric Lighting Committee, stated that the Corporation were producing their current at 2·4d. per unit, which was the lowest cost of production in the kingdom.

Reading.—The Reading Electric Supply Company announce that they will shortly be able to supply current to a large number of the additional thoroughfares.

Rhondda Valley.—A short time back the five wards of the Rhondda Urban District Council appointed a Special Committee to formulate a scheme for lighting the whole the Valley by electricity, and this Committee has met to consider the replies received from the various colliery companies on the subject. These replies are considered to be favourable to the scheme, and it is expected that current will be obtainable in this district at a price competing favourably with gas. It is understood to be the intention of the committee to recommend that the scheme be carried out in sections.

Skye.—We have received from Mr. R. A. Smith, of Messrs. Waygood and Co., the following particulars of electrical plant he has recently erected in Skye : "The installation was to the order of Mr. L. MacDonald, of Skeabort, and was for lighting his mansion with about 200 lights, the power being derived from the Skeabort River, where a fall of 15ft. was obtained some 220 yards distant from the house. I used a horizontal 'Waverley' turbine by Messrs. Carrick and Ritchie, of Edinburgh, and, owing to floods, &c., had to place the turbine on the top of the fall, and work by suction only, and this has been most successful. The turbine runs at 100 revolutions, driving the dynamo by belt. The dynamo is an Elwell-Parker 800 revolutions 150 volts, and is connected to the house by underground concentric cable, lead-covered, drawn into iron pipe for protection. At the house I have an accumulator consisting of 55 Epstein cells, which are working splendidly ; a separate regulating lead drawn in with the main leads enables the dynamo voltage to be regulated from the house. Underground leads connect the stables, which are lighted throughout. Special fittings were designed by the architect, Mr. Alex. J. Williamson, of Glasgow, for ball room, billiard-room, &c. Very great interest has been taken in this installation by the natives of the island, and the excitement was great when we started a search-light from the tower. The cables throughout are by Messrs. W. T. Glover, Salford, and the fittings by the General Electric Company, also sundry electric heating apparatus and switchboards."

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

January 1, 1895.

30. J. C. Quinn and R. McDougall. Pendleton. Improvements in gear wheels for electromotors and applicable to other purposes.

42. Max Binswanger. London. Improvements in and connected with telephonic apparatus, as adapted to mining and other purposes.

47. W. H. Brodrick and J. S. Banks. London. An improved dial for ships' telegraphs and the like.

52. W. Biddle. London. Improvements in electric light apparatus for railway cars.

56. Siemens Bros. and Co. (Limited). London. Improved electric cut out. (Messrs. Siemens and Halske, Germany.)*

57. J. Hopkinson. London. A method of ascertaining the difference of electric potential at a distant extremity of conductors.

60. W. Stevens. London. An improvement in electric arc lamps.

65. The London Electric Wire Company (Limited) and J. Willey. London. Improvements in dynamo brushes.

79. J. Manning. London. A new or improved machine for facing, thicknessing, and surfacing electro, stereo, and zinc-mounted blocks, also for surfacing solid metal for type-high or other desired thickness of work ready for printing.

82. C. Arnold. London. Improvements in and relating to electric winding mechanism for clocks.

January 2, 1895.

106. E. M. Levetus and H. Levetus, and W. Rowbotham. Birmingham. Improvements in primary batteries.

107. Edward M. Levetus and H. Levetus, and W. Rowbotham. Birmingham. Improvements in primary batteries.

148. O. B. Shallenberger. London. Improved methods and apparatus for measuring electrical currents.

157. C. A. Jensen. London. Improvements relating to telephonic call stations with automatic charge or fee-receiving devices. (N. Jacobsen, Norway.)*

January 3, 1895.

176. F. M. Lewis. Leeds. Improvements in connection with arc lamps, more particularly adapted for electric search lights.

178. H. Brittain and S. H. Brittain. Birmingham. Improvements in the manufacture of shades and shade frames for oil, gas, electric, and other lamps.

185. G. H. Bassano. Derby. Improvements in telephonic apparatus for simultaneous telegraphy and telephony on the same line-wire.

226. E. Herz and J. P. Hartfuss. London. Improvements in electric call and alarm apparatus.

January 4, 1895.

230. W. Kingsland. Llandudno. An improved electric cut-out for electric circuits.

231. E. M. Levetus, H. Levetus, and W. Rowbotham. Birmingham. Improvements in primary batteries.

238. A. Denny and A. C. Cormack. Glasgow. Improvements in fittings for electric lamps.

240. C. Meason and T. Ford. Birmingham. Improvements in decorating gas chandeliers, electroliers, hall lanterns, brackets, table, hanging, and floor lamps for oil.

261. F. Hodge. London. An improved electric stamper battery for ore crushing. (Charles Evenson, New Zealand.)

281. H. Oppenheimer. London. Improvements in and connected with telephones.

285. T. Coad. London. Improvements in holders for electric incandescent lamps.

297. C. F. Claus, jun., and H. S. Sutton. London. Improvements in the electrolytic treatment of tin, and its separation from alloys and mechanical mixtures.

298. J. Claret and Olivier Vuilleumier. London. Improved means for supplying an electrical current, and safety devices for use in combination therewith, with electric tram and other cars or vehicles.

January 5, 1895.

348. W. B. Close. London. Improvements in rectifiers for electrical currents.*

351. J. E. A. Gwynne and R. Kennedy. London. Improvements in electric arc lamps.

357. J. T. Rossiter. London. An improved street road or underground junction box for electric conductors.

358. J. Wershoven. London. Improvements in electrodes for secondary batteries,

January 7, 1895.

378. G. E. Fletcher. Stockport. An improvement in dynamos or electric generators, by means of which a constant pressure is maintained under varying speeds.

396. A. Slatter. London. An improved grid for secondary battery plates.

398. H. Whawell. London. Improvements in automatic telegraph instruments.

432. E. Ageron and A. Fournier. London. Improvements in electric accumulators or secondary batteries.

437. J. B. Barton. London. Improvements in and connected with electric arc lamps. (W. Jandus, United States.)

January 8, 1895.

480. E. S. Shoults and G. Binswanger. London. Improvements in electrical measuring instruments.

497. J. C. Love. London. Improvements in and relating to electric railways.*

523. R. Belfield. London. An improvement in lightning arresters. (The Westinghouse Electric and Manufacturing Company, United States.)

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

3,476. Little. Electric bells.

3,641. Mudd. Ship's telegraph and indicating apparatus.

3,667. Phonophore Company and Smith. Telegraphic apparatus.

4,691. Lundberg and others. Connecting and disconnecting electrical circuits.

7,121. Biddle and Kennedy. Electric lighting apparatus for railway cars, &c.

11,601. Kleber. Printing telegraph instruments.

21,250. Piedfort. Multiple telegraphic apparatus.

21,347. Childs. Telegraphic or telephonic exchanges.

21,461. Riordon. Electric motors.

496. Thompson (Coffin). Heating or welding metals electrically.

835. Hargreaves and Bird. Electrolytic apparatus, &c.

2,936. Brown. Telemotor apparatus.

3,101. Sayers and Others. Dynamo electric machines.

3,291. Money and Nash. Electric arc lamps.

3,863. Jones. Electric arc lamp.

21,707. Slater (Platt). Electric conductors of electric railways.

22,192. Siemens Bros. and Co. and Schlœmer. Electric exploder.

22,453. Robinson. Insulated electric conductors.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Company (Limited).

The forty-fifth half-yearly ordinary general meeting of this Company was held on Thursday, the 24th ult., at Winchester House, Old Broad-street, London. The chair was taken by Sir John Pender, G.C.M.G., M.P., who said: Before we begin the business of the meeting, I do not think it is too late to wish you a happy new year. You are entering on a new year, and I hope it will be a happy and prosperous one to us all.

The SECRETARY (Mr. George Draper) having read the notice convening the meeting, the minutes of the last half-yearly meeting, and the report being taken as read,

The CHAIRMAN said: Gentlemen, before asking you to approve the report, I will, as usual, give you some details of the working of our Company during the last six months. I have always found that these details interest the shareholders, and I am always anxious to afford them information at these meetings which will induce them to give us the benefit of their support.

The gross revenue for the half-year under review amounted to £362,557, as against, in the corresponding period of 1893, £369,967, or a decrease of £7,410. This decrease is in the traffic with India. There is a small increase in the trans-Indian traffic, but otherwise there is very little difference between the receipts of the present six months, as compared with those of the corresponding period of 1893. The total ordinary expenses for the half-year ended September 30, 1894, amounted to £97,533, as against, in the corresponding period of 1893, £92,157, or an increase of £5,376. From this increase must be deducted about £2,412 for proportion of stationery charged against this half-year's accounts. As explained at the last general meeting, we now charge, for the purposes of comparison, a proportion each half-year of the amount paid for the annual supply of stationery sent to our stations, instead of charging the whole annual amount in the March half-year. I may here mention that we have lately made more favourable terms for the supply of stationery, and this account will show a considerable saving in the future. The actual increase in the ordinary expenses is, therefore, about £2,964, but if we deduct items of an exceptional nature, such as our twenty-fifth anniversary expenses, the increase is reduced to £1,338. The details of increases and decreases in the various headings of the accounts are as follows: General expenses in London £8,493, as against, in the corresponding period of 1893, £9,255, or a decrease of £762. Working expenses at stations £79,316, as against, in the corresponding period of 1893, £75,707, or an increase of £3,609, or, deducting the item for stationery previously explained, of £2,412, leaving a net increase under this head of £1,197. This is mainly due to the operation of the scheme to provide a regular scale of promotion to the superintendents and the other members of the staff, £1,045 being due to this cause. There is also an increase of £582 in travelling expenses. We always endeavour to improve our system where it is possible to do so, and, being of opinion that an improvement might be effected in the speed and accuracy of the transmission of telegrams by adopting greater uniformity of working at our own stations and the stations of the associated companies, we brought to London as many of our principal superintendents as could be spared at one time, to confer together and give us the benefit of their practical experience before finally adopting certain improvements which had been contemplated. This, in a great measure, is the cause of the increase in travelling expenses. The contribution to staff pension fund amounted to £1,347, as against, in the corresponding period of 1893, £615, or an increase of £732. In the corresponding period of 1893 the pension fund scheme had been in operation only three months, so that the amount chargeable this time is necessarily larger. This Company's proportion of the expenses in connection with the twenty-fifth anniversary commemoration banquet and *fête* held at the Imperial Institute was £836, and the dinner to our home and foreign staff amounted to £790.

You see we are letting you very much behind the curtain, and showing you fairly well all that we are doing; but we think it is better that you should know as much as it is desirable should be known outside of our counting-house. I think we may say with perfect confidence that we did the thing very handsomely; indeed, nothing has been more appreciated in my time, at least, and every one who was present at the banquet and reception approved not only of the generous way in which it was conducted, but also of the remarkably able manner in which all the arrangements were carried out. We, therefore, I think, have every reason to be proud of a gathering which cost us comparatively little, for I have been told that as much as £10,000 has been spent by some of the submarine companies on a previous occasion. The Post Office, I believe, are going to do a similar thing; and on Monday next some of us are going to be entertained by Her Majesty's Government or the Post Office in commemoration of the twenty-fifth year of the working of the land-line telegraphs.

The expenses attending repairs and renewals of cables amounted to £43,709, against, in the corresponding period of 1893, £31,906, or an increase of £11,803. This item, gentlemen, as you can very well understand, is a very fluctuating and very uncertain element in our expenses. I wish it was less uncertain; but, as I have repeatedly said on these occasions, it is a great thing that we are able with our repairing ships at hand to effect our repairs without in any way interrupting our traffic or lessening our income. That is a very important feature, and, although the sum I have mentioned seems a very large one, yet you did not hear of interruptions to the cables excepting through the accounts which are submitted to you. We have, as it were, got within our hands the power to repair any breakages to our cables, and that is a fact which gives very large additional strength and stability to the submarine telegraph system. When we first laid down cables we had no idea that we should be able to repair them. We have now on this side and the other side of the world eight or ten ships employed in effecting repairs, and I am sorry to say that they are, perhaps, more frequently employed than we like them to be; but still, we maintain our system and our traffic, and we do so within reasonable bounds as regards expenditure—so much so, that the cost of effecting our repairs has not hitherto interfered with our dividends.

Full details of the work done by our ships during the half-year will be found on page 6, Abstract C, of the accounts. In the corresponding period of last year our expenses under this head were comparatively small, owing to our having received substantial credits from other companies for the hire of our ships for cable-repairing purposes, and the amount of cable used on repairs was less than usual. This time we have not received such a large amount for the hire of our vessels, and the extent of cable laid in for repairs was considerably more than was the case in the corresponding period of last year. Depreciation of spare cable amounted to £4,815, as against, in the corresponding period of 1893, £2,857, or an increase of £1,958. We had a larger stock of cable to depreciate this half-year than we had in 1893. The amount carried to maintenance ships' reserve fund was £4,860, as against, in the corresponding period of the previous year, £3,092, or an increase of £1,768.

As already explained, we have done comparatively little work for foreign Governments and other telegraph companies this half-year, so that a larger proportion of the depreciation of our ships had to be borne by ourselves. It will be observed on reference to the revenue account at page 3, that we have placed the two foregoing items in what we consider more appropriate positions, thus enabling the shareholders more easily to compare the total ordinary working expenses each half-year.

After providing the usual amount for interest on debentures and debenture stock and the usual two quarterly dividends, we carry forward the balance of £59,175, as against, in the corresponding period of 1893, £86,252, or a reduction of £27,077. It must be remembered that we had an exceptionally favourable half-year to September, 1893; but although the amount carried forward is considerably less this half-year, I am pleased to say that we have recouped the decrease shown at September, 1894, and for the nine months to December 31st we show a larger total than in the corresponding nine months of 1893. I trust that if the traffic continues as favourable for the next two months we shall be able to show a very fair result at the end of the financial year, when I hope to have the pleasure of meeting you again in July next.

I have now given you what I consider and what I am sure you will consider a very fair statement of our affairs. Nothing very definite has occurred during the last six months, but still a considerable amount of work has been done. For instance, we have been able to satisfy ourselves as to the connection made to the Seychelles and Mauritius—that is working satisfactorily, and I may say that the result is better than we originally expected it to be. No doubt it will be a growing traffic, because all these traffics grow more or less; but it takes some little time to make people feel that cables are indispensable to their wants. I think that merchants begin to find that if they had no telegraphs business would be in a very unsatisfactory state. As you know, we have been passing through very hard times—probably the hardest we have seen for many years—not only hard times at home, but hard times in all the places with which we have telegraphic connection. How long this is going to last it is very difficult to say; but if we judge from past experience, we should say that the boom of good times follows the depression of bad times. We have now had depression for some time; so let us hope that the boom of good times is not far distant.

The jubilee was a very important event in our history. I suppose there is nothing in the reign of Her Majesty that has shown such remarkable development as the submarine system of telegraphy. It is growing, and is connecting the whole world together, and this important work has been done in a very quiet way—I would say, a very unostentatious way. We have never appealed very much to the public for money, but we have got all the money we required to carry out our work, which has been well done. It has given satisfaction to all concerned. Just before coming here I wanted to ascertain how we stood on the Stock Exchange, which affords a very good criterion of the credit in which our concern stands. Our £10 shares are quoted to-day at 16½, and our debentures, which were originally issued at 95, stand at 123½. I cannot give you any better evidence of how we stand before the public as to the value of our property, nor of the appreciation of the public of the work we do, than when I tell you that our debentures stand at a rate which astonishes most men who have been connected with finance; and I may say also, incidentally, in passing, that the mode in which your business is carried on has been very satisfactory to our customers. If I could witness the progress which I anticipate will be seen during the next 25 years in connection with submarine telegraphy, I should be a very proud man indeed; but let us be thankful for what we have done in the past, and let us endeavour to make the future, as regards our system, in every way as efficient as it has hitherto been. You may depend upon it that if we maintain our efficiency we shall, no doubt, maintain our progress. I have said that telegraphy has now taken a very strong hold, not only on the political and commercial, but also on the social life of the world. That is an evidence of the work having been well done. It is true that we have not been able to pay the large dividends which some of us at one time anticipated; but the reason for that is that those who use the telegraphs are so clever in coding their messages that what at one time would have given us an enormous traffic is condensed now into a few words. Nevertheless, we are paying a very fair dividend, and we are accumulating a reserve fund, which will, I hope, when we come to the period of examining and testing the life of our cables, be found to place us in a very sound and satisfactory financial position.

I may now mention a matter in proof of the good position which we occupy with Governments. In the last few weeks I have been negotiating for an extension of that part of our system which now connects the Cape with this country. The present concession has five years to run; but the authorities are disposed now to make arrangements for continuing our subsidy, under revised conditions, for a further ten years, so that we may look forward now to fifteen years instead of only five years, the extension being upon terms which will, I think, be found equally advantageous for the telegraphing public, for the Governments, and for the Company. As you know, there is a great scramble going on just now in South Africa by all Governments other than the English; but England, I think, has got probably the richest part of the Dark Continent under her control. When we think of what is being done there now and the desire on the part of every Government to possess some portion of this country which has been added to the civilised world, I think we may congratulate ourselves that every extension in that direction must add in some way, smaller or greater, to the income of our Company, because, after all, the life, the heart, of the whole thing is in London. When we find that there is anything going on in our Colonies London is immediately interested, and the increase in telegraphing is rapid and continuous.

Gentlemen, I think I have given you all the information that it is in my power to give with reference to our affairs, but there is just one other matter that I may mention in conclusion. When it was understood that France was going to send an expedition to Madagascar we felt that they could not very well do that without laying down a line to connect Madagascar with our system at Mozambique. We therefore offered to do this work; but anyone who watches the progress of affairs in France now will see that that country is probably more ruled by the Press than it is by its Government; and, therefore, although our tender was many thousands cheaper than that of two French combinations, still, the latter obtained the order. The work has been given to two different constructors, and we shall see how the thing will be completed. If completed successfully it will be of advantage to France. But we have always ships about, with cable on board of them, and the chances are that we shall not be very far off if any hitch should occur in the work, and I should not be astonished if in this case, as in others, we should eventually lay this cable. I think I have now told you everything that I can, and I will therefore now move—

"*That the report and accounts of the Directors to September 30, 1894, submitted to this meeting, be and the same are hereby received and adopted.*"

The Marquis of TWEEDDALE: I beg to second the resolution.

The CHAIRMAN: Now, gentlemen, before I put the resolution to the meeting I shall be very glad to answer any question that may be asked by any of the shareholders; that is, as far as it is in my power to do so.

Mr. GOODSALL: You informed the meeting that the increase in your expenditure on repairs and renewals of cables cost £11,800 more than the outlay at the corresponding period of 1893. I suppose that this was the half-yearly account; and what I wish to ask is whether this £11,000 extends over the whole of our system, or is there one section that is giving out? You also mentioned that the depreciation of spare cable was some £4,000. Is it not unwise to keep so much stock on board, seeing that it depreciates? With reference to the Eastern and South African Company, you mentioned something about the renewal of the subsidy for ten years. It is to be hoped that when these arrangements are made the whole of that Company will fall in, as it should, to the Eastern Company, and be under one Board, thus saving a very large amount for Directors' fees and other items, which might all come under the Eastern Company, who are really the sole proprietors in that Company.

Mr. BAINES: It may be within the recollection of the Board and some of the shareholders that on a previous occasion I spoke of an increase of dividend for the Ordinary shareholders. The Chairman has to some extent anticipated the remarks I am about to make by telling us that we have never been able to realise and, perhaps, never shall realise the dividend, the prospect of which was held out to the shareholders in the early days of the Company's existence. The ingenuity of men's minds has been such as to preclude the possibility of our making the large profits which we originally anticipated; but at the same time we have been a very prosperous Company, and have been going on now for a considerable period with a dividend of 6½ per cent. I do not say that that is a despicable dividend, but I think that this Company is now so strong that, with due economy, you may take into consideration the interests of the Ordinary shareholders, who have run considerable risks, because at the beginning of the Company there were risks. It has been proved by experience that the "life" of cables is greater than was anticipated, and that is a point in favour of the Company. Every half-year we are told to be contented with this dividend; but that is all very well. We see our shares standing at 16¾ or 16½, or at a premium of about 6. We get nothing for that improved state of our property, except the satisfaction that it is secure. Still, that £6 premium is dead to us. It is a question with me whether the Directors might not see their way to do something in the interest of the shareholders by distributing certificates to them. The Ordinary shareholders ran great risk at the outset of this undertaking. I have mentioned this matter before; but the Chairman and the Directors have never dealt with it seriously. I hope, however, that they will do so in the future. because I think it is a point that should be seriously considered. Before I sit down I will say one other word—that the banquet was a very well conceived and conducted affair, and did a great deal to make this Company popular, and even better known than it was before. My great point, however, is that I think the time has arrived when the interests of the Ordinary shareholders should be taken into consideration. If you will just refer to past reports, you will see that in a great number of reports very large sums have been carried to reserve and used for capital purposes. That is so much dividend that has been diverted from your pockets, and you ought to have a certificate to represent it, but you have not. It is capital expenditure, and it ought to be replaced in the way suggested. The Directors might allot to you shares *pro rata*, or they might pay a little extra dividend, which would be the simplest way of dealing with the matter. There is, however, this difficulty—that if the dividend rises beyond a certain amount the Press and other combinations would be down on the Company as to their excessive rates. Remembering, however, our risks, I think that we do not get too much, considering that third-rate banks pay their shareholders a dividend of 8 per cent. I hold that we run greater risks than banks, and we ought, therefore, to pay a dividend proportionate to our risks.

The CHAIRMAN: The first thing I have to answer is the question put by Capt. Goodsall, whether the £11,000 of additional expenditure on repairs and renewals was over the whole of our system. Of course it is. It is not given as any special account, but applies to the whole of our system. With regard to the keeping of cable in stock, no man ought to know better than Capt. Goodsall that breaks come when they are least expected, and if we had to wait until the cable was made before we could effect our repairs, I think we should show that we were very unworthy of conducting such a business. What you have said about the position of the Eastern and South African Company is quite true; but we have had to build up this great concern. If we had attempted 20 years ago to place such a concern as this is at the present time before the public we could not have done it. We have built it up, and made it strong by a sound policy. We have made our finances strong by having a good reserve; and if any gentleman tells me that he has derived no benefit from all this, then I say to him, "Sell your shares, and you will get your benefit, but you cannot have your shares and your increased dividend at the same time."

A SHAREHOLDER: Certainly not.

The CHAIRMAN: I think that the policy of the Board is one which, beyond all doubt, ought to be approved by the sensible body of the shareholders. It is a policy we shall maintain, and if we have more money than we know what to do with, you may depend upon it that the shareholders will have a very good reason why we retain it if they do not get a portion of it. When that time arrives we shall be as confidential with our shareholders as we have been in the past. Our policy is one that will benefit the great body of the shareholders. If we continue to give them a fair dividend they will see the value of their shares increase, and if at any time they want to realise the benefit we confer on them they can get it. Those who remain with the Company will get the benefit of our improved position, while those who realise will also see how beneficial our policy is and has been.

Mr. GOODSALL: That is just what we do not want to do.

The CHAIRMAN: I am just reminded that I did not fully answer Mr. Goodsall, but we have five years before us in which to take into consideration the question referred to. While we are looking ahead one way we are not blind in the other. When the proper time comes we shall deal with that question, but it must be left with those who have had the bringing of this concern to its present satisfactory condition; it must be left with us to deal with at the proper time. I think I have now pretty well answered all the points that were raised, and I will now put the resolution, which is carried unanimously. The next resolution I have to propose is

"*That the Most Hon. the Marquis of Tweeddale, who now retires, be, and he is hereby re-elected, a Director of the Company.*"

As you are all aware, Lord Tweeddale has been associated with us from the beginning. He has been a steady supporter of a policy which has resulted, as you all know, most satisfactorily to all concerned; and I have the greatest pleasure in inducing him to remain among us, to see our success carried still further than it has been.

Mr. G. G. NICOL: I beg to second that.

The CHAIRMAN put the motion in the usual way, and declared it carried unanimously.

The Marquis of TWEEDDALE: I beg to thank you for this renewal of your confidence.

The CHAIRMAN: The next motion is—

"*That Sir Albert J. Leppoc Cappel, K.C.I.E., who now retires, be, and he is hereby, re-elected a Director of the Company.*"

As you are aware, Sir Albert Cappel—it is well that you should know something of the Directors who represent you on this Board—spent the greater part of his life in India, and got to the top of the Telegraphic Department there. We thought it would be a very great advantage to our Company to have Sir Albert Cappel's services, seeing that he had had great experience. We were very pleased, therefore, to give him an opportunity of joining our Board, of which he is now a member, and his information and long experience as a telegraph minister make his position at our Board a valuable one to us.

The Marquis of TWEEDDALE: I beg to second the resolution.

The CHAIRMAN put the motion in the usual way, and declared it carried unanimously.

Sir ALBERT CAPPEL: I am much obliged to you, gentlemen.

The CHAIRMAN: The next resolution comes from the body of the hall.

Mr. MUIR: I beg to propose:—

"*That the firms of Messrs. Deloitte, Dever, Griffiths and Co., and Messrs. Welton, Jones and Co. be, and they are hereby, elected auditors to the Company for the ensuing year at a remuneration of £100 to each firm.*"

Mr. COCHRAN: I second that.

The CHAIRMAN put the motion, and declared it carried. He added: I may say in regard to Messrs. Deloitte, Dever and Co., that they are really the representatives of the body of the shareholders. They not merely audit our accounts every six months, but every month in the year, and every day. You therefore have a continual audit. I do not know whether Mr. Griffiths, a member of the firm of Messrs. Deloitte, Dever & Co., is here or not, but I always hold him to be a responsible man to the shareholders, and independent of the Directors.

Mr. GRIFFITHS: Perhaps I may be allowed to return thanks to the shareholders for their re-election of my firm and of the firm of Messrs. Welton, Jones and Co. I assure them that we do take a very independent position with respect to the accounts of the Company, and we are perfectly satisfied with regard to the accuracy of the accounts and the stability of the Company itself.

The CHAIRMAN: That concludes the business of the meeting, and I have only to thank you now for your presence here to-day.

Mr. MUIR: I do not think, gentlemen, that we ought to separate without passing a vote of thanks to the Chairman and the Directors for their services.

Mr. COCHRAN: I am very pleased to second the motion. We are all satisfied with the way in which the Company has been managed, and we have no desire to see any alteration in the general policy of the Company.

The resolution was carried unanimously.

The CHAIRMAN: I should have been very sorry indeed if you had gone away without passing this vote after I have been for so many years so very free in telling you all that you are entitled to know. I shall continue to do that, and shall hope to have the support and encouragement of those whose work we are doing, and, I believe, doing well. We are not too old to appreciate a little encouragement, quite as much, in fact, as younger men appreciate it. The longer the present understanding exists, as I believe it will, between this Board and the shareholders of the Eastern Company, the better it will be.

The proceedings then terminated.

Direct United States Cable Company (Limited).

The thirty-fifth ordinary general meeting of this Company was held at Winchester House, Old Broad-street, on Friday, January 25, 1895, under the presidency of Sir John Pender, G.C.M.G., M.P.

The SECRETARY (Mr. T. Finnis) read the notice calling the meeting, and the minutes of the last ordinary general meeting, which were confirmed by the present meeting, and signed by the Chairman as correct.

The CHAIRMAN: I presume, gentlemen, that you will take the report as read: but, before asking you to adopt and approve it, I shall, as usual, make a few remarks, as I think it is always desirable to give the shareholders on these occasions as much information as will enable them to know how their affairs are going on. The revenue for the half-year to December 31st last, after deducting outpayments, amounted, in round figures, to £38,342, and the working and other expenses, including income-tax, but exclusive of cost of cable repairs, absorbed £19,024, leaving a balance of £19,318 as the net profit of the half-year, making, with £1,032 brought forward from the previous half-year, a total of £20,350, which has been appropriated as follows: Interim dividend of 2s. per share for the quarter ended September 30th last, £6,071 ; interim dividend of 2s. per share for the quarter ended December 31st, £6,071 ; set aside, pending settlement of disputed accounts, £3,400 ; set aside to reserve fund account, £3,000 ; balance carried forward, £1,808 ; making a total, as above, of £20,350. The revenue, as compared with that in the corresponding period of 1893, shows a reduction of £2,710, the whole of which occurred during the three months to September 30th. Since that date the traffic has improved. The expenses in London, as shown by Abstract "A" in the accounts, are, on the whole, £36 less than in the corresponding period, the items remaining practically unaltered. The expenses at stations, as shown by Abstract "B" in the accounts, compare as follows: Stationery and agencies stand for increases of £24 and £214 respectively, while reductions are shown in the following items: Salaries, £3 ; maintenance, £71 ; petties, £23 ; rent and taxes, £88 ; travelling, £22 ; and repairs and renewals, £197. On the whole these station items are £141 less than in the corresponding period. In the remaining items of expenditure there are increases of £75 in use of patents and £91 in income-tax, the present rate of tax being 8d., against 7d. in 1893. In the aggregate, the half-year's expenditure is £36 less than in the corresponding period. The cost of cable repairs has been £1,611, and this has, as usual, been charged to the reserve fund account. This account, on the other hand, has been increased by £4,131 from interest on the investments ; by £1,134 from profit on a security sold, and by £3,000 set aside from revenue, making the present balance of the fund £288,205. The investments have been increased during the half-year by £9,441, and considerable appreciation has taken place in the market value of the securities as a whole. They are entered in the balance-sheet at "cost," but their present market value is about £295,651, showing a profit of £40,000, or, say, 15 per cent. above cost. Now, gentlemen, I have given you an amount of detail as to our doings in the half-year which will interest you and show you pretty clearly the position which we occupy at the present moment ; but before asking you to approve the resolution for the adoption of the report and accounts, I will make a few further remarks. When I had the pleasure of addressing you last time there had just been added to the Atlantic group a cable, which was laid by the Commercial Cable Company ; and immediately afterwards another was laid by the Anglo-American Company. Both these cables were made upon the very best principles, and, no doubt, aided very considerably the carrying of the traffic in the Atlantic. There was also a third cable talked of as about to be laid by the German Government. That project is very much in the same position to-day that it was when I last addressed you ; but there is one thing which we may depend upon : when a Government makes up its mind to lay a cable, having not only their commercial, but also their political and, perhaps, strategical interests to think of, you may depend upon it that that cable will probably be laid. In the last six months there has also been an amalgamation or an absorption of the Pouyer-Quertier cable in France by a company called the French Telegraph Cables Company. That amalgamation appeared to be the absorbing by a poor company of a company which had some little money ; and, so far as we can learn, the little money which the Pouyer-Quertier Company had was very likely to go to pay the debts and carry on the French Telegraph Cables Company I believe that that Company was more or less encouraged, if there was not a distinct understanding on the subject, to carry out this scheme by the promise—or half promise, probably, you may call it—of the French Government subsidising them. They have not yet obtained their subsidy, but they want it on the plea that they will lay another cable from Brest to America to take the place of the cable, which has ceased to work, belonging to the Anglo-American Company. The Anglo-American Company evidently find that that cable does not pay, and I do not think from what I hear that they are likely to go to the expense of another cable to replace this one. In that case, therefore, if it is replaced, it will not be adding an additional cable to the Atlantic group, but a cable to replace that which has just ceased to work. So far, the French have not been very successful in their submarine telegraph enterprise ; but every country has to learn, and possibly they may be more successful in the future than they have been in the past. All that leads us to look to the work we have in hand, and I believe that in connection with that work we have very powerful combinations. I should say that at the present moment there are more cables in the Atlantic than there is work to occupy them. However, the present cables are getting old, and age comes upon cables as it comes upon individuals ; and what we are doing now is to do all in our power to keep our cables in as thorough and efficient working condition as possible. We are doing that, and, with a view to continuing to be able to do it, we are increasing our reserve fund, believing that we are justified in doing so ; for we shall be in a much stronger position with a large reserve fund in the event of our cable giving out, than if we appealed to the public for additional capital. If any Company were to attempt to go to the public and ask for money for an Atlantic cable, I expect that the response would be very meagre indeed. I am sure that you will agree with me that by strengthening our position, and doing all we can to keep up the "life" of our cable, we are best serving the interests of our shareholders. I may tell you—although I believe you are all aware of it—that submarine telegraphy is absorbing a very great deal of attention—quite as much as the land lines. I believe that at the present moment the world's commerce and the world's politics—which vary in different parts of the world—cannot do without submarine telegraphy, and even the social life of the world is sweetened more or less by this system. Such a system, so popular and so universally used, you may rest assured will be perpetuated. I believe the world would seem to stand still if all the submarine telegraphs were to break down at the present moment. It would cause consternation, and would create great difficulties for trade. I hope that such an event will not occur, and I believe that the submarine telegraph system, with its strong hold on the minds of the people of the world—because it embraces the world—must exist as a necessity. You have heard a good deal for some time past about the suit that has been going on in France. That matter has been before us now for a good many years, and the lawyers have had a good harvest out of it. I told you the last time I addressed you that we had gained the suit, but I think I told you at the same time that although we had gained the suit I did not see where the money was to come from. I hold the same opinion to-day. I should like to see this suit at an end for this reason. We are asking for money, and the companies who owe it to us do not possess it. The litigation is also keeping open a sore, and there are a great many sores between France and England at the present time. I should like to heal this sore ; I should like to see it out of the way altogether, and to see the French and English people come to a better and a more friendly understanding than exists at the present time. Speaking for my Board and myself, we shall be glad to do any little thing we can to bring about such an improved state of things. Since I had the pleasure of addressing you last one of our old Directors, Mr. Meara, has died. He was associated with us from the time we reconstructed the Direct Company. He has lived in Antwerp, and has been an important link in regard to our affairs. He held a good position there, and has been in many ways a valuable Director. He has now gone at a ripe old age. We are not going to replace him at the Board, because at the present time, exercising economies as we do, and looking to the fact that our Board is quite large enough, we do not think that it is necessary to fill up the vacancy. We shall, therefore, delay adding another Director to our Board until we see that our affairs require further attention. You will see that this is in the direction of economy. Looking at the history throughout of this Company, I want you to see that we have held our position very fairly among the other companies, of which we form part in the "pool." With regard to our Ballinskelligs station, in the early days the buildings there were all of wood. Wood deteriorates, particularly in stormy weather, and that is a stormy coast. We have, therefore, been altering by degrees our buildings there by putting up good substantial stone structures in place of the wooden buildings when the latter required to be re-erected or when it was impossible to repair them. You have before you here (referring to some drawings on the wall behind him) a sketch of our Ballinskelligs station. The buildings are all complete now except one pair of cottages. The centre is our working office, and the place where our bachelor workers live. I have been there more than once, and I can testify to the fact that it is a very nice and comfortable place. This part at the side has been erected for the married men. That building in the centre at the top of the plan is occupied by our Superintendent, and so far as the Ballinskelligs station is concerned, our staff are now comfortably housed. If any of you want to make a pleasant summer excursion you might do a great deal worse than visit this station. Our relations with all the other companies are satisfactory. We work very well together, and I hope that we shall continue to do so. We have had during the last half-year two repairs to our cable, of which, however, you have heard very little. One was in Halifax Harbour, and this was done by our own people, with the assistance of the Royal Engineers, who did the work effectually. The other repair was done by the s.s. "Minia." I may tell you that when we have a break at sea we must, of course, have a ship to effect the repair. We do not keep a ship ourselves, but we have to pay a certain fixed sum when a ship goes out, whether she does the work in a couple of days or in ten. A repair in deep sea, therefore, always involves a considerable amount of money. We only hope that these repairs may become necessary as seldom as possible. If we could only do without repairs we should get rich in our reserve fund quicker than we do. With these remarks I now beg to propose :—

"*That the report of the Directors, dated January 15, 1895, together with the statement of accounts to December 31, 1894, annexed thereto, be, and the same are hereby received and adopted.*"

Mr. C. E. GUNTHER : I beg to second that.

A SHAREHOLDER inquired whether the buildings to which reference had been made were erected on land belonging to the Company.

The CHAIRMAN replied that it was all freehold land. They would have had the one pair of cottages to which he had alluded completed, only they had not cared to proceed with the work until they actually had in their possession the title deeds of the land duly executed.

Mr. W. GRIFFITH proposed a vote of thanks to the Chairman and Directors for the very satisfactory state in which the affairs of the Company stood at the present time. Great discrimination had been used in making their investments, and he was very glad to hear that they showed such a large increase in market price as compared with their cost to the Company. The idea had occurred to him that it might be advisable to sell some of their Consols now that they were at 105, and invest the proceeds in some other security, but this matter might be left to the Board, who had showed so much wisdom hitherto in regard to the investments.

Mr. JOHN NEWTON seconded the motion, remarking that it was always a great pleasure to attend meetings over which Sir John Pender presided, as the hon. gentleman always gave them information which it was well worth coming to listen to. The statement regarding their investments he considered very satisfactory.

The resolution was carried unanimously.

The CHAIRMAN : Before thanking Mr. Griffith and the shareholders for their kind recognition of our services, permit me to state that the point to which Mr. Griffith has drawn attention with regard to our Consols has not been overlooked. I had a statement prepared a little time ago with reference to the whole of the Consols that are held by the respective telegraph companies over which I preside, as I thought that when they touched 105 it would be a prudent measure to sell. Just when I was thinking about it, however, I saw that they jumped up to nearly 106. I did not like to get out of them before they got to as high a point as I thought they might touch, and, after very serious thought, and having consulted more than one banker, I came to the conclusion that it was not yet time to sell our Consols, although I may tell you that if we sold our holding to-day we should make £5,000 profit by the transaction. These bankers, however, told me that I must appeal to my common sense, and I am following that advice. I may be wrong, and they may be wrong; but it stands fairly to reason that Consols may go still higher. You cannot get from bankers to-day 1 per cent. for money on deposit; in fact, I am told that there is a difficulty in getting anything at all. I know of a transaction the other day in connection with £1,000,000 as to which a banker said that he would give ½ per cent. for £500,000, but not a shilling for the £1,000,000. Therefore, as everyone is now endeavouring to get something for his money, a great many people have gone into Consols, and as 2 per cent. interest can be got out of Consols, it is quite possible that they may still rise. I may tell you that the bankers to whom I alluded think they will rise to 110. I do not think that I should be disposed to hold at over 110; but I think there is a little attraction sometimes in speculation. As I should have made a mistake if I had sold our Consols at 105, as they are higher than that to-day, I will, if you will let me, hold them a little longer to see if the view of these bankers comes true, that they will advance to 110. I thank you for your attendance, and for the unanimous way in which you have approved our conduct of your affairs.

The proceedings then terminated.

Anglo-American Telegraph Company (Limited).

The ordinary general half-yearly meeting of the proprietors in this Company was held on the 25th ult., at Winchester House, Old Broad-street, under the presidency of the Marquis of Tweeddale.

The SECRETARY (Mr. T. H. Wells) having read the notice convening the meeting, the report of the Directors was taken as read.

The CHAIRMAN said: Gentlemen, I have now to ask your approval of the report and accounts. The traffic receipts of the past half-year show a decrease amounting to £6,948 as compared with those of the corresponding period of last year. This is not the first decrease we have had to lament during the past year or two. This time last year I had to inform you that the falling off for the six months amounted to £8,493, and to July last the decrease in our receipts as compared with the previous half-year amounted to the large sum of £16,791. This result is due, of course, to the extreme stagnation in commercial circles which has prevailed for so long a time. Some think that they see an end to it, and I only hope that this may be the case; for until a turn takes place, I fear that we cannot look for any great improvement in our traffic receipts. Fortunately our expenses, bothat the head office and at the stations, show a material decrease amounting to no less than £3,399. The expenses of our ship "Minia" are also less by £1,146, and that steamship has come again to our rescue, as it has done more than once on previous occasions, by earning for us the handsome sum of £4,500. The result of this is that the net revenue is more than at this time last year by £1,146. If it had not been, therefore, for the necessity which we felt of laying a new cable, and thereby diminishing very considerably our renewal fund, we should have been able to pay as good a dividend as we paid at this time last year. But you are aware that since that cable was laid, we have found it necessary to devote part of our profits, in addition to the interest on the renewal fund, to building up that renewal fund afresh. Last July, we placed the sum of £12,000 to the renewal fund, in addition to the interest earned by that fund, and on this occasion we have done the same thing. The amount available for dividend is therefore £10,859 less than it was last year, and we are only able to recommend a final dividend of 14s. for the last quarter, or 23s. on the half-year. This must be admitted to be a very modest return on our stock, but I do not well see how we can expect any increase until we are permitted to enjoy greater prosperity than we have had for a very long time. The condition of our cables is on the whole satisfactory, having regard more especially to their age. The new cable is doing splendid work, and is quite able to carry the whole of our traffic. The 1873 and the 1880 cables are in fair condition, and the 1874 cable, which was repaired last year, is also in good condition, with this reserve, that it is interrupted in very shallow water, about 100 fathoms, off the Irish coast. This interruption will be repaired without delay as soon as the weather permits our repairing ship to approach the coast. The Brest cable is certainly in no better condition than it was when I last addressed you and told you that we had great doubts whether it was worth repairing; but we do not propose to come to a definite decision on this point until we are obliged to, later on, towards the time when repairing expeditions are sent out to the Atlantic. Our sheet anchor—our renewal fund—now amounts to £586,076. I am glad to say that it is valued at middle price market quotations is £64,903 in excess of that sum. I may also mention that the securities which were sold to pay for the new cable realised a profit of no less than £30,144. On the last occasion I referred to the desire which had been shown by the Governments of France and Germany to lay cables to America, independent of those already existing. I have no reason to suppose that those Governments have changed their minds as far as that desire is concerned, but I am not aware that any substantial progress has been made in giving effect to those desires. The question of the French law suit is still *sub judice*—that is to say, it has not been disposed of yet. Its position is this: In July last our report informed you that, although the decision of the French Courts was generally favourable to the Company, we considered the limitation of the period within which damages were to be assessed—namely, between December, 1886, and May, 1891—most unreasonable and unjust, and that we proposed to take counsel's opinion as to the advisability of appealing from that portion of the decision. Acting on our French counsel's advice, we have taken steps to lodge an appeal. Of course it is impossible for me to say when that appeal will be heard, but I hope it may be heard and decided before I meet you again. I think I have now referred to all the points of interest in connection with your property in the Atlantic. All we can do is to maintain the property in a high state of efficiency. I think anyone who knows anything about it will recognise that this duty of ours has been carried out to the very fullest extent, and that no telegraphic service in any part of the world surpasses it in respect to celerity and accuracy. Having done that part of our duty, all we have to do is to wait patiently for those better times which I hope may come, and which I believe will come. At any rate, I have this little consolation to offer you—that since the beginning of the year there has been a substantial increase in our daily receipts. If this increase continues during the half-year I have no doubt we shall be able to present you next time a more favourable report than it has been in my power to do to-day. With these observations I move the adoption of the report and accounts.

Mr. F. A. BEVAN seconded the motion.

Mr. GRIFFITH remarked that a majority of the shareholders would hardly approve the payment of so small a dividend. He thought that the people who benefited by their Company were not the shareholders, but those who laid cables. The Chairman had spoken highly of the new cable, and had made a remark that it was able to carry all the traffic. He had been surprised at that remark, for if one cable could carry all the traffic, why have two? or if two were considered necessary for the sake of insurance, why have three or four? It was the general opinion of the public and of experts in submarine telegraphy that there were too many cables in the Atlantic, and the Chairman had himself now endorsed that opinion by informing them that one cable was able to carry all the traffic the Company had. At a previous meeting he stated that some companies when they wanted a new cable, instead of paying all at once hundreds of thousands of pounds for it, agreed with a construction company to lay the cable and charge a rent for it. This seemed to him to be a very common-sense proceeding. The Cuba Company had adopted this course, and it paid to its ordinary shareholders half-year by half-year a dividend of 8 per cent. per annum; and their Preference shares stood at a very high price. If it really was necessary for this Company to throw away their money in the Atlantic let them, at all events, do so in driblets, and not all at once.

Mr GARNER wished to know whether there was likely to be any limit to the renewal fund. Directly it amounted to £1,000,000, nearly half of it was expended on another cable. The shareholders had looked forward to benefitting by the interest on the renewal fund when it was increased to £1,000,000.

Mr. WOOD inquired if all the cables were now in perfect working order excepting the Brest cable; and he also desired to be informed of the oldest of their cables that was now working really well. He entirely agreed with the policy of the Directors that the Company should have a very strong renewal fund, for this was a very sensible arrangement, and also tended to the stability of a company. Many of them had witnessed the excessive folly of companies through having no reserve fund. At the same time there was a limit to such a fund. Previously, the Directors said that £1,000,000 was the point to which they would add to the renewal fund, and he would like to ask whether the Directors thought that such a large sum as this was necessary now, seeing that they had only just laid another cable. He thought it would be an excess of caution if the Directors were to increase the renewal fund again up to £1,000,000. He desired to congratulate the Directors for the shrewdness they had displayed in regard to the Company's investments. With reference to the litigation in Paris, he very much doubted the policy of the Directors in continuing to fight the French company. He thought it would have been very much better to have settled with that company, and have taken the money.

Mr. WALKER said he had always been a supporter of the Directors' policy in building up a good and strong reserve fund; but there were limits to this. In view of the Chairman's statement that day that one cable was sufficient to carry their traffic, and that they now held amply sufficient to lay a fresh cable, he thought that some limit should be placed on the renewal fund. He also wished to know whether the decrease in their receipts was really owing to the stagnation in trade, or whether it was through competition or bad bargains with other companies.

Mr. GOODSALL asked whether the shore ends and the intermediate sections of their 1880 cable were not the original 1865 cable. He thought that very great credit was due to Capt. Trott for the way in which he had repaired the 1874 cable and restored it to full working order, especially remembering the great depth from which it had been picked, and the many years which it had been buried.

The CHAIRMAN: With respect to Mr. Griffith's criticism as to the necessity of the fourth cable, I would point out, in the first place, that this matter was fully discussed a year ago. I have before me the report of that meeting, and the discussion was one of the fullest we have ever had, and it resulted in complete approval of the Directors' policy in laying a fourth cable. In these circumstances it would scarcely be necessary for me to answer these criticisms, but I should like to point out to those who are not aware of it that our share in the "pool" depends on our maintaining at least three if not four cables. What would our position have been had we not laid this fourth cable? We should then have had three cables, I will not say infirm, but good cables, some of which have, however, shown signs of infirmity. They were not to be relied upon absolutely, and we might have found ourselves, if we had not laid this fourth cable, in the predicament of having no cable capable of carrying our traffic. Therefore, to secure our traffic as well as our share in the "pool"—which amounts to something over 55 per cent.—it was absolutely necessary for us to lay a fourth cable. Many gentlemen seem to think that it is a pleasure to us to spend the Company's money in laying new cables, but we have no desire of the kind. It was a source of great sorrow to us to find ourselves obliged to spend a considerable sum of money, depleting our renewal fund, and necessarily causing us to devote a larger sum to this fund than we had done for one or two years. One hon. proprietor asked if there was to be any limit to the renewal fund. Before the new cable was laid it was agreed and approved by the shareholders that when this fund reached £1,000,000, no further addition should be made to it. I think that on one occasion the interest of the fund was applied not to increasing it, but to augmenting the dividend. I do not think we have yet come to the time when we can properly consider whether it is advisable or not to cease adding to the renewal fund, which amounts to something under £600,000. I do not think that anyone who knows anything about cables would consider that that is a sufficient renewal fund for a company having four cables. Two of the cables are over 20 years old, and a cable which has been laid for over twenty years cannot be relied on to carry our traffic. One shareholder asked, Why fight the French company? It does not give us any pleasure to fight the French company, and we should not do so unless we thought we should gain something by it. The decision of the French court, which to some extent was in our favour, contained a condition which would limit very much the amount that would reach us on account of damages; and our object in making our appeal is to get rid of that condition, and thereby, I hope, increase the amount which may come to us on that score. I think that Mr. Walker asked if the decrease in our traffic arose from the bad condition of trade or from the competition of other companies. The competition of other companies operated a long time ago. The Commercial Cable Company has been in existence ten years, and the effect of that was felt long ago; but the reduction in the traffic to which I referred, in the last two years or the last year and a-half, is entirely due to the condition of trade. Mr. Walker probably knows something about it; but if he is not aware of it I would invite him to look over our canvassers' reports, in which he would see the same monotonous reason given for the falling-off of traffic; namely, that there is no business doing between the two countries, as compared with what used to be done. Mr. Goodsall inquired whether the shore ends of our 1880 cable are not those of the 1865 cable. The answer is that they are the ends of the 1866 cable. I think I have now answered all the questions which were addressed to me, and I am very much obliged to those gentlemen who have offered criticisms. The fact is that as long as trade is dull traffics will be small. I hope that in the course of Mr. Griffith's remarks he complimented us on the reduction of our expenses, this not being the first time that I have had to report that to you.

The resolution was then adopted.

Mr. BEVAN next proposed, and Mr. SAMUEL BARBER seconded, the re-election of the Marquis of Tweeddale as a Director, which was unanimously agreed to.

The CHAIRMAN, after acknowledging this renewal of the proprietors' confidence, proposed the re-election of Mr. Charles Burt to the seat at the Board, and Mr. BEVAN seconded the motion, which was carried unanimously.

Mr. BURT, in reply, stated that this was the thirtieth year that he had been connected with the Company, to which he was formerly solicitor. All the Directors took a very deep interest in the welfare of the Company. With regard to the French litigation, one gentleman seemed to think that the Company at one time had an opportunity of taking the money and settling the matter. This is what they would have liked to do, but they had never had an opportunity of getting any money, and it had only been by constant "driving" in the French courts that they had been able to obtain any decision at all from those courts. He thought he might say that if an opportunity were presented to them for effecting a friendly and reasonable settlement of the question the Board would be willing to consider it.

On the motion of Mr. JOHN NEWTON, the auditors, Mr. Joshua Dean and Mr. John Gane, were re-elected.

A vote of thanks to the Chairman and Directors brought the meeting to a close.

Yorkshire House-to-House Electricity Company (Limited).

The following is the report of the Directors of this Company, to be presented to the ordinary general meeting to be held at the registered offices Central Electric Lighting Station, Whitehall-road, Leeds, on Tuesday next, the 5th inst., at half-past two o'clock :—

The profit (including £155. 6s. 1d. brought forward from the previous year) amounts to £3,672, which the Directors propose to appropriate :—In writing off the balance of preliminary expenses, £1,186, reserve fund £500, in payment of dividend of 4 per cent. per annum upon the Ordinary shares, £1,824, carrying forward £162.

The Directors trust that this result of the first full year's operations will be gratifying to the shareholders. The Company's plant (including that put down during the year), has continued to run satisfactorily, and the supply of current is maintained at a high standard of efficiency and regularity. On December 31st last the number of lights connected to the mains was equivalent to 19,858 35-watt lamps, whilst on December 31, 1893, the number was 10,647, showing a large increase for the year.

An agreement has been made with the Corporation of the City of Leeds, under which the Company will shortly commence to supply all the electrical energy required in lighting the Leeds Town Hall and Municipal Buildings, where lamps equivalent to about 6,000 35-watt lamps are installed. The Directors have given considerable attention to the question of encouraging the use of electricity for other purposes than lighting, with a view to securing a more constant employment of the Company's plant during daylight hours, and it has been decided to supply current for cooking, heating, and power purposes at the price of 3d. per Board of Trade unit.

As mentioned at the last general meeting, the Directors were able to make a favourable agreement with Messrs. John Fowler and Co., Leeds (Limited) for the exchange of the Company's 100-I.H.P. engine and 50-kilowatt dynamo for plant of four times the capacity, the business having developed so rapidly as to render such an exchange desirable. The new plant is expected to be completed during the coming summer, and the engines then at work will have an aggregate capacity of 1,800 I.H.P. As the extensions decided upon required a small amount more capital than that already provided, the Directors arranged with the bankers for a temporary overdraft, secured by a mortgage debenture for £10,000, till the time arrives when a further issue of capital is considered desirable.

The retiring Directors, Mr. John Thomas Pearson and Mr. Robert William Eddison, being eligible, offer themselves for re-election, as does Mr. John Gordon, junior, as auditor.

The following shows the progress of the Company's current supply for the year 1894. The total units sold were 291,113, and the respective numbers of 35-watt lights installed at different dates during the year were as follows :—

January 1st	10,647	July 12th	11,683
February 22nd	10,850	September 6th......	14,205
April 19th............	11,054	November 1st	16,184
June 14th	11,548	December 31st......	19,858

Liverpool Overhead Railway Company.

The following is the report of the Board of Directors to be presented to the thirteenth ordinary half-yearly general meeting of the shareholders, to be held at the Law Association Rooms, 14, Cook-street, Liverpool, on Tuesday, the 12th inst., at 3 p.m. :—

In presenting the half-yearly statement of capital and revenue accounts to December 31, 1894, the Directors have to report that the gross revenue receipts amount to £25,700. 19s. 2d., and the working expenses to £17,162. 4s. 10d.

The number of passengers carried since the opening of the railway being as follows :—

	March 6, to June 30, 1893.	Half-year ending Dec. 31, 1893.	Half-year ending June 30, 1894.	Half-year ending Dec. 31, 1894.
First-class	235,487	... 260,221	... 277,653	... 362,179
Second-class	956,922	... 1,293,840	... 1,246,975	... 2,228,224
Workmen (special return tickets)	178,333	... 921,578	... 1,336,809	... 1,050,976
Total	1,370,742	2,475,639	2,861,437	3,641,379

The increase in the traffic shown by these figures is gratifying. The Directors consider the increased working expenses are mainly due to the additional train mileage of 70,933 miles due to the opening of the Northern Extension, and the cost of working the three new stations, at the Nelson and Langton Docks and Seaforth Sands. The traffic on the Northern Extension has fully answered expectations, and the experience which the Directors have thus obtained has determined them to ask the shareholders to approve of the construction of the Southern Extension, for which the Company hold Parliamentary powers.

REVENUE ACCOUNT.

	£	s.	d.
Receipts from passenger traffic amount to	£25,336	11	9
Miscellaneous receipts................................	364	7	5
	£25,700	19	2
Less working expenses..............................	17,162	4	10
	£8,538	14	4
From which deduct interest on debentures and calls paid in advance	2,520	17	7
	£6,017	16	9
Add balance brought forward, June 30, 1894......	1,248	4	1
Leaving available for dividend	£7,266	0	10

Out of this balance the Directors recommend the declaration of dividends at the following rates (less income-tax), payable on and after February 16th, viz, 5 per cent. per annum on Preference shares (£2,428s. 8s. 5d.); 2 per cent. per annum on Ordinary shares (£3,750); leaving a balance of £1,087. 12s. 5d. to be carried forward to next half-year.

The Directors retiring by rotation at this meeting are Mr. E. Lawrence and Mr. G. H. Robertson, who, being eligible, offer themselves for re-election; the retiring auditor, Mr. J. S. Harmood Banner, is also eligible for re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1894, pages 274-300, *&c. &c.*]

ELECTRICAL OIL REFINING COMPANY (LIMITED).—This Company was registered on January 26th with a capital of £5,000 in £1 shares, to acquire a patent and provisional specifications relating to the refining and purifying of oils and fats by means of electricity or otherwise, and obtaining colouring matter therefrom, and to carry on the business of dye manufacturers, bleachers, refiners, and purifiers of oils, fats and other substances by means of electricity or otherwise.

HARGREAVES & SHAW (LIMITED).—This Company was registered on January 29th, 1895, with a capital of £5,000 in £5 shares to take over the business carried on by Ellis Hargreaves and Ellis J. Hargreaves, trading as "Hargreaves & Co," at Atlas Works, Curzon Road, Ashton under-Lyne, as electricians and mechanical engineers, and to carry on the business of an electric light company, in all its branches, to construct, lay down, establish, fix, and carry out all necessary cables, wires, lines, accumulators, lamps, and works, and to carry out the business of electricians, mechanical engineers, suppliers of electricity, manufacturers of electrical apparatus, machine and engineering tool makers, &c. The first Directors are:—George Shaw, Thomas Shaw, Ellis Hargreaves and Ellis J. Hargreaves.

NEW-MAYNE ELECTRIC RUDDER MOTOR SYNDICATE (LIMITED).—This Company was registered on January 29th with a capital of £20,000, in £10 shares, to acquire the English patent and one moiety of the foreign patents to be taken out if considered advisable of Messrs. New & Mayne's invention for an electric rudder-motor, which is covered in Great Britain by letters patent dated 8,316 of 1893, 15,921 of 1894, and 22,134 of 1894, to generate, produce, store, accumulate, and distribute electricity, electromotive force or other similar agency for the purpose of lighting omnibuses, tramcars, boats, vehicles, buildings, mines, ships, lighthouses, railways, &c.; to acquire the right to use or manufacture and put up telephones, telegraphs, electric bells, phonographs, and other electrical apparatus, and to carry on the business of electrical engineers, electricians, mechanical engineers, electrical apparatus manufacturers, &c. The subscribers (with one share each) are John L. Higgs, Ashley College, Walton-on-Thames; James B. Gilbert, "Hingston," Ealing, W.; James B. Hutchins, Silverdale, Sydenham, S.E.; William H. Williams, Osbaldeston-road, N.; Harry P. Herbert, 57, St. Germaine's-road, S.E.; Robert Wolfenden, 141, Ferme Park-road, Hornsey; John J. Fleming, Bedford-villas, Leyton.

ROBERT SYKES AND SONS (LIMITED).—This Company was registered on January 24th, with a capital of £20,000 in £50 shares, to acquire the business carried on by Robert Sykes as an electrical engineer and iron and steel merchant, at Stalybridge, Oldham and Ashton-under-Lyne.

TRAMWAYS ELECTRICAL TRACTION COMPANY (LIMITED).—This Company was registered on January 28th, with a capital of £172,500, divided into 15,000 shares of £10 each and 15,000 shares of £1. 10s. each, to enter into and carry into effect an agreement with the Tramways Company of France (Limited), and to carry on the business of manufacturers of and dealers in tramways, carriages, trucks, locomotive and other engines, and other effects required for the making, maintenance, equipment and working of tramways, omnibuses, and light railways. The subscribers are: Lord Richard H. Browne (50 preference shares), James B. Concanon (100), H. R. Brutin (100), W. G. Woolston (100), James Walker (4), Ernest Lazarus (50), and J. Barber Glenn (50). The Directors are: Lord Richard H. Browne, Charles Burrell, James B. Concanon, Woolfe Haldinstein, and Ernest Lazarus.

BAILY AND GRUNDY, LONDON (LIMITED).—Mr. R. M. Baily, and Managing Director of this concern, states that the Company has never done any business, and that the writer has provided all the expenses. The name of the Company will, therefore, be struck off the Register of Joint Stock Companies.

BEDFORD ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company, made up to January 14th, has been filed. The capital is £15,000 divided into 250 Founders' and 14,750 Ordinary shares, each of £1. 154 Founders' and 882 Ordinary shares have been subscribed for and allotted. The full amount has been called on the Founders' shares, and a call of 1s. per share has been made on the Ordinary shares, resulting in the receipt of £197. 19s., and leaving 3s. in arrears.

BOURNE AND GRANT ELECTRICITY SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to January 21st, has been filed. The nominal capital is now £45,000, divided into 44,900 Ordinary and 100 Founders' Shares of £1 each; 34,900 Ordinary and all the Founders' Shares have been subscribed for and allotted, and calls amounting to 15s. per share made on each, resulting in the payment of £26,750.

BRITISH AND FOREIGN ELECTRIC AND ENGINEERING COMPANY (LIMITED).—The statutory return of this Company, made up to December 7th, was filed on December 17th following. The nominal capital is £2,000, divided into 1,950 Preference and 50 Ordinary shares of £1 each. Only the seven signatories' shares have been taken up, and no calls have as yet been made.

BROMPTON ELECTRIC FITTINGS COMPANY (LIMITED).—Writing on December 22nd, Mr. Francis R. Reeves, the secretary, states, "that the above Company has practically ceased to exist. The whole of the assets have been sold, the creditors paid, and the Company has ceased to carry on business for many months." The name of the undertaking will therefore be struck off the Register.

BULLERS (LIMITED).—The annual return of this Company, made up to November 23rd, was filed on December 1st following. Out of a nominal capital of £200,000 divided into 10,000 £6 per Cent. Cumulative Preference Shares of £10 each, and a like number of Ordinary shares of similar value, 5,731 Preference, and 6,731 Ordinary have been taken up and allotted. 5,731 of each class have been issued as fully paid to the vendors, and the full amount has been called and paid on the remaining 1,000 Ordinary shares.

DALZIEL'S NEWS (LIMITED.—The statutory return of this Company made up to November 13th, has just been filed. Out of a capital of £150,000, divided into 60,000 Preference and 90,000 Ordinary shares of £1 each, 2,007 Preference, and 22,000 Ordinary shares have been taken up. All the latter have been issued as fully paid, while the full amount has been called on the former, resulting in the payment of £2,000, and leaving 7 in arrears.

SECTIONAL STANDARDS (LIMITED).—The annual return of this Company, made up to December 12th, has been filed. Out of a nominal capital of £3,000, in shares of £10 each, 200 have been taken up, and the full amount has been called and paid.

VENEZUELA TELEPHONE AND ELECTRICAL APPLIANCES COMPANY (LIMITED).—The annual return of this Company, made up to November 7th, has just been filed. The whole nominal capital of £70,000, in shares of £1 each, has been taken up, and 56,506 have been issued as fully paid. The full amount has been called and paid on the remaining 13,494 shares.

CITY NOTES.

BICESTER ELECTRICITY SUPPLY COMPANY (LIMITED).—The Directors of this Company did not proceed to allotment, and deposits were returned to the intending shareholders.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY (LIMITED).—The half-year's report of the Directors of this Company states that arrangements have been concluded with the British Thomson-Houston, Limited, for the electrical construction and equipment of the City to Kingswood section of the Company's system, and that the Directors anticipate the line will be opened for traffic in the ensuing summer.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LIMITED).—The Directors of this Corporation have decided to recommend a dividend at the rate of 5 per cent. for the half-year ended December 31st last, making (with the interim dividend at the rate of 4 per cent. paid August 15th last) a distribution for the year 1894 of 4½ per cent., and that the balance of upwards of £2,300 be applied to reserve, depreciation, &c.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended January 27th were £998, as against £951 in the corresponding period of 1894, being an increase of £47. The total receipts for the half-year amount to £3,999, as against £3,839 for the corresponding period of 1894, an increase of £160.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—A dividend at the rate of 8 per cent. per annum for the past six months is announced by the Directors of this Company.

GREAT NORTHERN AND CITY RAILWAY COMPANY.—The prospectus of this Company is issued, inviting subscriptions for £1,000,000, in shares of £10 each, payable 10s. on application, £1. 10s. on allotment, and the balance in calls not exceeding £2 at intervals of not less than three months. Interest at 3 per cent. per annum is to be paid on all sums due and paid during the period of construction. This payment of interest is authorised by the Company's Act. Guarantees have been entered into with the Great Northern Railway Company equivalent to interest at £2 per cent. per annum upon the whole share capital of the Company (£1,500,000). The engineers are Sir Douglas Fox, Francis Fox, and J. H. Greathead. The secretary is Mr. J. Eland, and the offices of the Company are 12, New-court, Lincoln's Inn, W.C. The railway, when completed, will be about three miles in length, and effect through communication between Finsbury Park (connecting the main line of the Great Northern) and Moorgate-street, tapping the thickly-populated districts *en route*. The motive power used will be electricity, the tunnels being 16ft. in diameter, constructed to take the Great Northern Railway Company's heaviest suburban traffic. The railway is estimated to accommodate 320 trains per day each way. It is estimated that the total cost of construction, including all expenditure up to the completion of the contract, will be £1,400,000. The list of subscriptions closes on Monday next, February 4th.

HALIFAX AND BERMUDAS CABLE COMPANY (LIMITED).—This Company has joined the International Telegraph Convention.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 27th inst. amounted to £943. The amount for the corresponding week last year was £632.

NATIONAL TELEPHONE COMPANY (LIMITED).—The Directors of this Company yesterday resolved, subject to final audit, to recommend, at the forthcoming general meeting of shareholders, the following dividends, less income-tax, for the half-year ended December 31st last:—At the rate of 6 per cent. per annum on the amounts paid up on the First and Second Preference shares, and at the rate of 5 per cent. per annum on the amounts paid up on the Third Preference and Ordinary shares, carrying £35,000 to reserve and about £4,000 forward. The transfer books of the Company will be closed from the 4th to the 14th inst. inclusive, and dividend warrants will be posted on the latter date.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT COMPANY (LIMITED).—The Directors of this Company recommend a dividend at the rate of 9 per cent. per annum on the Ordinary shares of the Company for the half-year ended the 31st December last, making with the interim dividend previously paid, 6½ per cent. for the year.

STOCK EXCHANGE NOTICES.—Application has been made to the Committee to grant a quotation in the Official List to the following:—Edison and Swan United Electric Light Company (Limited), 89,261 "A" shares and 100,000 Four-and-a-Half per Cent. Debenture Stock, in lieu of shares of the Swan United Electric Light Company (Limited).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended January 25th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,412.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Jan. 23.		Price Wednesday, Jan. 30.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 30.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	9/0	Anglo-American	41	42	41	42	4 16 3	Jan., Apr., July, Oct.	41	..
£2,993,560	Stock	18/0	Do. Preferred	77	78	77	78	5 2 7	" "	77⅞	77½
£2,993,560	Stock	6/0	Do. Deferred	6½	7	6½	7	..	..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 17 1	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	11½	11¾	11½	12	5 8 4	Mar., June, Oct., Dec.	11⅞	11½
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	109	113	109	113	4 8 11	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	147	152	147	152	4 12 1	Jan., Apr., July, Oct.	148	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	19½	20½	20	2	3 16 2	" "	—	..
12,931	5	1/8	Direct Spanish (fully paid)	4	4½	4	4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9½	10	9½	10	5 0 0	" "	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8½	9	8½	9	5 0 0	Jan., Apr., July, Oct.	9	8¾
400,000	10	2/6	Eastern	16⅛	16⅝	16⅛	16⅜	3 19 6	" "	16½	16⅛
70,000	10	6%	Do. 6 per Cent. Preference	17	17½	17¼	17¾	3 7 7	" "	17⅝	17½
£1,297,337	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	122	125	123	126	3 3 6	May and November	124⅝	123
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	110	106	110	4 16 0	February & August	..	..
260,000	10	2/6	Eastern Extension	16⅜	16⅝	16½	16¾	4 3 7	Jan., Apr., July, Oct.	16¾	16⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	123	126	123	126	3 3 6	February & August	124	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	102	106	103	106	4 14 9	January and July	104	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	102	106	103	106	4 14 9	" "	103	—
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106	109	106	109	3 14 9	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	111%	114%	111%	114%	3 10 10	May and November	112	—
180,227	10	1/6	Globe Telegraph and Trust	9	9½	9¼	9½	4 14 9	Jan., Apr., July, Oct.	9$\frac{7}{16}$	9⅜
180,042	10	6%	Do. 6 per Cent. Preference	16¼	16½	16¼	16½	3 12 9	" "	16½	16¼
150,000	10	5/0	Great Northern	21¾	22¼	21¾	22¼	3 17 2	Jan., April, and July	22¼	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	137½	—
17,000	25	12/6	Indo-European	50	62	50	52	4 16 2	May and November	51½	50¾
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	105	109	105	109	5 10 10	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	104	107	105	108	3 14 3	..	..	—
11,839	8	4/0	Reuter's	2	4	3	4	..	April and October	3$\frac{15}{16}$	3½
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	114	119	118	123	4 17 7	" "	..	—
15,609	10	5/0	West African Telegraph	3	5	4	5	..	January and July	..	—
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	102	105	4 17 4	March & September	..	—
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	98	103	7 15 4	June and December	..	..
88,321	10	6d.	West India and Panama	1	1¼	1	1¼	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	5 6 8	May and November	10⅞	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 10 6	June and December	..	..
64,242	15	3/0	Western and Brazilian	10¾	11¼	10¾	11¼	4 18 3	May and November	11¼	11
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	..	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	4½	5¼	4¾	5¼	..	..	5¼	4⅞
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	103	107	103	107	5 15 5	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	103	107	103	107	5 15 5	" "	..	—
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115	120	115	120	5 18 5	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 13 5	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	—	..	2¾	..
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	$\frac{1}{16}$	$\frac{3}{16}$	$\frac{1}{16}$	$\frac{3}{16}$	—	May and November	..	—
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	¼	⅝	¼	⅝	..	Yearly	..	..
484,597	5	3/4	National	5¼	6¼	5½	6¼	4 6 11	June and December	6⅜	5¼
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 16 0	" "	16¼	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	" "	15⅞	15¾
119,234	5	3/4	Do. 5% Non-Cumulative 3rd Pref.	5⅞	6⅛	6	6¼	4 0 0	..	6$\frac{3}{16}$	6$\frac{1}{16}$
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	105	107	3 5 5	January and July	106⅛	105¼
58,000	5	1/0	United River Plate	1	2	1	2	..	" "	..	—
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	86	91	86	91	5 9 11	" "	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	14½	15½	14½	15½	..	—	15¼	14¾
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15¼	15¾	15¼	15¾	3 16 2	..	15⅝	15⅜
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	132	135	133	136	3 13 6	June and December	134	133½
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	4½	5½	4½	5½	3 12 9	—	..	..
£57,400	£100	6%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	—
8,322	£5	..	House-to-House Electric	..		..		—	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		—	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		—	January and July	..	—
45,000	£5	2/6	Liverpool Electric Supply (fully paid)	7$\frac{5}{16}$	7$\frac{7}{16}$	7$\frac{5}{16}$	7$\frac{7}{16}$	—	—	..	—
111,000	5	..	London Electric Supply	⅜	⅜			..	..	..	—
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	9¾	10¼	9¾	10¼	2 8 9	..	10$\frac{3}{16}$	9$\frac{13}{16}$
£150,000	Stock	4½%	* Do. 4½% Debs.	117	120	117	120	3 15 6	June and December	..	..
6,452	£10	..	Notting Hill Electric	7	7½	7	7½	..	..	..	..
19,080	£5	2/0	St. James and Pall Mall	7¾	8¼	7¾	8¼	..	..	8¼	7¾
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 15 8	..	8$\frac{13}{16}$	..
59,900	5	2/0	Westminster Electric Supply (fully paid)	7½	8	7½	8	2 16 3	..	7⅝	7¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	8	1/6	Brush Electrical Engineering	2⅝	2⅞	2⅝	2⅞	5 5 3	..	2$\frac{13}{16}$	2⅝
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2⅜	2⅝	4 11 5	—	2⅜	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	111	114	113	116	5 13 11	March & September	..	..
20,000	5	8/0	Crompton and Co., 7 per Cent. Cumulative Pref.	3	3½	3	3½	—	January and July	..	..
12,139	5	..	Edison and Swan United	—		—		..	—	—	—
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		—		..	—	—	..
120,000	2	..	Electric Construction	½	½	½	½	—	—	..	..
12,845	2	2/9⅞	Do. 7 per Cent. Cumulative Pref.	1¼	2	1¼	2	..	—	—	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1¼	1⅜	1¼	1⅜	—	—	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	—	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	25½	26½	24½	25½	4 9 2	February & August	26	25⅝
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 8 3	March & September	103½	—
15,995	£10	6/4	International Okonite Ordinary	..		..		—	—	..	—
16,000	£10	..	Do. 8 per Cent. Preference	—		—		—	December and June	..	—
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	¼	¼	—	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	41	43	41	43	5 11 6	March and July...	43	42¼
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 13 6	January and July	..	..
37,514	£6	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	—		—		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	—		—		..	—	..	—
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	9	10	9	10	5 0 0	..	10	—
£30,000	10	..	Do. Preference	..		..		..	..	..	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1%	City and South London Railway	44	40	43	50	2 0 0	May and November	49	45½
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	14$\frac{9}{16}$	14¼
£67,130	Stock	4%	Do. 4% Perpetual Debenture	127	129	128	130	3 1 7	May and November	129½	128½
37,500	£10	1%	Liverpool Overhead Railway	8½	8¾	8½	8¾	1 3 2	..	—	—
6,295	10	5%	Do. 5% Preference	13	13½	13	13½	3 16 6	..	—	—
125,000	Stock	4%	Do. 4% Debenture	110	112	110	112	3 11 5	January and July	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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NOTES.

The Conference on Light Railways called together by the Board of Trade just before Christmas has concluded its labours. The Report of the Committee appeared in our last issue, and to-day we publish the discussion which arose on its presentation and acceptation. We trust no one expected the Committee to make specific and technical suggestions either as regards matters of law or of engineering, because we do not care to see anyone disappointed. The Board of Trade, it was evident, desired two things, and these it has secured. It wished to ascertain in a public manner whether light railways were really wanted by those for whom they have been gratuitously prescribed, and it also wished to have a direct public mandate to relax its rules and to facilitate the promotion of light railway concerns. The Committee considers that the present necessity of obtaining Parliamentary sanction for every twopenny-halfpenny local line is expensive, and it suggests the authorisation of local concerns by Local Authorities, "an ultimate appellate jurisdiction being reserved to the Government Department charged with the inspection of railways." The Committee further expresses its belief that on most of the lines of the kind now contemplated "the regulations which have been enforced with a view to the public safety may be considerably relaxed." That the Conference has not been in vain is, moreover, evidenced by the passage in the Queen's Speech, announcing a Bill "for facilitating the construction of Light Railways," and the introduction of that Bill by Mr. Bryce.

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Some eight appendices expressing individual views of greater strength and precision than the committee as a whole felt warranted in adopting, have been published along with the report. These views are mostly of the kind now very common, and known as "democratic" or "progressive." By all means relax rules and cheapen the promotion of these light railways, and do not permit the commonweal to be lost sight of in the midst of the antiquated absurdities of the common law, but substantial justice must be done to *all* concerned. Municipal management must not, in the interests of the commonweal, be allowed unless private capital cannot absolutely be coaxed into making the necessary outlay, and the need for any line at all is self-evident. Municipalities profess to regard light railways and tramways with a benevolent eye. The action of the London County Council last week, and the fact that the Committee refers to the deterrent effect of the often onerous conditions required by local authorities, would seem to indicate that the common law is not the only obstacle to the development of urban and rural rapid transit schemes.

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One of the first qualifications for a member of a deputation which is to lay a case before a public department is, one would have thought, a thorough knowledge of the case to be presented. Be this as it may, the principal speeches on the occasion both of the deputation of the Municipal Corporations Association last week, and on the occasion of the deputation of the London County Council last Monday, revealed a lamentable lack of accurate acquaintance with the telephone agreement so much discoursed about. Last week it appeared to come as a surprise to many members of the deputation when the Postmaster-General alluded to the absolute veto of the local authorities upon the exercise of statutory privileges by the National Telephone Company. As to the London County Council's deputation, it was all at sea as to the present charges of the National Telephone Company and the present extent of its twin-wire system in London; and it was discreetly oblivious to the £30–£50 rentals charged in the United States, though wide awake enough to the low rentals obtaining in countries so similar in every way to England as Canada, Australia, and Scandinavia. Upon the top of this display of inaccuracy and ignorance came the calm proposal that the telephonic needs of the metropolis should in future be catered for by these highly competent County Councillors. With the trunk wires in the hands of the Government, the possibility of municipal telephony may prove useful as a stimulus to the National Telephone Company in our smaller towns; but a democratic telephone exchange system on a metropolitan scale could not be regarded with equanimity either by potential telephone subscribers or by the ratepayers.

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Although our present number seems to be redolent of gas, and to resound with explosions, we must find a few lines to call attention to the testing device which Prof. Clowes describes in another column. For coal mines, petroleum tanks and steamers, and doubtless also in gas works, such an apparatus should be, and in many cases is, of great value. We had an opportunity of examining the apparatus at work, after the reading of Mr. Redwood's Paper before the Institution of Civil Engineers, and no one who has seen it can fail to admire the clearness of its indications. It is no doubt a scientific instrument, and as much cannot be said for the

Ansell detector, which we described three weeks ago. But it is evident that the habitual use of the hydrogen apparatus in crowded thoroughfares is almost impossible. The sampling of the air taken from boxes, and its subsequent analysis at the supply works is more practicable but does not seem very satisfactory. The scientific objections which have been urged against what are called physical instruments, though such objections may be of importance in connection with coal mines, cannot be accepted in the present application without some practical proof. The comparison of such instruments is a work which, if Major CARDEW will excuse the suggestion, might be undertaken by that active Government department which has already investigated the explosions and their causes. We suggested a modification of the Ansell instrument about a year ago, and although the porous diaphragm may become clogged with coal dust in mines, and though carbonic acid may be present in coal pits to such an extent as to neutralise the indications, it does not follow that similar conditions arise in street junction boxes and conduits.

OUR appeal to telephone men to justify their grumblings about the constitution of the Council of the Institution of Electrical Engineers has not been fruitless; but has resulted in a practical and carefully arranged Paper, the conclusion of which, together with a report of the discussion, we print elsewhere. The response to our suggestion was perhaps too prompt. Not that Mr. KINGSBURY has scamped his work in the least degree; but the Institution of Electrical Engineers, as usual, gives the technical press no chance of producing the Paper properly. We were obliged to omit several illustrations last week, and those which we succeeded in producing were hurriedly engraved from patent specifications, and although the author has done all he could *after* the reading of his Paper, the Institution has, as is often the case, given us no assistance whatever. The wealth and prestige of the Institution of Civil Engineers has nothing whatever to do with the complete state in which all its Papers are invariably printed with illustrations both in the text and on folding plates, several days before the Paper is read. General circulation of the Papers is, of course, a matter of expense. Papers read before the Institution of Electrical Engineers obtain far greater publicity in the columns of the technical Papers than in the *Journal* of the Institution, and for the authors' sakes we greatly regret that we are so often compelled to publish them in so imperfect a state.

British Association.—The next (Ipswich) meeting will open on September 11th, and close on September 18th.

Professorial Appointments.—Prof. E. Warburg, Professor of Physics at Freiburg University, has been appointed Prof. Kundt's successor at Berlin University.

Electrical Bills in Parliament.—Mr. Campion, Examiner on Standing Orders, has found that the Standing Orders have been complied with in the case of the London, Walthamstow, and Epping Forest Railway Bill.

London Chamber of Commerce.—We understand that the London Chamber of Commerce is thinking of leaving its present headquarters at Botolph House, Eastcheap, to take larger and more convenient premises within a short distance of the Bank.

Conduit Explosion at Rochester.—Another explosion took place at Rochester on Saturday in a chamber beneath the pavement connected with the electric light. It occurred at the same spot as the previous explosion, and apparently from a similar cause—an escape of coal gas coming into contact with an electric spark.

Erratum.—A correspondent calls our attention to an error in our Notes of last week, in which the discovery of the planet Uranus was attributed to Adams. We should have stated, as doubtless Prof. Crookes actually said, that the planet Neptune was discovered by Adams by observation of the perturbations of Uranus.

The Electric Arc, &c.—Owing to extreme pressure on our space we have been obliged to hold over the continuation of Mrs. Ayrton's article, Mr. Heaviside's article, the report of the Physical Society, a long letter from Prof. Eric Gérard, and other matters. We have to hold over also an article on the delineation of alternate-current curves, by Prof. Fleming, together with some very interesting curves of alternators under various working conditions.

The Explosion Scare.—On Tuesday afternoon, at a meeting of the St. Luke's (Middlesex) Vestry, it was unanimously decided to support the Vestry of St. George-the-Martyr, Southwark, in their appeal to the Board of Trade against allowing the construction of transformer chambers in the main thoroughfares of the metropolis. The argument was the extreme danger to life and property.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
Gibraltar—Cadiz	Jan. 14, 1895.	Feb. 4, 1895.
Pernambuco—Ceara	Jan. 12, 1895.	Feb. 5, 1895.
Latakia—Cyprus	Nov. 27, 1894.	—
Cadiz—Teneriffe	Dec. 26, 1894.	—
Hongkong—Macao	Dec. 31, 1894.	—
San Thome—Loanda	Jan. 22, 1895.	—

The Dover Conduit Explosion.—Some further particulars have come to hand with regard to the electric light conduit explosion at Dover recorded in our last week's issue. The chamber, the lid of which blew off, was only about 8ft. in cubic capacity. The mains had never been charged. Some operations were being carried on with a light in another street-box about 30 yards away. Immediately after the explosion, there was a strong smell of coal-gas in the box the men were working in, although it was not noticed before. It is supposed that the gas leaked into the chamber from the gas mains in the street.

Military Telegraphy and Telephony.—A course of instruction in telegraphy for the Austro-Hungarian cavalry has just been approved by the Emperor, and will immediately come into force. The object is to train commissioned and non-commissioned officers of that arm of the service for the despatch of communications by telegraph and telephone. The technical part of the course will be under the control of the chief of the Telegraph Department, who will be assisted by a cavalry officer and three non-commissioned officers, as well as by a couple of men from the Railway and Telegraph Corps and a number of subordinate teachers.

City Commissioners of Sewers and the Telephones.—On Tuesday the new Commission of Sewers for the City of London was opened at Guildhall. At the instance of Mr. A. C. Morton, M.P., it was resolved that, in the opinion of the Court, a Select Committee of the House of Commons should be appointed to consider the proposed agreement between the Post Office and the National Telephone Company, so that the whole question of telephones might be carefully examined and reviewed in the interests of the public generally, and it be suggested to the Postmaster-General accordingly; and that a copy of the resolution be forwarded to various municipal bodies in the Metropolis suggesting their co-operation.

Water Power Utilisation in Italy.—A central station has recently been completed and put in operation for the electric lighting of the town of Brescia. The public lighting comprises 51 500 c.p. arc lamps, and 40 50-c.p. incandescent lamps. The central station is situated at Calvagese, a distance of about 12 miles, the water power of the river Chiese being utilised. The generating plant comprises three vertical turbines, driving three Thury continuous-current dynamos. The electrical energy is transmitted to Brescia along four bare wires of silicious bronze 5·6mm. in diameter, supported on poles every 131ft.

Electrolytic Preparation of Manganese.—At their chemical laboratory at Linden, in Hanover, Germany, Messrs. Konigsmaier and Ebell have undertaken the electrolytic separation of manganese from its compounds. They have succeeded in obtaining the metal in a condition practically pure, in the form of a fine powder. In preparing alloys of the metal, in order to avoid the loss inevitable from this finely divided condition, they use in the crucibles alkaline chlorides and chloride of manganese, which is not subject to oxidation by the air. The processes adopted have been covered in Germany by patents.

Accumulator Traction on Common Roads.—An electrically-driven vehicle has been careering about Paris lately. The motive power is derived from a 21-cell battery of Tommasi accumulators. In its latest form the perforated cylinders which hold the active material, and which are the characteristic feature of this cell, are of celluloid. The capacity of the Tommasi cell is said to be 25 ampere-hours per kilogramme of electrode. The total weight of the 21-cell battery on the vehicle amounts to 280 kilogrammes. This battery gives 100 amperes, at 40 volts, and is occasionally called upon for 200 amperes. The total weight of the vehicle, with two passengers, is about 1,200 kilogrammes, and it can run at 20 kilometres an hour. Under normal conditions the battery can drive the vehicle for an hour and a-half.

Zeitschrift für Instrumentenkunde.—The *Zeitschrift für Instrumentenkunde* announces that Prof. A. Westphal, who has belonged to the editorial staff since the foundation of the journal, and who has since 1888 been sole editor, finds it necessary to resign that post in consequence of the increase of his official duties; he will, however, remain business manager of the Redaktionskuratorium, which is now composed of Prof. H. Landolt, Prof. A. Westphal, Prof. E. Abbe, Dr. H. Krüss, and Herr Haensch. The editorship has been taken over by Dr. St. Lindeck, of the Reichsanstalt. The readiness with which Dr. Lindeck was allowed to add the function of editor to his other duties causes the Editing Committee to hope that the connection between the *Zeitschrift für Instrumentenkunde* and the Reichsantalt, "the acknowledged protectress of präzisionstechnik," will in future be even closer than in the past, without, however, imperilling the independence of the journal. The *Zeitschrift für Instrumentenkunde* will also in future be more in touch with the Deutsche Gesellschaft für Mechanik und Optik, since Dr. Krüss, its President, has joined the Editing Committee of the journal.

The London County Council and the Trolley System.—Mr. Joseph Nelson contributes the following to the *Pall Mall Gazette* anent the action of the London County Council, reported on page 402 of our last issue. We agree with the writer's sentiments, and admire the vigour of his style:—

> SIR,—I always read the *Pall Mall Gazette*, because it gives me instruction and pleasure. I have had upwards of 50 years' experience as a promoter, locator, and constructor of railways and tramways, both in the United Kingdom, North and South America, and on the Continent of Europe. I went yesterday to witness the proceedings of the London County Council upon the application of a tramway company for permission to introduce the electric system of traction for about *one mile* within the jurisdiction of the London County Council. After listening to the speeches against the innovation, I said to myself, Am I living in the year 1835, when I began my first railway survey? For through all the intervening period I have never listened to such senseless objections as those which were uttered yesterday. My experience extends to the evidence before thousands of Committees of the Lords and Commons; but, above all, the most violent and unfounded statements were those made by Mr. John Burns. If he is a sample of the Progressives of the County Council, I shall not be surprised if that section meets with a severe reverse in the coming election. I have no interest whatever in the Company that applied for the permission, but I have a deep interest in seeing the perfect success of the tramway system in the United Kingdom, of which I was one of the first authors.

Very Stray Magnetism.—The *Electrical Engineer* of New New York is responsible for the following narrative. An engine and dynamo, direct-coupled, were started and worked in a satisfactory manner. After a time, however, complaints were received of unsatisfactory regulation. From the character of these complaints it was concluded that there might be some defect in the governor, and the maker incurred the expense of sending a complete new governor, requesting that the old one should be returned. The new governor was placed, adjusted, and the plant started, and the report came back that the regulation was perfect. In the course of a week or ten days complaints were again made of unsatisfactory regulation. It then occurred to the engine builders that possibly the governor was affected by magnetism. They conferred with the makers of the dynamo, and were told that in their judgment such could not possibly be the case. The governor wheel, it should be stated, was on the far side of the engine. It has since been ascertained that a monkey wrench is held fast to the rim of the governor wheel when the engine is under full speed; the speed of the periphery of the wheel being about 5,400ft. per minute. When the engine is in service the magnetic attraction is sufficiently strong to pull a man, standing at the front or crank end with a wrench held out within 2ft., into the engine. Any magnetic substance, such as iron or steel, if placed on the throttle valve wheel is held firmly. The distance between the centre of the dynamo and the eccentric is about 48in.

A Cruel Decoration.—Sir Herbert Maxwell, writing to *The Times*, of yesterday, draws attention to a thoughtless use of electric light, which surely needs only to be explained to be prevented:—

> CRUELTY TO ANIMALS.
>
> TO THE EDITOR OF "THE TIMES."
>
> SIR: I appeal to you to assist in putting down an ingenious form of cruelty which, unless it meets with stern discouragement, is not unlikely to become common. Table decoration has been brought to a high degree of elaboration, and ministers greatly to the luxury of fashion; but my appetite was completely destroyed on a recent occasion by the exquisite torture inflicted on certain dumb animals employed as ornaments. A crystal bowl occupied the centre of a round dinner-table, in which were half-a-dozen goldfish. Among these an electric burner had been introduced, with an effect upon the fish which a moment's reflection will show to be excruciating. Fish are extremely sensitve to light, not only in their eyes, but (some of them) over the whole surface of their bodies, as is shown by the faculty possessed by trout of altering their colouring according to that of the ground over which they swim. But the peculiarity which renders exposure to strong light intolerable to fish is that they have no eyelids. Some species can endure a good deal of sunshine, because the rays, falling from above, strike the surface of their eyes obliquely. But by the arrangement I have described above the source of intense light was brought close to and level with the fish. There was no escape for them, no cranny where they could hide their wretched heads, no protection for their lidless eyes. How would the guests have enjoyed their feast if the centre of the table had been occupied by a pillar of intense light 6ft. high, that being about the proportion to their stature which the burner bore to the size of the goldfish! They could at least have sat with closed eyes. Fish cannot close their eyes. Need any more be said to prevent this inhuman device becoming popular? It is just one of those torments which thoughtless people are prone to inflict, but which, if they were to realise it effects, they would abhor as much as I do.

Electric Lights for an Astronomical Telescope.—A 20-in. equatorial telescope has recently been set up at the Chamberlin Observatory, Denver, Col. Prof. H. A. Howe, director of the observatory, has contributed to *Astronomy and Astro-Physics* an article describing the instrument, in the course of which he writes of its illumination as follows:—"As the entire building is lighted by an alternating current at a pressure of 50 volts, this current has been utilised for the 2 c.p. lamps which illuminate the verniers of the main declination circle, the large setting circles, the micrometer, the hand lamp, &c. The main hour circle is lit up by two lamps of 16 c.p. each, which are so placed that they light up the dials south of the pier as well. As the voltage of the house current is too high for the small lamps, it is run through a special converter. The converter is inside of the pillar (supporting the telescope), about 4ft. above the floor, and is reached through a large opening on the north side of the pillar. The secondary wires run up from the converter through the clock case, thence out of a hole in the nose of the headstock, up through the polar axis (which is hollow) into the declination sleeve, emerging at the inner end of the sleeve, and being there attached to a series of concentric rings. Springs fastened to the telescope tube, and pressing against these rings, lead the current to all required points on the tube. All switches are placed just where they ought to be, and the writer expects great satisfaction from the completeness and easy manipulation of the electric lighting."

The Utilisation of Water Power.—It is not without interest, says *Engineering*, to see with what satisfactory results water power is being employed elsewhere, and a few particulars in this respect from the Grycksbo paper mills in Sweden throw some light upon this subject. A small river passes through the works; but its power would be altogether inadequate were it employed direct. The river has, however, several small falls, which are utilised for electric transmission. At a distance of a few miles several of these falls are, through a canal of about 1 mile in length, collected to a fall of 51ft. in height. The water is conveyed to the engine-house through a pipe 800ft. long, and works there a turbine of 200 effective horse-power. Directly coupled with this is a generator with a capacity of 3,500 volts and 30 amperes. The current is conveyed overhead to Grycksbo, where it works an electric motor of 150 effective horse-power. The plant has been working for several weeks, and has given entire satisfaction. About a mile further down the river the water is employed for a similar power station, which is intended to supply the electric light at the works. At the mills themselves, where the river, as mentioned, makes several falls, there are five or six turbines, which are used for various purposes. More power is, however, required, and this will be taken from a fall some four miles distant. The station to be erected there will be larger than the others, and the generator to be used will be the largest in Sweden, viz., 300 effective horse-power, from where power will be taken for the new paper mills which are being built at Grycksbo.

Electrical Coast Communication.—The scheme recommended by the Royal Commission having been sanctioned by the Treasury, telegraphic and telephonic communication in connection with the Liverpool lifeboat service has been established by the Post Office authorities, under the supervision of Mr. J. R. Edwards, the Department's Superintending Engineer. To render the life-saving resources as effective as possible it is necessary to have means for promptly summoning the steam lifeboat at New Brighton and any other boats at their respective stations in Liverpool Bay. The new system provides telephonic intercommunication between the lifeboat station at Formby, the coastguard station at Blundell Sands, the Prince's Landing-stage, the Ferry-stage at New Brighton, and the Liverpool head post-office, besides telegraphic communication between the latter office and the "look-out" stations at Voelnant (Point of Air), Hilbre, Hoylake, Bidston, and the Crosby lighthouse. On the Welsh coast the lighthouses on the Great Orme's Head and at Menai are now placed in communication with the lifeboat stations at Llandudno and Penmon respectively. The lighthouse on the South Stack, the signal station on the North Stack, and the lifeboat stations at Rhosneigir and Rhoscolyn are in direct telephonic communication with the coastguard station at Holyhead. The work of providing telephonic intercommunication between the coastguard station at Amlwch and Cemmaes, the signal station at Point Lynas, and the lifeboat stations at Bull Bay and Moelfra (the scene of the wreck of the "Royal Charter") will be completed shortly, as also a telephonic extension to the lifeboat station at Llanddwyn, Carnarvon Bay. Twenty lighthouses, under the jurisdiction of the Commissioners of Northern Lighthouses, are now electrically connected with the postal telegraph system.

The Petroleum Supply of the Caucasus.—According to the *Moniteur Officiel du Commerce*, the petroleum springs existing around Baku do not appear to have lost their prolific character, at all events in the districts of Balakhani-Salrundschi, Bibi-Eybat, and Romamy, where the petroleum industry is concentrated. In 1893 the production of mineral oil was 337,051,834 pouds (1 poud = 36lb.); of this quantity, 324,763,197 pouds (13·6 per cent. more than in 1892) underwent treatment in the local refineries, the remainder having been used for purposes of fuel or lost. The increase arises chiefly from the fact that the springs, without the aid of pumps, supplied about one-third of the aforesaid total. The price of the unrefined petroleum has been affected by this abundant supply; it has varied from 2.75 copecks (1 copeck = 1 farthing approx.) per poud in winter to about 0.75 copeck in summer. In 1893 there were 38 springs and 458 wells with pumps. A set of pipes, from 75 to 150 millimetres in diameter, and of a total length of 260 kilometres, connecting the wells and the works, has permitted of the refining of about 1,440,000 pouds daily. There are only 85 refineries in work, and several have had but little to do, because in Russia, as everywhere else, the larger establishments are crushing out the smaller. The refineries have produced and exported the following quantities: Refined petroleum, 85,633,791 pouds; lubricating oils, 6,232,740 pouds; benzine, 252,493 pouds; tar and gasoline, 437,620 pouds; and petroleum residues, 145,538,399 pouds.

The Inter-Colonial Postal Congress.—The Inter-Colonial Postal Congress opened at Hobart on Monday. The Pacific cable question was discussed. Mr. Thynne (P.M.G., Victoria) moved a resolution in favour of the construction, working, and maintenance of a cable through British territory and under British control, from Vancouver to Australia, to be undertaken by the Governments of Great Britain, Canada, and Australasia, and the cost to be borne equally by the three countries. The route proposed was from Vancouver by Neckar Island to Fiji, and thence to Caloundra in Queensland. If Neckar Island could not be placed under British control the route would be by Fanning Island instead Neckar Island. The motion further advised that a commission of the three countries should be appointed to conduct the financial arrangements, and that the Government of Canada should be requested to continue their good offices in promoting the undertaking. Mr. Cook (P.M.G., Queensland) moved an amendment reaffirming the desirability of a Pacific cable, and urging the Governments to take steps in the matter. The amendment was carried.—In regard to the cable guarantee, Mr. Ward (P.M.G., Tasmania) moved that Victoria should reconsider its withdrawal. The conference went into committee to confer on this point. As the result of the consultation, Mr. Ward moved before the conference that the colonies should agree to guarantee an international revenue to the Eastern Extension Telegraph Company up to £227,000 per annum, making up any loss below that amount, provided it did not exceed £10,000; also to guarantee a revenue from the New Zealand cable of £20,000, making up the loss if it did not exceed £9,000, provided the rates were not higher than at present; the agreement to be from year to year and terminable on two months' notice. We understand that the negotiations now in progress will probably lead to a prolongation for a term of years of the present reduced rates for cable messages.

The Manufacture of Chloride Accumulators.—In its issue of Dec. 19th, the *Electrical Engineer* of New York gives an interesting illustrated description of the Philadelphia works of the Electric Storage Battery Company, which until recently were the sole manufacturers in the United States of what is somewhat misleadingly called the "chloride" accumulator. The following description of the process of manufacture as elaborated in America is worthy of notice. The first step consists in reducing commercial lead to a fine powder, which is accomplished by directing a blast of compressed air against an orifice from which issues a fine stream of molten lead. The result is a spray of lead which cools and falls as powder. The lead finely divided in this ingenious way is then dissolved in nitric acid, and then precipitated as chloride of lead by the addition of hydrochloric acid. The white chloride of lead thus obtained forms the basis of the material which subsequently becomes active in the battery plate. The chloride of lead is then mixed in a certain proportion with chloride of zinc and brought to a molten state, the resultant product being cast into "pastilles." These "pastilles" are placed in a mould and held in position by pins projecting through the holes provided at their centres; the molten lead is then forced into the mould under a pressure of 75lb. to 180lb. per square inch. The plant of the Philadelphia Company is capable of turning out 10 tons of battery plates per day. The plates as they come from the casting room are stacked by alternating each lead plate with a slab of zinc all immersed in tanks filled with dilute chloride of zinc. The primary battery so formed is then short-circuited, the chloride of lead is reduced, the chlorine leaving the "pastilles" to form chloride of zinc, and the "pastilles" being left in a high crystalline state. The reducing process occupies about 48 hours. The plates thus formed are ready-made negatives. Those intended for positives are kept about two weeks in dilute sulphuric acid, and the proper continuous current applied. The plates in the cells are separated from each other by a sheet of asbestos, as well as by a perforated partition of cherry wood.

GAS-TESTING IN STREET CULVERTS.

BY FRANK CLOWES, D.SC., F.I.C.

Many explosions of a dangerous character have taken place in the electric culverts and in the street-boxes in connection therewith. The repetition of these occurrences has now forcibly drawn the attention, not only of electrical engineers, but of Government officials and of the public, to the serious risks incurred, and the questions are being asked freely—What is the explosive substance present in the culvert? and, How may its presence be detected without leading to danger?

As regards the answer to be given to the first question, there is great diversity of opinion; but the generally accepted view is apparently the correct one, and the danger is attributed with much probability to the presence of coal-gas in the air of the culvert.

There can be no doubt that the substance present in the air is an inflammable gas or vapour. In one special case, Mr. Boverton Redwood has examined the air drawn from several different parts of a closed electric culvert in the Metropolitan district, and has obtained unequivocal evidence in this atmosphere of inflammable matter.

The apparatus employed by Mr. Redwood was a modern inflammable gas and vapour detector, which was the joint invention of himself and of the writer, and was finally brought into a working form by Messrs. W. J. Fraser and Co., of Commercial-road. Their apparatus enables a sample of the air which is to be tested to be withdrawn from any inclosed space through a small opening, and to be stored in a compressed state for examination.

The air is tested by being passed over a standard flame of hydrogen gas in a specially-devised apparatus, and by the appearance over this flame of a pale "cap" or halo the presence of inflammable matter in the air is at once made evident. Further, by the height of this "flame-cap," which is at once measurable in the apparatus against a scale, the percentage of the inflammable material present can be measured with considerable accuracy. Repeated trials of this flame-test have proved that it is not only delicate in detecting inflammable gas or vapour in air, but that it is also accurate in measuring the amount present.

The principle applied is that originally employed for the detection of the dangerous "fire damp" of the coal mine. In the mine an oil flame or a spirit flame has been applied in a safety lamp for producing the cap. But the substitution for these flames of the hydrogen flame has not only much increased the delicacy of the test, but has also increased the accuracy with which the amount of inflammable gas present can be measured.

The writer first succeeded in adapting the hydrogen flame to a miner's safety lamp, and showed that proportions of fire-damp ranging between 0·1 and 6 per cent. could be detected with certainty and measured with accuracy in the air of the coal mine (*Proc.* Royal Soc., Vol. LII., p. 484; Soc. Arts, Cantor Lectures, 1894). Mr. Redwood, who applied the hydrogen flame in a special form of safety apparatus to the detection and measurement of petroleum vapour in tanks and other spaces, found that the hydrogen flame was equally satisfactory in detecting and measuring this inflammable vapour (*Proc.* Inst. Civil Engineers, CXVI.). Mr. Redwood's apparatus was specially designed for examining air in spaces into which the testing apparatus itself could not be introduced, while the portable hydrogen safety lamp devised by the writer is carried into the space, and the examination is made directly and *in situ*. In the confined space of the culvert the safety lamp is, of course, unsuitable, and the stationary apparatus fed from a collecting vessel is the form applicable to the special case. But in larger spaces the small portable safety lamp will be found more convenient and more rapid in its indications.

Although the apparatus was originally devised for the detection of fire damp and of petroleum vapour, it has since been examined in air-spaces containing some other inflammable gas or vapour, such as coal-gas, water-gas, or hydrogen. The testing apparatus is found to be equally delicate in detecting all such inflammable gases and vapours, while the scale for indicating the proportions of these inflammable materials present in the air requires little alteration from that supplied for the measurement of fire damp.

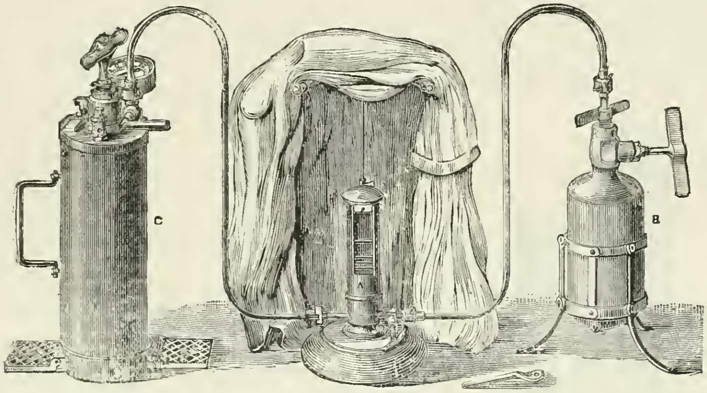

Fig. 1.

There is no doubt that this flame test is in every sense more trustworthy and more delicate than the detectors which depend upon physical principles. This latter class of detectors have their indications of light inflammable gases reduced, annihilated, and even reversed by the presence of carbonic acid. Carbonic acid is a normal constituent in large proportion of the air present in the ground. Hence it is certain to make its way into street culverts just as coal gas does. Accordingly physical tests lose their value from this probable disturbance, while the flame test is fortunately not affected by any proportion of carbonic acid up to 5 per cent.

In testing the air of an electric culvert it is only necessary to have a small aperature made, through which a narrow flexible tube can be pushed. Through this tube the air of the culvert enters the storage vessel, into which it is pumped and in which it is inclosed. Thus the air of the culvert undergoes no alteration in nature or composition by opening the boxes, and a true indication is obtained of the actual composition of the culvert atmosphere at the time the sample was collected.

It will therefore be evident that satisfactory knowledge regarding the condition of the culvert air is thus at once obtainable at any time and at any place, and it is obtained with great ease, certainty, and convenience.

The stationary apparatus is shown in the accompanying sketch (Fig I). The vessel to the right, B, is a small steel cylinder containing compressed hydrogen gas. This is connected by means of a metal tube with the jet from which the hydrogen test-flame is burnt. The flame burns in the small metal cylinder, blackened inside and with glass front, which is shown in the middle of the sketch, A. The air to be tested is stored in the metal cylinder to the left, C, and is allowed to escape from this vessel and to pass in a stream over the standard hydrogen flame in the central observing vessel, A; proper arrangements are made for preventing any risk of firing or explosion. When an observation is being made, the vessel A and the observer's eye are placed in darkness by surrounding them with a black cloth, as is done when a photographic camera is being used. Thus the pale flame-cap, which furnishes the indication of gas, is easily seen, and its height is measured against a scale fixed upon the glass through which the cap is observed. This height at once gives the percentage of gas present.

It is necessary before commencing a series of tests to adjust the hydrogen flame to its standard height by properly regulating the valve of the hydrogen cylinder; and in order to prevent the extinction of the flame, the bottom of the observing vessel is only closed immediately before the air is turned on from the collecting vessel, and after the apparatus A has become sufficiently warm to prevent condensation of water on the glass.

Messrs. W. J. Fraser and Co., of 98, Commercial-road East, the makers of this apparatus, send out with it a number of cylindrical collecting vessels. Each of these vessels is numbered, and can be filled by attaching it to the pumping apparatus, C, shown in the figure. From this pumping apparatus a flexible collecting pipe can be lowered into each manhole. Thus a separate sample of air can be taken at each manhole of the culvert, and can be stored for subsequent examination in a vessel numbered to correspond with the number on the manhole.

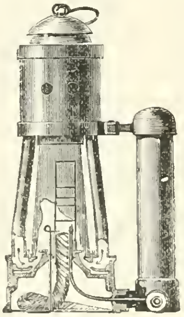

Fig. 2.

An ordinary mechanic can collect these samples, and transport them to a central station, where they are subjected to examination and the results observed duly recorded in a register with the necessary particulars.

In case observations must be made on the spot, the observing apparatus can be readily transported to the place where the sample is collected, and the test can be made as soon as the sample has been collected.

For the detection of inflammable material in the air contained in larger spaces, into which the observer can enter, the hand safety lamp, with small detachable cylinder of compressed hydrogen gas, will be most convenient. The lamp is shown, partially in section and with the cylinder attached, in Fig. 2. The best form of miner's safety lamp in use for gas-testing is so fitted that it can be at once converted into a delicate hydrogen flame-testing apparatus when required. After it has been used for testing it can immediately be reconverted into an ordinary lighting safety lamp. The scale for measuring the "cap" is contained within the lamp, and it is only necessary to produce the standard hydrogen flame and to read off at once by inspection the proportion of "gas" present in the air.

The change from a lighting to a testing lamp can be made in the atmosphere which is being tested, without opening the lamp or incurring any danger. It should be remarked that the lamp-test here referred to and recommended depends for its efficiency only upon the *inflammability or explosive character* of the gas or vapour present in the air. It detects, therefore, *all dangerous gas or vapour* which may enter the culvert. It is not only a detector of coal gas, but of all other inflammable gas or vapour. Experience has now abundantly proved that it is not sufficient to trust to the detection of these gases by their smell. Coal gas itself may be more or less completely deodorised by passage through the earth, and other dangerous gases exist which are always free from smell. Hence arises the paramount necessity for employing a means of detection which does not depend on smell or upon other physical characters, but which detects the gas or vapour by means of the property which makes it dangerous; that is, by means of its combustibility in air.

LIGHT RAILWAYS.

ADJOURNED CONFERENCE.

The adjourned Conference between the Board of Trade and representatives of various public bodies on the question of light railways was held at the Westminster Town Hall on Thursday, January 31st, Mr. Bryce, President of the Board of Trade, again presiding. The Board of Trade representatives present were Sir Courtenay Boyle, K.C.B., Permanent Secretary; Mr. F. J. S. Hopwood, C.M.G., Assistant-Secretary, Railway Department; Mr. Garnham Roper, Private Secretary to the President; Major Cardew, Electrical Department; Major-Gen. Hutchinson, Lieut.-Col. Yorke, and Major Addison, Railway and Tramway Inspecting Officers. Sir Jacob Wilson represented the Board of Agriculture, and representatives of the following bodies were present: London County Council, Association of Chambers of Commerce, Central and Associated Chambers of Agriculture, London Chamber of Commerce, Railway Companies' Association, Institute of Civil Engineers, Association of Municipal Corporations, Association of County Councils, Surveyors' Institution, Tramways Institute of Great Britain and Ireland, Mansion House Association on Railway and Canal Traffic, Institution of Electrical Engineers, Royal Agricultural Society of England, National Traction Engine Owners and Users' Association, British Dairy Farmers' Association, British Iron Trade Association, and Convention of Royal and Parliamentary Burghs of Scotland.

Amongst those present were Earl Cathcart, Lord Thring, Lord Claud Hamilton, Lord Edward Fitzmaurice, Sir Bernhard Samuelson, M.P. (Chairman of the Committee), Hon. T. Farrer (Secretary to the Committee), Sir Edward Carbutt, Sir Alexander Rendel, Sir Juland Danvers, K.C.S.I., Mr. Storey, M.P., Mr. Humphreys Owen, M.P., Mr. Cyril Dodd, M.P., Mr. Alexander Siemens, Mr. Carruthers Wain, Mr. R. H. Rew, Mr. G. C. Kent, Prof. Jas. Long, Mr. J. S. Jeans, Mr. A. Beveridge, Mr. Meik, Mr. Wm. Acworth, Mr. T. Sloan, Mr. Macnamara, Alderman Brownsword, &c.

Mr. BRYCE, in opening the proceedings, said he was glad that, notwithstanding the extremely inclement weather, so many representatives were present. Their first and principal business would be to consider the report of the Committee, which he regretted they had not a longer time to consider before its discussion; but they must bear in mind that they had been a little pressed by time, owing to the near approach of the Parliamentary Session. He might take it that they were all agreed in the desire that action should if possible be taken in the coming Session of Parliament, and that being so it was, of course, desirable that before the Session opened the Board of Trade should be in possession of the views of the Conference, as well as of the Committee, upon the subjects with which the report dealt, in order that they might see their way to the settlement of any legislative proposals which it might appear desirable to submit to Parliament during the coming session. That was the reason why it was impossible to allow a longer time for the summoning of the Conference. It was not for him to express any opinion on the report beyond saying that it struck him as a very valuable document which justified the arduous labours which the Committee had bestowed upon it. Speaking generally, he thought their recommendations would commend themselves to the Conference as being those of men eminently qualified to deal with the subject, but he would like to express on his own behalf, and also on behalf of the permanent officials of the Board, their sense of indebtedness to the Committee for their labours and assistance.

[*]Sir BERNHARD SAMUELSON, M.P., then presented the report of the Committee (which was published on pp. 404-406 of our last issue), stating that its general effect was that relaxation was necessary in the requirements for the construction and working of light lines and recommended that Parliament should empower local authorities, under proper safeguards, to

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[*] Remarks revised by speaker.

authorise the construction and working of light lines. With regard to the position of gentlemen who had not signed the report, there were first Sir Courtenay Boyle and Mr. Hopwood, who, as officials of the Board of Trade, had not thought that it would be proper for them to express an opinion on points which dealt so very intimately with questions which would be brought before Parliament, and which asked that additional powers and discussion should be given to that Department. Mr. Carruthers Wain and Mr. Sellon had signed memoranda in reference to the report; but it appeared that they did not desire that these should be treated either as amendments or as adjuncts to the report. The Committee felt much indebted to those gentlemen like Sir Benjamin Baker, Sir Alexander Rendel, and Sir Andrew Clarke, gentlemen of great technical experience, and having important occupations, who had nevertheless devoted their valuable time to the question, and to Mr. Farrer for the great service which he had rendered as secretary of the Committee.

Earl CATHCART, in moving the adoption of the report, said that, representing agriculture, he did not regard light railways as a panacea for the prevailing agricultural distress, but they were the most practical steps that had yet been proposed, and he was convinced that they would be most advantageous in serving the rural districts, especially in regard to "basket" agriculture, in conveying market produce to the adjoining towns. With regard to the question of gauge, he was very strongly impressed with the idea that light railways in connection with main lines should be of the normal gauge, unless in any particular districts there were overwhelming objections to it, or overwhelming advantages in favour of fancy gauges.

Mr. STOREY, M.P., in seconding the adoption of the report, said he should have been better satisfied if it had gone further than it had done. The common practice was for reports to be strong, and for the legislation that followed them to be weak; but in this case he sincerely hoped that as the report was weak the legislation which followed would be strong. While he seconded the adoption of the report he would like to take the opportunity of putting before the Conference the points on which six or seven members of the Committee thought it might have been stronger, and these were contained in the following memoranda:—

"Whilst concurring in much that is in the Committee's report, we express our regret that its recommendations are not more precise and specific, and we respectfully record our opinion that no legislation can be effective in securing the construction of light railways, tramroads, and tramways to any sufficient extent unless it provides:—

"1. A simple method of procedure by which schemes after being examined and approved by county councils may be sanctioned by certificate or licence of the Board of Trade.

"2. A cheap and simple provision for the compulsory acquirement of necessary land.

"3. That no deposit should be required until the lines have been authorised and notice has been given to the county council that the work of construction is about to commence.

"4. That the opposition of owners and frontages should not prevent examination of any scheme by the county councils or the Board of Trade on merits.

"5. Optional powers to county councils to construct or to aid in the construction."

These suggestions were signed by himself, Mr. Carruthers Wain, Mr. Sellon, and Mr. Beechcroft, and by Mr. Humphreys Owen subject to further consideration of paragraph 3; and he had also the authority to attach the names of Sir A. Rollit and Mr. Channing. In putting those suggestions before the Conference he did not wish to go in opposition to the Committee's report, and providing that the memoranda could be attached to the report, and have the same means of coming before Parliament as the report itself, he was authorised to say that the non-official gentlemen who had not signed the report would be willing to sign it, and so make it the unanimous report of the Committee.

Mr. CYRIL DODD, M.P., while regarding the report as an admirable one, said there was lacking from it any intimation as to how they would suggest that the compulsory purchase of land should be dealt with. In agricultural districts that was the crux of the whole question. Speaking for the district which he knew well, the larger landowners would be willing to part with their land at the current market prices without raising any question as to damages for severance or complicated compensation, but the difficulty that required to be dealt with was that the key to the situation often lay in the hands of a small but needy or avaricious landowner.

Sir E. CARBUTT expressed his regret that the Conference had not had longer time to consider the report before being called upon to express their opinions upon it, and especially that being there as representatives they had no opportunity of consulting the bodies by whom they were appointed, and he suggested that the Conference should be adjourned for that purpose. He asked whether they had been called together to express their own view, and the views of those whom they represented, or were they merely to register the ideas of the Board of Trade.

Col. MAKINS said that he did not regard Mr. Storey's suggestions as being indicative of opposition in the Committee, but rather as additions to the report. Personally he did not go with those suggestions, for he considered if the common-law rights of the people with regard to the property were to be dealt with they should be dealt with not only as regards light railways but as regards all works of public utility. He thought it would be going rather too far for the Committee to propose such a wide-reaching change of the common law of the land as would be obtained if they were as a committee to adopt those suggestions. He was very glad, however, that the suggestions had been made, and thought it was quite right that they should be appended to the report for the information of the public generally.

Mr. CARRUTHERS WAIN said that those who had spent their lives in railway and public enterprise felt that it was their duty to make certain practical recommendations, which in their view were not included in that report. Some reference had been made to the common law; but they were not there as representatives of the common law, but of the commonweal, and he thought the general good of the public should override minor considerations. He suggested that the evidence taken by the Committee should be printed.

Mr. BEACHCROFT said the extension of suburban railways was a most important factor in the extension of cities themselves, and he thought the report might be considered as extending to larger cities, as well as to the smaller. The Committee had scarcely felt itself constituted to suggest any process by which the law should be altered as regarded the compulsory acquisition of land and the assistance which might be required in order to facilitate fresh schemes. He believed those matters were discussed, but that no evidence was taken in regard to them. He hoped if the report went up to Parliament it might go with the addenda suggested by Mr. Storey.

Lord THRING said he resented excessively the suggestion that they were appointed by the Board of Trade for any purpose whatever. He considered he was absolutely independent, and that during the first two or three days, at all events, he himself had been in entire antagonism to the Board of Trade. He thought himself that the acquisition of the land ought to be left either to a valuer appointed by the Board of Trade or to have it left to three valuers appointed by the county council.

Sir JULAND DANVERS said there was one omission in the report which he would like to refer to; he found that no allusion was made to the relations between the new railways and the existing lines. It would be very satisfactory to know whether the Committee had received evidence of any kind which would enable them to judge as to what position would be taken by the existing companies in regard to these branches.

Mr. REW, as representing the Central and Associated Chambers of Agriculture, said that whatever might be the feeling of farmers with regard to this subject, he was sure there was only one feeling as to the action of the Board of Trade, and that was one of appreciation of the attempt to afford some help to agriculture.

Mr. LONG (British Dairy Farmers' Association) said he was sorry that Mr. Storey and those who agreed with him had not spoken in stronger terms, and as there were such great differences of opinion as to what should be done in the future he would like to see greater time given to the consideration of the report.

*Sir BERNHARD SAMUELSON, M.P., said that before the motion was put to the Conference it might be desirable that he should state the reasons which weighed with the Committee in declining to enter into some questions which some of the members of the Conference thought they might properly have dealt with. As regarded the observations of Sir E. Carbutt and Mr. Long, he hoped it would not be presumptuous on his part if he expressed the hope that, in addition to the report which the Committee had made, the Board of Trade would take into its serious consideration any representations which might be made by bodies such as the London Chamber of Commerce and the Dairy Farmers' Association and similar bodies; but the Committee were anxious to make in their report such recommendations as would meet with as little opposition as possible when presenting them to Parliament. With reference to the acquisition of land, the Parish Councils Act provided to a certain extent a hint of what might be done in reference to the appointment of valuers, but it would have been rash, he thought, on the part of the Committee to have made any definite recommendation in regard to that matter. For his own part he saw no reason why valuers who were appointed as competent and impartial men by a county council should not be entrusted with the valuation of land to be taken for public works of that kind, but Col. Makins was of a different opinion, and he should be sorry if the proposed Bill should be wrecked because in a matter of that sort they travelled too far out of the record. With regard to conferring powers on county councils to construct railways or tramways themselves, or to aid in their construction by grants, that also was an extremely difficult point, and although personally he was in favour, and several members of the Committee were in favour of it, there was this to be considered, that neither Mr. Hobhouse nor Lord Edmond Fitzmaurice, who represented the county councils in that matter, said not one word of favour in support of a proposal of that kind.

Mr. STOREY: Nor one word against.

*Sir B. SAMUELSON: That might be so; but if that was a matter which they thought ought to be rectified he believed they would have given expression to that opinion. With regard to Mr. Beachcroft's suggestion, though they had not dealt with tramways of first magnitude they had dealt with those of secondary magnitude, and there was nothing to prevent the latter being grafted on to tramways of the first magnitude, just as light railways could be grafted on to railways of the first magnitude. The relations of new lines to existing lines opened also a point of extreme difficulty. Unless the old railways were benevolent to the new lines it would be very difficult for them to be as useful as they would otherwise be; without that benevolence they could scarcely be expected to pay their way, or to be undertaken in the first instance. But he was glad to say that in the course of the Conference a feeling of benevolence was expressed by Lord Claud Hamilton and before the Committee, by Mr. Jackson, and also by Sir Henry Oakley which led him to hope that this was a matter which might be arranged without much difficulty. It was a matter which could be best arranged by the Board of Trade, who were in daily contact with these railways. What weighed with the Committee above all things was that they should make a report which would encourage the Board of Trade to do something, and which would not incite them to do more than Parliament was likely to accept during the present session.

Mr. BRYCE, in putting the motion for the adoption of the report, said he saw no reason at all why those members of the Conference who desired to consult the authorities they represented should not do so, and let the Board of Trade have the benefit of any deliverance to which those bodies might come. They would be very happy to receive the views of the London Chamber of Commerce and the Associated Chambers of Agricul ture after they had had an opportunity of discussing the report, and hoped that those views would arrive in time to enable them to utilise them in giving the final touches to the Bill which they hoped to introduce. He did not see any reason why Mr. Storey's addendum should not be added to the report and published and circulated along with it, as it would be of advantage, in afterwards discussing the matter, to have all the light they could, and especially the expression of strong views of a considerable section of the Committee.

Mr. STOREY said that in that case Mr. Sellon and Mr. Carruthers Wain would sign the report so that it would be a unanimous one.

Mr. BRYCE said that that could be done. He then put the motion for the adoption of the report to the Conference, which was carried unanimously.

Mr. JEANS asked if there was any difficulty in the way of the evidence being printed and placed on sale.

Mr. BRYCE said his impression was that the evidence was taken simply for the purposes of the Committee; but he would inquire into the matter.

Sir E. CARBUTT moved, and Mr. BROWNSWORD seconded, a hearty vote of thanks to Mr. Bryce for the able manner in which he had presided over them.

Mr. BRYCE, in reply, said it had been a matter of great satisfaction to him to find that the invitation of the Board of Trade had met with so cordial a response from influential bodies. He hoped that what the Conference had done would give a set forward to this movement, which they all admitted to be a matter of great importance. He felt with Lord Cathcart, and several other speakers, that they must not expect light railways to be a panacea for agricultural depression ; but feeling very deep sympathy with the agricultural interest, they had taken every step in their power to afford it relief by securing a cheaper and easier method of transportation. They could not but hope that some good results would follow.

Sir COURTENAY BOYLE proposed, and Lord CLAUD HAMILTON seconded, a hearty vote of thanks to Sir Bernhard Samuelson, M.P., and Mr. Farrer, who, as Chairman and Secretary of the Committee, had rendered them such good service.

Sir BERNHARD SAMUELSON having briefly responded, the proceedings terminated.

THE CANNON STREET EXPLOSION.

MAJOR CARDEW'S REPORT.

I have the honour to report that, in accordance with the instructions of the Board of Trade, I have held the inquiry detailed above. This inquiry occupied three days—the 19th, 20th, and 23rd inst. Mr. W. Russell Griffiths appeared for the Aldermen and Commissioner of City Police, Mr. E. A. Baylis for the Commissioners of Sewers, and Mr. R. W. Wallace for the City of London Electric Lighting Company. These gentlemen rendered great assistance in elucidating all the facts material to the inquiry. I append my notes of the evidence taken, and also a transcript from the notes of the shorthand writer employed by the city authorities. Twenty-nine witnesses were examined, of whom 17 were present at the time of the occurrence, several of these having suffered injury and electric shock The other witnesses were various officials of the Company and experts. Among these latter Mr. Foulger, chief distributing engineer of the Gas Light and Coke Company, gave very valuable evidence.

I attach to this report the following documents, &c., handed in at the inquiry, viz.:—

(*a.*) Copy of reports of City of London police on previous explosions in electric street boxes (*vide* Appendix I.).

(*b.*) Copies of letters from the Brush Electric Engineering Company (Limited), dated February 25, 1891, and the Laing, Wharton and Down Construction Syndicate (Limited), dated February 27, 1891, to the principal clerk to the Commissioners of Sewers in reply to an inquiry from him as to how it was proposed to keep the street boxes ventilated so as to prevent the accumulation of explosive gases in them. Also copies of correspondence between the engineer to the Commissioners of Sewers and the engineer and manager of the City of London Electric Lighting Company (Limited) relative to the contiguity of the high and low-pressure mains in the street-boxes and possible danger therefrom (*vide* Appendix I.).

(*c.*) A plan of the City of London showing in red the route of the main, the breaking down of which caused the accident.

(*d.*) An enlarged plan of a portion of Cannon-street, showing the positions of the street-boxes at which the explosions took place.

(*e.*) A diagram showing the connections between generating and converting stations at the time of the accident.

(*f.*) A diagram showing the positions of the cables in the switch room at the generating station at the same time.

(*g.*) A plan and section of a street-box of the City of London Electric Lighting Company (Limited), showing construction and entry of high-pressure and low-pressure conduits.

(*h.*) and (*i.*) Records of recording voltmeters in action at the time of the accident, showing duration of the fault.

(*k.*) A plan of the district where explosion occurred, giving particulars of pavement.

I have also prepared a diagram (*reproduced*) showing the positions of the principal points referred to in this report (*vide* Appendix IV.).

Description of System.

It will be of advantage to shortly describe the system of supply in use by the City of London Electric Lighting Company (Limited). This consists of a high pressure alternating-current supply by means of concentric mains to converting stations, which, as a rule, have been constructed underground, and from these a low-pressure supply is given to consumers by distributing mains. The supply has until lately been given from two generating stations, one at Wool Quay near the Custom House, and the other at Bankside on the south side of the river. These stations were only intended to provide temporarily for the lighting, and a large permanent station has recently been conducted at Bankside, and partly equipped with plant and machinery. The operations connected with the transfer of the load to the permanent station were being carried out at the time the accident occurred.

General Account of Occurrences.

It appears that on the 10th ult., about 1 p.m., a mare attached to a brougham belonging to Mr. C. Boutlaud, of 21, Cousin-lane, Thames-street, E.C., was turning out of Cannon-street into Budge-row, when she pitched forward on her knees, then turned on her side, and died in about four minutes. The driver, G. Clark, got down, and immediately felt an electric shock in both legs. He was unable, on account of the intensity of the shock, to touch the mare, but disconnected the traces and backed the brougham clear. A warehouseman, named James Hutchins, who was at work in Budge-row, went to assist ; but he also experienced a severe shock, and was unable to approach the mare closely. Shortly afterwards the iron lid of the street-box opposite the Liberator Building Society's office was lifted about 2ft. in the air by an explosion, and thick smoke issued from the box. According to one witness there were three reports, each accompanied by a flash of blue flame. This street-box is the one marked B (*vide* Appendix IV.). Two witnesses received severe shocks by stepping on to the street-box cover on the opposite side of Budge-row. Apparently simultaneously with the explosion in Budge-row a more serious explosion occurred at the street-box at the corner between Walbrook and Cannon-street, west side. In this case the lid was blown sufficiently high to be shattered by its fall, and the paving-stones in the vicinity were also dislodged. Several persons were injured by this explosion ; in most cases the injuries received were only trifling. Two persons, however, I was informed, were unable to attend my inquiry on account of the injuries they had received. The veterinary surgeon who made a post-mortem examination of the mare stated that all her organs were perfectly healthy, and he could not account for her sudden death otherwise than as a result of severe electric shock.

The immediate causes of these serious accidents were : The breaking down of the insulation of a high-pressure main in the street box at the corner of Budge-row, leading to the formation of a powerful electric arc between the outer conductor of this main and the end of the iron pipe, forming a conduit for the mains under Budge-row, which projected into this street-box, and the consequent charging of this pipe to a dangerous extent ; and the presence of gas in the Electric Light Company's pipes and street-boxes to an amount which formed a highly-explosive mixture in the street-box at Walbrook, where the more serious explosion occurred, the gas being fired by the electric arc. It is true that Mr. Foulger, on behalf of the Gas Company, informed me that since the accident they had tested the soil in the vicinity of this street-box, and had not detected the presence of gas in it ; but, on the other hand, expert evidence was given of the actual presence of a highly-explosive mixture of gas and air in a neighbouring street-box, connected with it by means of several pipes, on the 19th instant. No gas was detected in the box where the explosion occurred at this test, but the cover of an intermediate box was loose at the time, thus providing a means of escape for the gas. On the whole, considering the nature of the explosions, the fact that one of them occurred at a distance of 26 yards from the electric fault, that the locality was admitted to be one where defects in gas pipes had been rather frequent in consequence of the disturbance of the subsoil by the excavation for the completion of the Inner Circle Railway, and that no system of ventilation had been provided by the Electric Light Company for their conduits, there can, I think, be no doubt that the explosions were due to the firing of an accumulation of gas in the conduits by the electric arc formed at the point where the main broke down.

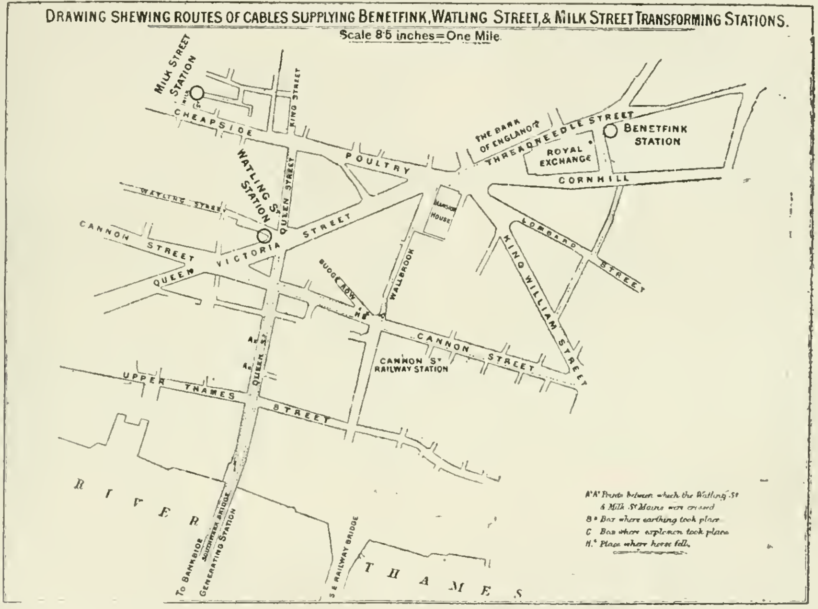
The breakdown of the main was the consequence of a careless mistake, whereby an abnormal electrical pressure was brought upon the outer conductor, and this pressure found a point of weak resistance, probably a partial abrasion of the insulation, where the main was bent to enter the pipe leading from the box. The existence of mechanical injury to the insulation is almost a necessary postulate, since a piece of main containing the fault, now in my possession, shows the insulation to have been of ample thickness and first-class quality, and it should easily have withstood the maximum pressure to which it was on this occasion subjected. Indeed, I am informed that it had been tested with a much greater pressure.

The mistake that was made was as follows :—Two new mains had recently been laid, one from the generating station at Bankside to Watling-street converting station, the other from Bankside to Milk-street converting station. It was intended to connect the Watling-street main into the new switching apparatus provided for it at Bankside ; but the end of the Milk-street main was put in by mistake, while the end of the Watling-street main was left lying on the outer lead coating of another new cable. The end of this main was prepared to be put into its switch pillar and was not sealed up, as otherwise it should have been, and the inner conductor must have been very nearly in contact with the lead coating, and thus by means of the iron rack in which the cables were lying, with the lead coatings of several other cables, all of which coatings were thoroughly connected to earth. While the Watling-street main was lying in this position instructions were sent to the foreman of the transformer department, Mr. Joseph McMahon, to switch the pressure on to it from the Watling-street converting station. As soon as he did this an electric arc started at Bankside between the end of the inner conductor of this main lying as above described and the lead coating adjacent to it, thus effecting a connection of the inner conductor of this main, and of the whole system of mains, to earth.

Now, in a concentric system of mains used for the transmission of alternating currents, under normal conditions the outer conductors are very nearly at the potential of the earth, and practically the whole working pressure exists between the inner conductors and earth. But a connection to earth of the inner conductors tends to reverse this condition, and raises the pressure between the outer conductors and earth. The inner conductor of the Watling-street main may have been absolutely touching the lead coating or "dead to earth" when first charged, and in this case the pressure between outer conductors and earth would have been raised to the full 2,000 volts at which the station was working. When the arc started in the street-box in Budge-row, however, the pressure would be probably nearly equal on the inner conductors arcing to earth at Bankside, and the outer conductors arcing to earth in Budge-row.

This break-down occurred in full daylight, so that the load on the station was comparatively light, and the sudden increase of current was at once noticed at Bankside, both by the powerful disturbance it caused in the telephone at which the engineer in charge of the station happened to be at the time, and by the peculiar noise, indicative of a short circuit, made by the generating machines. Some of these generating machines were at once switched out of circuit, and the abnormal load thrown upon the only two machines left running caused such a lowering of pressure on the whole system that the lights are said to have gone out altogether. The foreman at Watling-street station noticed a flickering of the lights shortly after he switched the new main on, and suspecting that his action had in some manner occasioned a fault he at once switched it out of circuit. This was certainly the best thing he could have done, but it did not remove the fault, since the electric arc in the Budge-row-street box had, of course, rapidly burnt away the insulation between the two conductors of the main and established an arc, or short circuit, which still continued to burn furiously, melting away a considerable amount of both conductors. The engineers at Bankside in the meantime after consultation determined to switch off mains in succession until the fault was discovered, and by this means the fault was removed from the circuit.

APPENDIX IV


DRAWING SHEWING ROUTES OF CABLES SUPPLYING BENETFINK, WATLING STREET, & MILK STREET TRANSFORMING STATIONS.

Scale 8·5 inches=One Mile.

Explanation and Comment.

Having thus given an outline of the occurrences, I will now deal more particularly with the points in which I consider the Company and their officers and employées were to blame for want of judgment, carelessness and inattention to the regulations imposed by the Board of Trade, and with the manner and means by which any repetition of such an alarming and serious accident may be avoided.

1. In the first place, it will naturally be asked, how was such an egregious mistake committed as the charging of one main under the impression that it was another? Bearing in mind that the pressure was one dangerous to life, it is evident that the consequences of such a mistake might easily have been fatal, since the end of the main that was charged might have been in a man's hand at the time?

2. Why when the breakdown had occurred, since it certainly occasioned an excessive current in the mains affected, were these mains not automatically cut out of circuit?

3. Why in the absence of proper automatic disconnectors were there not at any rate some indicators to show the disturbance of potentials with regard to the earth and the rush of current through the mains affected; and how far might such indicators have prevented the breakdown or shortened the duration of the dangerous condition?

4. How was it that the surface of the street at Budge-row could become so dangerously charged in consequence of any defect in the electric mains; and how can this danger be removed?

5. Why was not the high pressure main in the street box enclosed in strong metal casing efficiently connected to earth as required by regulation 7 (*vide* Appendix III.) since this box also contained low-pressure conductors?

6. Why was the accumulation of gas allowed to which the Company attributed the explosion, and which they have themselves proved to exist in a neighbouring street box since the explosion?

1. The facts elicited at the inquiry with regard to this point disclose in my opinion great negligence on the part of some of those concerned. It appears that the two new mains to the Milk-street and Watling-street converting stations respectively run side by side down Queen-street. The pipes to contain these mains had been laid some time previously, but the mains themselves were drawn in between October 9th and November 7th some delay having occurred during the progress of the work owing to the cables not being ready, and to alterations in one of the street-boxes. The mains are drawn into the pipes in lengths extending from one junction box to the next, the ends of each length are labelled to correspond, and the jointers subsequently effect the necessary joints at the junction boxes. Owing probably to some obstruction met with, the pipes between two junction boxes in Queen-street were to some extent twisted round each other, so that their ends occupied different relative positions at the two boxes. The two mains were drawn in at the same time, according to Mr. A. Cook, the superintendent of cable laying, and probably in consequence of the twisting of the pipes, either the labels were wrongly applied on the ends of the cables at one side of one or the other of these junction boxes, or the jointers jointed ends marked "Watling-street" and "Milk-street" together. There is a direct conflict of evidence on this point between the foreman in charge of the laying and jointing respectively, but I do not think it is necessary that the Board of Trade should inquire too minutely into the question of the exact proportion of blame to be borne by the various subordinate officials of the company. The main fact is admitted that between this point and Bankside station and in the station itself the main to Watling-street was labelled Milk-street and *vice versa*.

It is not, however, so surprising that such a mistake should have occurred, considering that the mains were not laid and jointed up at the same time, and that the engineer in charge had not apparently given very close personal supervision to the work, as that one of these mains should have been charged to high pressure and connected into an electrical circuit, the electromotive force in which was maintained by large engines and dynamos, amounting to over 1,500 H.P., without previously identifying the main—that is to say, ascertaining by the very simplest electrical test—a test thoroughly understood by every telegraph linesman's assistant, that one of the cables brought into Bankside was in connection with the cable in Watling-street station, and which of the two it was. This blunder appears to have been partly due to a misunderstanding between the superintendent of cable-laying and the electrician in charge of testing, but principally, I think, to the latter having made a report that the Watling-street cable was good without having ascertained that the rough test of insulation, which was the only test he had taken, had been really applied to the whole cable. Had he taken the precaution to test this by directing the distant ends of the main to be connected together so as to pass a current through the circuit thus formed, the wrong labelling of the two mains would have been at once discovered. It also appears to me that in a matter of so much importance the superintendent of cable-laying was too easily satisfied that the main was correct when he knew that only a rough test had been made, and that he might with advantage have been present when the main was switched on.

2. The answer to this is that the fuses inserted with the object of providing an automatic means of cutting any main out of circuit in the event of a breakdown required much too large a fusing current to be an effective protection, more especially since under the system of cross-connection of converting stations at present in use, the fault will draw current from each end of the main, so that only a proportion of the current which is doing the mischief passes through either fuse. In this instance the main which broke down in Budge-row was protected at each end by fuses calculated to act with 700 amperes passing, and it was practically impossible for the generating power running at the time to actuate them. The reason alleged for the use of such large fuses is that up to the present time the whole supply has been given through a few mains, and any failure in one of these mains would throw an excessive load on the others. Fuses calculated on the normal maximum load for each main would, therefore, be insufficient to carry the increased working current in such a case, and a total stoppage of supply might result. Since, however, the maximum current intended to be carried by any one main is only 150 amperes, I consider that the fuses used were far too large, even from the point of view that continuity of supply was the first consideration.

The proper proportioning of fuses does not appear to me to have received due attention. The guiding principle seems to have been to take care that they were so large as not to cause inconvenience by acting.

It is at times of light load that large fuses fail to act, and I am of opinion that it would be a desirable precaution on all large mains used for high-pressure supply to use a small fuse for light loads, and switch in a larger one before the time of heavy load. Of course, a reasonable margin must be allowed for possible unforeseen demands for current, and inattention might cause some trouble, unless the switching-in of the large fuse could be provided by automatic means; but the small fuse might be arranged to give warning when the current began to exceed its capacity.

While on the subject of fuses I would direct attention to the omission on the charging of the new Watling-street main of a very simple precaution, which, had it been taken, would certainly have prevented the accident, viz., to charge the new main in the first instance through a fine fuse wire. Had this been done the moment the arc started at the other end of this cable the pressure would have been cut off.

3. The observation of the potentials, with regard to the earth, of the two sides of an electric supply circuit is rarely provided for by electric light engineers, although it is a very important precaution, more especially in the case of high pressure systems. Where the mains consist of separately insulated conductors, the occurrence of any fault of insulation is at once detected by the effect produced on their potentials, and the insulation resistance of the whole circuit can be obtained at any time without any stoppage of supply being necessary for purposes of testing. In the present case, where the mains are concentric throughout, and where the potential of the outer conductor should always remain nearly the same as the earth, any rise of potential on this conductor must indicate a fault and a dangerous condition of the circuits. Such a rise of potential must have occurred before the breakdown in Budge-row took place, and it is probable that if a simple indicator of such rise had been fixed at Watling-street station, and if the foreman there had been warned that it was an indication of danger, to be observed when any unusual operation was in progress, the accident would have been avoided.

Then, again, as regards the current indicators: It appears from the evidence that the engineers at Bankside were quite in the dark as to where the unusual current was passing, and they had to resort to the expedient of switching off mains in succession until they discovered which were affected. Valuable time would have been saved had there been a current indicator for each main to refer to. I do not, however, wish to press this point too hard, as the new switch room at Bankside was at the time in an incomplete state. The evidence of the station engineer is that the faulty cable was cut out in 13 minutes; the recording voltmeter curves show a duration of 15 minutes. I think with suitable indicators and prompt action it might have been cut out within one minute, and had this been done the explosions would not have occurred, and possibly, even, the death of the horse might have been avoided.

4. The charging of the surface of the ground resulting in the death of a horse and shocks to human beings was brought about in identically the same way as in the case of the accident at Bournemouth on January 8th last, referred to in my report dated January 20, 1894. Here, again, there was a short length of iron pipe (about 37ft. in this case, 32ft. in the Bournemouth case) terminating at the brick walls of the junction boxes at each end, and not in metallic connection with the iron pipes on the other sides of these boxes. The depth of the pipe below the street level varied from 1ft. 4½in. to 2ft. 6in. (about 18in. in the Bournemouth case). In this case it is true that the surface of the street was wood pavement, which might be supposed to offer considerable resistance to the passage of an electric current; but the weather had been unusually wet for some time before the occurrence and the wood blocks and underlying concrete were no doubt thoroughly saturated with water and their resistance thereby diminished. Since the Bournemouth accident, I have carried out, with the assistance of the instructor in electricity at the School of Military Engineering, Chatham, some experiments to determine the rate of fall of potential on the surface of the ground produced by charging a pipe under similar conditions. The results of these experiments are detailed in a joint Paper communicated to the Royal Society, and published in their *Proceedings*, a copy of which I attach to this report (*vide* Appendix II.). They fully confirm the view I took of the nature of the Bournemouth accident, which has been repeated in this case. The cause of the fatal shock to the horse and of the comparative immunity of human beings is fully stated in the report and Paper above referred to.

To remove this particular danger the whole system of iron pipes enclosing high-pressure mains must be thoroughly connected together, and additional precautions, which are detailed below, should be taken to prevent any possibility of a discharge from mains to pipes. The duty of providing against this danger is distinctly imposed upon the Company by regulation 8 (*vide* Appendix III.), and they should not have permitted short lengths of pipes containing high pressure mains to remain isolated.

5. I consider that there was a distinct failure to comply with regulation 7, and I had previously brought this matter to the notice of the Company. It had also been brought to their notice by the engineer to the City authorities (*vide* Appendix I.).

It happened that in this case the low pressure conductors did not become dangerously charged, and they do not even appear to have been damaged either by the electric arc or the explosion, but the strong metal casing would probably have protected the cable against injury to the insulation, and even in the event of a breakdown would have much reduced the chance of accident by making a metallic connection from pipe to pipe across the street-box. If an arc had been formed at all under these conditions it would have been a much smaller one, and time would have been given to cut off the pressure before the arc had eaten its way through the metal of the casing, or for the fuses to act, had they been sufficiently sensitive.

The Company now propose to encase the high pressure mains across all street-boxes by wrapping them with several layers of stout copper strip continued into the pipes at each side, and this precaution alone will, in my opinion, considerably reduce the risk of similar accidents.

6. The question of the accumulation of gas in the conduits and street-boxes of the Electric Lighting Company is the most difficult to deal with of all the question raised by this accident. The danger is a well-recognised one, and regulations 14 and 15 (*vide* Appendix III.) impose upon the Company the duty of efficiently protecting their conduits and street-boxes against such accumulation. That this duty had not been adequately performed had been forcibly demonstrated by several previous explosions, of which particulars are given in the reports marked (*a*). One of these, the double explosion on January 8th last, was investigated by me, and the Board of Trade called the attention of the Company to the fact that they were not adequately complying with regulation 15. The Company thereupon informed the Board of Trade that they were maturing a scheme of ventilation for their conduits. At this inquiry, however, it appeared that no means of ventilation has as yet been provided. What has been done is to keep two men constantly employed inspecting street-boxes and reporting any accumulation of gas. These reports have been forwarded to the Gas Light and Coke Company, and in many cases the information thus supplied has enabled leakage of gas to be detected. Since the accident the number of men employed in opening street-boxes has been increased to 12.

It certainly appears that up to the time of the occurrence of the recent accident the Company had not displayed sufficient vigour in dealing with this very important matter; but it must be admitted as some excuse that there is at present some diversity of opinion as to how, in cases where the soil is heavily charged with gas by leakage from the gas pipes, it can be best prevented from accumulating in the conduits of the electric lighting companies. Thus, at the present inquiry, Mr. D. Cook, on behalf of the Electric Lighting Company, gave particulars of a scheme of thorough ventilation, which they were prepared to adopt, while Mr. Foulger, who appeared on behalf of the Gas Light and Coke Company, stated that in his opinion this system of ventilation would be dangerous, and Gen. Webber gave it as his view that the pipes and conduits should be plugged at each street-box to prevent percolation of gas, thus making thorough ventilation impossible. The Company have a very extensive network of pipes occupied with their own mains, and they have also numerous spare pipes laid in communication with the same street-boxes, and intended, I understand, to accommodate telephone wires. The whole length of their pipes and conduits exceeds, I am informed, 700 miles.

In my opinion a system of thorough ventilation of all street-boxes by natural or forced draught should be provided, and in addition everything possible should be done to prevent the entry of the gas by making the sides and bottoms impervious. Also the air capacity of these boxes should be reduced where practicable by filling them with incombustible material. At the same time the system of regular inspection should be continued, and immediate notice of any leakage of gas detected given to the Gas Company, who appear to take a very reasonable attitude in the matter, and expressed through Mr. Foulger their desire to render all the assistance possible towards the prevention of any further explosions. In the provision of ventilating pipes, it will be necessary to consider the possibility of the ignition of the gas issuing from these pipes. If they are attached to houses they should in all cases be carried up above all windows, and if they are erected in the streets the orifice should be at least 8ft. from the ground.

So far I have dealt with the immediate causes of the accidents and the mistakes made, but it is I think, desirable also to draw attention to the fact that the work of the officials of this company has been lately carried out under very difficult conditions. The Company commenced business with two so-called "Pioneer" stations, and have erected and partially equipped the new generating station at Bankside, in order to be able to efficiently meet the rapidly-increasing demand for electric light. In this station nearly the whole of the plant and equipment is of novel design and unusual size and power, and the difficulties met with in the thorough testing and adjustment of this must naturally have been considerable. Before, however, the station was completed, before much of the plant had even been erected, still more before it could possibly have been thoroughly tested, and the adaptation of each part for its required action sufficiently studied by those who were to use it, the work of supplying electric energy to the City of London was thrown upon the new station. The whole of the operations connected with the transfer of the load had to be carried out without interfering with the continuity of the supply, and at the same time the system of distribution mains was largely added to and remodelled. It is certain that in this transition stage risks were run—risk to the apparatus, risk to the employés of the Company, and, as has been practically demonstrated, risk to the public. Here, I think, we have the real element of danger, which may, if not properly guarded against, occasion even more serious accidents. The same unfortunate experience has been the fate of other electric lighting companies. More especially are companies using a high-pressure system liable to become involved in the difficulties of a transition stage, since they are able to start with a very small capital expenditure, and yet carry the supply over a large district, picking up a customer here and there, while with low pressure this is impossible.

Requirements.

I will now summarise the precautions which should be taken by the Company to prevent a recurrence of the accidents which form the subject of this inquiry.

1. In the first place, greater care is necessary in the testing and identification of new cables before connecting them to the high-pressure system.

2. Every new cable should be connected to the charged system in the first instance through a fine wire fuse, to be kept in circuit for at least two hours before any working current is passed through the cable.

3. Prompt action of the safety fuses should be secured by properly proportioning them to the working currents, and, if found practicable, by the use of more sensitive fuses at times of light load.

4. The interconnecting mains between converting stations should be kept out of circuit, except where in any case they may be absolutely necessary to maintain the supply, so that in the event of a breakdown of a main, current shall not be supplied to the fault from both ends, thus rendering the action of the safety fuses uncertain.

5. Suitable indicators should be provided at the generating and converting stations of the current passing in each main and branch connection, and especially of the pressure between the outer conductors and the earth, unless the Company prefer to provide against the possibility of this pressure becoming large under any conditions by making an efficient connection of all the outer conductors to earth at the generating station. Of course this can only be done with the approval of the Board of Trade and the concurrence of the Postmaster-General. This approval has been already obtained by the London Electric Supply Corporation and several other companies using concentric cables. Such an earth connection seems so far to have had no ill results, and it is certainly of great value in the interests of the public safety.

6. All high pressure mains, where they pass through street-boxes, should be enclosed in strong metal casing extending to some distance into the pipes at each side, so that the whole length of main shall be enclosed within metal which is in connection with earth throughout its length.

7. Accumulation of gas should be prevented by thorough ventilation, by making the sides and bottoms of street-boxes impervious to gas, and by filling up the boxes as far as practicable with incombustible material.

8. Finally, while the Company's arrangements for generation and distribution are still in a transitional stage, and while new and untried apparatus has to be brought into use, the very greatest care and the closest possible supervision are necessary. There is, I think, reason to hope that the Company have now nearly completed the task of getting their system into proper working order, and if the precautions I have specified above are thoroughly carried out, I do not consider that there will be any further cause for anxiety as regards the public safety.

APPENDIX I.

Explosions in Electric Tube-Boxes in Public Streets.

City of London Police, November 14, 1894.

October 14, 1892.—8:55 p.m. Great Tower-street. No person injured.

January 8, 1894.—10:5 a.m. St. Paul's Churchyard. No person injured.

January 8, 1894.—10:5 a.m. Ludgate-hill, by Creed-lane. Youth injured taken to St. Bartholomew's Hospital: removed home suffering from shock to system.

March 14, 1894.—8 p.m. Cheapside. No person injured.

November 10, 1894.—1:20 p.m. Cannon-street, by Budge-row. Six persons injured, and horse attached to brougham killed.

Signed O. Mackenzie, Superintendent.

Re *Gas Explosions, &c., October 14, 1892.*

City of London Police, November 14, 1894.

P.C. (777) Carter reports that at 8:55 p.m. he was informed that an explosion of gas has just occurred in the electric light manhole opposite No. 17, Great Tower-street, whereby the iron frame and stone covering to the said manhole was destroyed. Also Thomas Loveland (40), No. 87, Elderton-road, Bermondsey, who was passing at the time, complained of being injured. The police constable accompanied him to Guy's Hospital, where he was seen by the house surgeon, who said he was suffering from shock, and discharged him. At the time of the explosion some workmen in the employ of the Gas Light and Coke Company were engaged seeking for an escape of gas a few yards from the said manhole, where it was supposed the gas accumulated, and was exploded by the electric current.

(Signed) Charles Matthews, Acting Station-Inspector.
(Signed) James A. Izzard, Chief Inspector.

Copy of Report, Monday, January 8, 1894.
Explosions, &c.

City of London Police, November 14, 1894.

P.C. (504) Hoad reports that at 10:5 a.m. an explosion occurred in a test-box belonging to the City of London Electric Light Company, in front of 3, St. Paul's-churchyard, blowing the cover of the box into the air. The police-constable remained there till P.C. (474) Vincent informed the person in charge at the above Company's depot, Cloak-lane, who sent men to take charge of it. Witnessed by the police-constables, and F. H. Bacon, Oddle-street, E.C., and F. Wills, No. 11, Ludgate-hill.

Also P.C. (438) Robinson reports that at 10:5 a.m. an explosion occurred in the test box belonging to above Company at the corner of Creed-lane by Ludgate-hill, blowing the cover of the box and Charles Nash, aged 17, clerk, No. 33, Angus-street, New Cross, some distance into the air. The police-constable conveyed Nash in hospital cart No. 15,362 to St. Bartholomew's Hospital, where he was examined by the house surgeon, who said he was suffering from shock to the system, and advised the police-constable to accompany him home, which he did per rail, Nash paying expenses. P.C. (468) Thorp remained by the box till the arrival of the Company's men, who were informed as above. In each case there was an escape of gas, and P.C. (481) Mawby was sent to inform the Gas Company at 146, Goswell-road, who sent men to take charge of it.

Witnessed by Frederick G. Harris, No. 53, Lewisham High-road, but not by police-constable. The explosions are supposed to have been caused by the gas escaping into the Electric Light Company's boxes.

(Signed) Geo. Palmer, Chief Inspector Western District.

Copy of Report, dated March 14, 1894.
Gas Explosion.

City of London Police, November 13, 1894.

P.C. (10) Phipps reports that at 8 p.m. the lid of an electric tube-box in the footway opposite No. 133, Cheapside, belonging to the City of London Electric Lighting Company, blew up with a loud report; P.C. (570) Latter remained in charge, and the police-constable sergeant informed Mr. Bryce, engineer, Bankside. He sent two men, who examined the box and said the explosion was caused by an accumulation of foul gas in the box, replaced lid, and thanked the police for informing them.

(Signed) S. M. Hosking, Chief Inspector, Central District.

The Brush Electrical Engineering Company (Limited),
Belvedere-road, Lambeth, London, February 25, 1891.

Dear Sir: In reply to your inquiry of the 23rd inst., as to how we propose to keep our junction and service boxes ventilated so as to prevent the accumulation of explosive gases in them, I beg to submit our proposals as follows: The lids of the junction-boxes to be made air-tight by means of a yarn and tallow gasket. The pipes or conduits to be made perfectly air-tight. The ends of all conduits to be plugged *except* the one leading to the nearest lamp standard. The lamp standard to be perforated near the top to create an upward draught, which will keep the box perfectly free from gas.—I am, dear Sirs, yours faithfully,

The Brush Electrical Engineering Company (Limited).
(Signed) John Raworth, Superintending Engineer.

Henry Blake, Esq., Principal Clerk, Sewers Office, Guildhall, E.C.

The Laing, Wharton, and Down Construction Syndicate (Limited),
82a, New Bond-street, London, February 27, 1891.

Dear Sir,—Referring to your letter of the 23rd instant in regard to the ventilation of our service boxes and manholes, we now beg to inform you that we propose providing against an accumulation of gas in the boxes by sealing up the ends of the pipes and conduits and making them air-tight, and by carrying up into the lamp-post a tube from the box to serve as a ventilating shaft, an outlet for gas being made at the top of the post.—We are, dear Sir, your obedient servants,

The Laing, Wharton and Down Construction Syndicate (Limited).
(Signed) C. J. Wharton.

Henry Blake, Esq., Principal Clerk, Sewers Office, Guildhall, E.C.

Engineer and Surveyor's Department, Guildhall, E.C.
September 18, 1894.

Dear Sir,—The inspector of the electric lighting works has drawn my attention to the contiguity of the high and low tension mains in many of the street boxes in the City, and as there is some risk of the low tension cables being dangerously charged by the high pressure arc leads, I shall be glad if you will give the matter your attention with the view to this being rectified.—Yours truly, (Signed) D. J. Ross.

D. Cook, Esq.

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1 and 2, Great Winchester-street, London, E.C.
19th September, 1894.

Dear Sir,—I am in receipt of yours of the 18th instant, drawing my attention to the contiguity of the high and low tension mains in many of the street-boxes. The matter is constantly before us. Some time ago I arranged with Major Cardew of the Board of Trade, who has several times inspected the boxes, that the high and low tension-cables shall be separated by metal in the boxes. This shall be done as soon as the work of drawing in cables is completed. In the meantime there is not the slightest danger of the high-tension current getting into the low-tension cables. All our cables are new, of first-class manufacture, of the highest insulation resistance, and are frequently tested. You need not, therefore, have the slightest misgiving on the score of danger.—Yours faithfully,

The City of London Electric Lighting Company, Limited,
(Signed) David Cook, E. and M.

D. J. Ross, Esq., Engineer to the Commissioners of Sewers, Guildhall, E.C.

APPENDIX II.

(*From the Proceedings of the Royal Society, Vol. LVI.* *)

"On the Difference of Potential that may be established at the Surface of the Ground immediately above and at various distances from a buried mass of Metal charged from a High-Pressure Electric Light Supply." By Major Cardew, R.E., and Major Bagnold, R.E. Communicated by Lord Kelvin, P.R.S. Received June 24, 1894.

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* *The Electrician*, Vol. XXXIII., p. 624.

THE EUSTON-ROAD EXPLOSION.

MAJOR CARDEW'S REPORT.

I have the honour to report that, in accordance with your instructions, I held an inquiry on the 10th inst. as detailed above. The inquiry was held in the St. Pancras Vestry Hall. Prof. Robinson, the consulting engineer to the Vestry of St. Pancras, represented the Vestry, who are the owners of the electric light conduits. Mr. Bassett Hopkins and Mr. Gunyon represented the London County Council, and Mr. Foulger, engineer to the Gas Light and Coke Company, represented his Company. I attach a transcript of the shorthand writer's notes of the evidence given at the inquiry. I also append to this report a return, furnished by the metropolitan police, of previous explosions which have occurred in connection with the system of electric lighting mains laid down by the St. Pancras Vestry.

The supply of electrical energy for lighting and other purposes in this district is provided by the St. Pancras Vestry, who are the undertakers under the St. Pancras Electric Lighting Order, 1883. The greater portion of their system of mains consists of bare copper strip, supported on porcelain insulators, fixed about 6ft. apart with intermediate distance pieces in a conduit which in general is constructed of brickwork and cement concrete; but in portions at road crossings, or at places where sufficient depth is not obtainable to suit this construction, the conduit is formed by means of a cast-iron pipe 8in. in diameter. At intervals, which vary according to the requirements of the locality, street boxes or chambers have been made giving access to the mains for purposes of jointing, testing, &c. These are formed of brickwork in cement, and are closed in the usual way with an iron cover filled in with York stone. These street boxes are generally of considerable internal capacity and allow of a man getting into them to effect cross connections or other operations on the mains. The mains are laid on the three-wire system, and consist of a positive, a negative, and an intermediate main, the pressure between the positive and negative mains being rather over 200, and that between either and the intermediate main rather over 100 volts.

General Account of Explosions.

It appears that at 12 midnight on the 29th ultimo, P.C. James Diprose, 436 D, was on duty at the corner of Gower-place and Endsleigh-gardens, and heard the report of an explosion in the direction of the Euston-road. Immediately afterwards a second explosion occurred at the corner of Endsleigh-gardens and Euston-road, which he witnessed, and he saw the cover of the street-box at this corner projected about 20ft. into the air. This cover was afterwards found to have been broken. A few yards to the westward, along the Euston-road, he found the cover of another street-box displaced about 8ft., and beyond this again, for a distance of 30 yards, the pavement had been raised over the electric conduit by about 2in. Two men, Charles Govier and David Petrie, sustained injury by these explosions. The former attended the inquiry, and stated that they were walking together along the Euston-road when the first explosion took place; he saw a flash in the ground, was hurled into the air, and came down on his back. He struggled to his knees, when the ground heaved up, probably from the effect of the second explosion, and he was thrown into the gutter. On getting to his feet he found Petrie in a dazed condition, clinging to the railings. They were assisted to the University Hospital, where their injuries were attended to, and they were able to leave in a short time. The house surgeon's report was stated to be to the effect that Govier had sustained a bruise in his side, and Petrie a sprained ankle—both mild cases.

According to the evidence of Mr. Baron, the chief engineer and manager of the St. Pancras Electric Lighting Station, and from my own inspection, I find that the street-boxes in which the explosions occurred were numbered 26A and 27. They are about 10 yards apart, and the conduit between them is an 8in. iron pipe. The upheaval of pavement took place west of No. 26A, where the brickwork and cement conduit is in use. No external disturbance was apparent above the iron pipe. I had the whole length of this pipe exposed to view, as it appeared to me that possibly electrolytic action might have been in progress from a connection between one of the mains and this short length of pipe, and that this might have damaged service pipes or mains of gas or water in immediate proximity. There was, however, no trace of any such action. The brickwork conduit had been seriously damaged, the top being mostly shattered, and the bottom cracked to a considerable extent. The length of the portion so damaged is about 30 yards. The whole of this was opened up, and I closely inspected the conductors, but could not discover any sign of electrolytic action or of any electric arc or short circuit having taken place. In fact, these conductors are practically in as good condition as when first laid. At several of the insulators, more especially in the street-boxes, there was an incrustation of a saline material in the vicinity of the negative conductor; this was distinctly damp, and no doubt would cause in the aggregate a serious leak. The tendency to the formation of this incrustation in the case of bare conductors used for electric lighting currents has been observed in several previous cases. The insulation resistance of this section of the mains was taken by Mr. Thomas, the outdoor inspector, the day after the explosion, and was found to be only 330 ohms for the negative and 110 ohms for the intermediate mains in a short length of about 100 yards. That such a very low insulation as this is not an exceptional case on this system of mains is evident from a copy of a report on some tests of mains handed to me by the chief engineer, by which it appears that in May and June last year the insulation of the negative main in sections in or about the Euston road was found as low as 160 and even 80 ohms, while in other parts very low insulation of this main was found, in one case only 40 ohms.

The chief engineer stated that he smelt coal gas immediately after the explosions in street box No. 27, in which the second explosion took place. Mr. Thomas, the outdoor inspector, stated that he smelt a strong smell of gas in a neighbouring street-box, No. 26, on the 30th ultimo, and also on the 31st, when he drew the attention of Mr. Gunyon, engineer to the London County Council, to the smell, who also perceived it. Edwin Benyon, an electrical jointer in the employ of the Vestry, also smelt gas in No. 26 immediately after the explosion.

It appears that the street boxes are systematically examined, for the presence of water or gas, at intervals of from four to six days, and that gas was reported in No. 27 on the 13th ultimo. On the other hand, both No. 26A and No. 27 had been examined on the 28th ultimo, probably about 36 hours before the explosions took place, and were found free from gas, and Mr. Foulger, the engineer to the Gas Light and Coke Company, stated that the tests made by his company since the explosion had failed to indicate any leakage of gas in the neighbourhood; nor could I detect any smell on the 31st ultimo, or on the day of the inquiry. Since the inquiry, however, Mr. Foulger has informed me that a 4in. main was found to be leaking on the 9th instant near the entrance to the London and North-Western Railway, Euston-square, and from information received from the Vestry it appears that the position of this leak was about 80 yards from the electric light conduit. The electric lighting officials admit that they frequently discover accumulations of gas in their street-boxes, and the return furnished by the police gives particulars of six explosions, all of which were probably caused by the firing of an explosive mixture of gas and air, in connection with the electric lighting mains in St. Pancras.

It has been suggested that in the particular case now under consideration the explosive gas was derived from the sewers, but I do not think this at all a probable explanation. Mr. Foulger suggested at the inquiry that the gas might have been hydrogen generated by electrolytic action. This is certainly a more tenable proposition, and I took care to examine the conduits and conductors for any material evidence which might support it. No trace of such action was, however, discoverable.

After careful consideration of the evidence and of my own investigations I am of opinion that the explosions were caused by the firing of a mixture of coal-gas and air by an electric spark.

I account for the presence of the coal-gas by leakage from the mains of the Gas Light and Coke Company at one or more points in the vicinity of the electric light conduits; percolation of the escaped gas along the lines of gas and electric mains, which are parallel and in close proximity, where the soil has been frequently disturbed; and entry into the electric conduits and boxes wherever small openings may exist, which, from the construction and materials used, will certainly be the case at many points. The gas would naturally percolate into the open space provided by the electric light conduit, and this would be facilitated, to some extent, by the small amount of heat produced by the electric current in the mains. It is probable that since the general adoption of wood pavement, and other forms of pavement which prevent the escape of gas from the soil directly into the open air, the danger of its percolating into underground chambers has been materially increased.

The means provided by the Vestry for the immediate escape of any gas from their conduits are, in my opinion, totally inadequate; and even a slight leakage of gas into the conduits would be likely to accumulate until the proportion of gas in the air reached that necessary to form an explosive mixture.

The occurrence of an electric spark was, I think, probably a result of the formation of the salt incrustation on the insulators as mentioned above. This, no doubt, acts to some extent as a conductor, and if a piece break away, a small spark would very likely be caused. There are many other ways in which an electric spark might have originated, especially with this system of mains; but from my examination I think the cause suggested above the most probable. It is true that at about the time of the explosions the electrician on duty at the generating station observed a momentary fall of pressure, which probably indicated a sudden rush of current lasting for a very short time; but I am inclined to consider this occurrence as an effect rather than a cause of the explosions since I could find no trace of any electric arc. It is possible that the intensely heated gases of the explosions may have allowed of the passage of a considerable current, and a number of partially conducting bridges of solid materials may also have been formed during the progress of the explosion connecting the oppositely charged mains.

The Vestry of St. Pancras should lose no time in removing the two existing causes of danger which I have indicated above, viz., the possibility of an accumulation of coal gas in their conduits, and that of the occurrence of an electric spark at their bare conductor mains.

This system of mains and conduits was selected, I believe, mainly for economical reasons, and no doubt it has advantages in this respect; but these economical advantages must not be reaped at the expense of the safety of the public using the streets. The Vestry were, I understand, advised by Prof. Robinson after the serious explosion which occurred on January 12, 1894, in a street-box in Endsleigh-gardens, close to the position of the recent explosions, to carry out a system of efficient ventilation wherever possible, and in a report on this accident, which was forwarded to the Vestry by the Board of Trade, I also advised this; and further recommended that where possible two small chambers should be substi-stituted for the large ones at present in use as street-boxes, and that the low insulation of the negative main, which was then, as now, a very noticeable defect, should be remedied.

Sufficient attention has not, I consider, been paid by the Vestry to these recommendations. It was stated by Mr. Baron at the inquiry that there are only 11 ventilating pipes and three ventilating covers to street-boxes for a total length of 6½ miles of conduit, and the nearest ventilating pipe was about 300 yards from the scene of the explosion. None of the large street-boxes have, it appears, been divided into two smaller ones, as suggested by me, and the attempts made to remedy the serious leakage on the negative main have not, so far, been successful.

I am of opinion that the Vestry should immediately provide a thorough system of ventilation, or means for the immediate escape of gas from their conduits and street-boxes, should reduce the empty space available for accumulation of gas in their street-boxes as far as possible, and should carefully guard against the dangerous formation of an incrustation of salts on the insulators of the negative main by frequent inspection and by protecting these insulators against drip from the condensation of moisture on the iron lids of the street-boxes.

RETURN OF EXPLOSIONS WITHIN THE ST. PANCRAS DISTRICT SINCE JANUARY 1, 1890.

Division.	Date.	Time.	Place.	Particulars of occurrence.
D	10/10/94	5:50 a.m.	Tottenham Court-road	The plate of a manhole belonging to the St. Pancras Vestry was broken, probably caused by being forced out of the aperture by foul air.
E	12/1/94	5:10 a.m.	Endsleigh-gardens and Euston-road, corner of	The cover of a manhole belonging to the St. Pancras Vestry was blown out by an escape of gas, which exploded with a loud report. No personal injury.
S	28/12/92	10:30 a.m.	Cumberland-terrace	Iron covers of culverts belonging to the St. Pancras Vestry were blown out by an accumulation of gas in the culvert.
S	29/12/92	12:20 a.m.	Cambridge-place	Iron cover of culvert belonging to the St. Pancras Vestry blown out by an accumulation of gas in the culvert.
S	24/1/93	4:59 p.m.	Euston-rd. (nr. George-st.) Euston-rd. (nr. Melton-st.)	Switch door to electric light post belonging to the St. Pancras Vestry blown off its hinges and shattered by an accumulation of gas in the culvert.
D	29/12/94	12 night	Endsleigh-gardens and Euston-road, corner of	Two iron plates to manholes belonging to St. Pancras Vestry blown out, supposed by an accumulation of escaped coal gas in electric channel. 2 persons slightly injured, and flagstones displaced for 40 yards.

ELECTRIFICATION DERIVED FROM INCANDESCENT CONDUCTORS.

In the *Nuovo Cimento* for December, 1894, Drs. Vicentini and Cinelli describe a further series of experiments on the transmission of electricity through gases surrounding red-hot current conductors. They used a glass globe provided with four mouths (Fig. 1), two of which, A and B, serve to admit thick copper wires connected by a small piece of platinum wire, *a b*, 0·15mm. thick, whilst the other two, C and D, admit air, carbonic acid, or hydrogen through the tube *t*, and out at the bottom. A glass tube, *p q*, carries a platinum wire bearing a small plate of platinum, *m n*, at its lower end, fixed about 10cm. above *a b*. The other end leads to an electrometer, and the wire through D is put to earth.

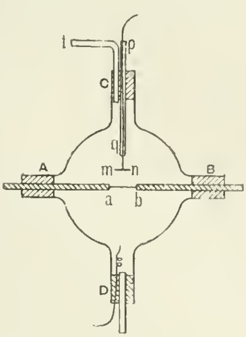

FIG. 1.

On heating *a b* to a red heat by means of a current *m n* was found to assume potentials slightly higher than the mean potential of *a b*, the excess varying with the gas employed. The potential acquired diminished as the distance between the wire and the plate increased, but changed very little when the distance was near 10cm. On placing the plate below the wire the potential fell rapidly with increasing distance, almost vanishing at 12cm.

Fig. 2 gives the electrification of the plate in hydrogen (H), air (A), and carbonic acid (CO_2) respectively, as depending upon the temperature of the wire. The latter was measured by the change of resistance of the wire itself. In the figure, the abscissæ denote the resistance in ohms, and the ordinates the differences of potential in volts. It will be seen that hydrogen conveys positive electric charges most readily. The maximum of electrification is attained at 0·65 ohm in hydrogen, at 0·73 ohm in air, and at 0·75 in carbonic acid, which means that the three gases require correspondingly increasing temperatures to convey their maximum charges.

The average potential of the wire *a b* was 4 volts. Hence the hydrogen particles, which charged the plate to 4·25 volts, acquired an excess of voltage of 0·25, whilst those of air and carbonic acid acquired one of nearly 1 volt. With a further increase of temperature, hydrogen shows an inversion, so that for resistances of *a b* beyond 0·65 ohms the plate has a potential lower than that of the wire.

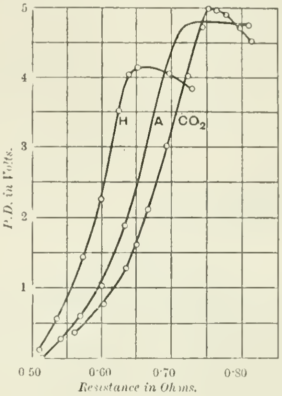

FIG. 2.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, February 8th.

PHYSICAL SOCIETY.

5 p.m. Annual General Meeting. Exhibition of Simple Apparatus by W. B. Croft. The following Paper will be read: "The Tin Chromic Chloride Cell," by S. Skinner.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting at 28, Victoria-street. The following Paper will be read: "The Magnetic Condition of Matter, with Experiments," by C. E. S. Phillips.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. The following Paper will be read: "The Construction and Maintenance of Roads," by Chas. H. Godfrey.

MONDAY, February 11th.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

7 p.m. Council Meeting at the Palatine Hotel, Hunt's Bank, Manchester.

8 p.m. Ordinary Meeting at the Palatine Hotel, Hunt's Bank, Manchester. The following Paper will be read: "Electricity as Applied to Mines," by G. S. Corlett.

TUESDAY, February 12th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Monthly Ballot. The following Paper will be discussed: "The Mechanical and Electrical Regulation of Steam Engines," by John Richardson.

WEDNESDAY, February 13th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read: "Light Railways," by W. M. Acworth.

THURSDAY, February 14th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting at 25, Great George-street. The following Paper will be read: "Reversible Regenerative Armatures and Short Air Space Dynamos," by W. B. Sayers.

The Electrician.

The Oldest Electrical Journal, 1861—1878.

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GAS EXPLOSIONS.

A modest, tidy man going back to his work after his dinner on Friday last, and, doubtless pondering over the Notes in that morning's *Electrician* about gas explosions, lighted his pipe on Southwark bridge. We have reason to suppose that it was not a cigar or a cigarette, because pipes are more common on Southwark bridge; we know that he was tidy because he did not merely throw his match into the street, but dropped it down a grating; and his modesty is evinced by the fact that, having caused a serious explosion, which has engaged the attention of the Board of Trade, occupied the time of City and police officials, necessitated the attendance of witnesses, given another opportunity for the gas companies to show their contempt for such trifles, and has actually cast suspicion upon the immaculate working of the City of London Electric Lighting Company, he has not come forward to make his bow. Possibly he was the man who was "blown into the air several feet" amid "three clouds of smoke"—what a study for BUONARROTI!—and who subsequently fell into a chasm torn out of the street, and was removed to Guy's Hospital, and thought that he had had enough of it. Electrical engineers may well resent the attribution to them of such accidents; but the public are indebted to them for the part they have played in exposing the reckless waste of gas, the pollution of the soil, and of all closed spaces in the neighbourhood of gas mains, by explosive mixtures. Not only has the carelessness of the gas companies been thus exposed, but the services of the electrical adviser to the Board of Trade have been granted to investigate the question. The remarkable succession of explosions in London during the last week or two is no doubt connected with the severe frost: the rigidity of the road, severer shocks on the surface, straining of the pipes, and in the present case, perhaps, some contraction of parts of the iron bridge may have facilitated the leak. Besides this, it must be remembered that the gas pipes are getting old and rusted; but, so long as there is not enough waste of gas to affect their dividends, the gas companies, who care much more about the sale of their residuals and the underselling of gas stoves, do not mind, and rely upon the blame being thrown on their rivals. Another reason why gas explosions are becoming more common is to be found in the nature of the road surface. Wood as commonly used, impregnated with creosote and set on cement and then tarred, has only to become wetted to form a thoroughly air-tight covering, and asphalte is, of course, equally efficient in retaining any gas and compelling it to seek some other exit than the broad area of the roadway.

We alluded last week to the existence of two factors in these explosions—the gas and the spark. The reason why we unhesitatingly throw the blame of these accidents upon the gas companies is that a spark, or even an arc, between two conductors need not do anybody any harm. Leakages of high-pressure conductors to earth may or may not accompany, or be accompanied by, a spark, but if gas be present in suitable proportion, and a spark does perchance occur, an explosion will ensue. Such leakages are unknown, and are almost impossible on a well-devised and well-constructed system, and must be discussed quite apart from gas explosions. The explosion at Dover on Thursday, January 31st, was an example of a case similar to that on Ludgate Hill (January 8th, 1894), and at Eastbourne (January 25th, 1895). A flame was being used by jointers 30 yards away from the box which exploded. In this case the electric supply plant is not yet completed, and the gas men are, of course, silenced. The fact that the boxes are destined some day to be used for electric supply is a mere accident; they might have been made in connection with supply of compressed air, steam, hydraulic service, pneumatic despatch, or in connection with the sewers, as was the case on Southwark Bridge. We do not wish to raise any needless alarm; but it is evident that if the gas companies continue to be complacently indifferent to the decay of their pipes and mains these explosions will take place not only in electric supply conduits of a few inches cross section, and in mere boxes, but in the large sewers which run below the streets. The probable results of such explosions are too awful to contemplate, and it it is for this reason that we are thankful that the Board of Trade has lost no time in causing scientific inquiry to be made.

Elsewhere in our present issue will be found official reports on two explosions, the one in the St. Pancras district and the other in the City. In both of these the electrical work was faulty, and is most ably criticised by Major Cardew. The reluctance of Prof. Robinson, a year ago, to describe his system of ventilation is now fully explained, the explanation being identical with that which so fully accounted for the brevity of the famous chapter on "Snakes in Iceland." It is very doubtful whether, in the absence of gas in the St. Pancras conduits, and with the provision of fuses of sensible carrying capacity, a "dead short" between the mains would be made evident to passengers in the street immediately above the spot. A similar occurrence in a closed chamber might possibly raise a solid lid by the expansion of the air, but the fuses ought to prevent any serious consequences. Of what use, indeed, are fuses if they will not do so, for the engines would not be capable of making the mains themselves red hot? Major Cardew's hypothesis for the spark, namely, the dropping off of a mass of corroded copper, is sufficient, but speaks volumes against the system of mains. On the other hand, the list of accidents which will be found in an appendix to his report reflects much more seriously against the rotten state of the gas service in that district, in which, if we remember right, a gas main exploded and ripped up a street some years ago. Turning to the City report, we find a record not so much of bad design of plant as of hopeless muddle in execution. Major Cardew's report is not only both clear and severe, but contains bits of dry irony which make it decidedly more interesting than most official documents. Serious as was the electrical misfortune, the gas explosion must be carefully separated from it. The City of London Electric Lighting Company have no less than twelve men engaged in inspecting and testing for gas, but we regard the appointment of Mr. Bailey as chief engineer to the Company as much more likely to remove this and many other difficulties under which they have been labouring. The Southwark bridge explosion was, by-the-bye, a lively incident in Mr. Bailey's first day's work for the City Company.

It is very satisfactory to find that the Board of Trade regulations are considered to be sufficient to meet all the cases that have yet arisen, and the public may be assured that these explosions are not the result of any unforeseen combination of circumstances, but that, if some authority can be found to deal stringently with the gas companies, it is only necessary that the existing electrical regulations should be more carefully enforced by inspections and tests in order that these accidents may disappear as quickly as they have appeared.

Major Cardew's reports confirm a remark which we made last week, namely, that no explosion has yet occurred in a box which had been provided with any means of ventilation, and enables us, further, to assert that in all cases of explosion, no provision whatever had been attempted to get rid of accumulated gas. Though it appears that the Board of Trade regulations are sufficient to meet every case, it still remains to discover the most efficient and economical means of carrying them out. It has been suggested that the boxes should be loosely filled with blocks of wood to break up the flame, or with sand bags to reduce the gaseous contents of the box. These might be roped together, in several lengths to to avoid tangling, and might thus be quickly moved, but the result could only be to reduce the violence of an explosion. There appear to be two general courses, and these cannot be combined. The one we suggested last week, to afford the freest possible ventilation by simple diffusion, making the covers mere gratings; the other depends upon forced draught. To effect this, air must be forced along the whole system of pipes and conduits. In order to ensure the displacement of the contents of the most remote conduits and boxes, the system must be tolerably air-tight. It is supposed already to be water-tight in a general way, and where proper traps are set for drainage, the iron-pipe-and-connection-box system ought to be sealed without much difficulty. A pressure of half an inch of water ought to be sufficient to keep back or get rid of a general diffusion of gas, but considerably more than this would be required to deal with the common results of the carelessness of the gas companies. But it would be next to impossible to seal up the bitumen-concrete blocks, the iron troughs of St. James, and the concrete conduits of Westminster, Kensington, and Notting Hill. In the two last districts it must be remembered that no trouble whatever has arisen, and while in the Notting Hill district serious outbreaks of gas have been discovered, incessant inspection and thorough ventilation have prevented accident. The inspection, it is needless to say, is by the staff of the Electric Supply Company, and not by the real offenders.

Proposals have been made, and patents granted, for continual ventilation by means of gentle suction, either by natural up-draught, or by lamp-posts, or by electrical resistances; but all such devices, although they may remove the gases, which must be replaced somehow by fresh air, will actually draw gas into the conduits from the saturated earth through which they run. The burying of mains direct in the earth, a system which has serious disadvantages in certain kinds of soil, prevents the possibility of the ventilation of the *boxes* by a forced draught. If a forced draught is practicable it can only be carried out by running a large number of conduits or pipes in parallel. The series plan adopted in coal mines could not be carried far, on account of friction and local reduction of pressure due to leaks. Blowers might be run at sub-stations, but in any case a serious expense is forced upon electric supply companies by the contemptuous incompetence of the gas companies.

RIGHTS OF OWNERSHIP IN THE SUBSOIL.

There has lately been much discussion about increasing the facilities for railway communication, and in particular as to the means of diminishing the cost of constructing railways. If Parliament can find any time this session to devote matters of practical utility, we may even see an Act passed giving effect to some of the views which have been put forward on the subject. Under these circumstances the public will be inclined to look jealously at anything which seems to place obstacles in the way of those who are endeavouring to build railways on a cheap system, and to avoid the heavy claims which beset the acquirement of the ground whereon to lay them.

The recent decision of Mr. Justice Kekewich in the case of Farmer *v.* The Waterloo and City Railway Company, which we fully report elsewhere, apparently presents such an obstacle; and, although this may not in fact prove to be of serious importance to the Company directly concerned, it accentuates a difficulty of the kind which we think might with advantage be got out of the way of future undertakings. The decision depends upon a legal maxim which is probably well known to everybody—"*Cujus est solum, ejus est usque ad inferos.*" The fact that this rule is usually quoted in Latin speaks for its antiquity; while the fact that, notwithstanding its age, it is not worn out, warrants the assumption that the doctrine has not hitherto been found inconsistent with our modern social requirements. The litigation we refer to gives a further illustration of the law which lays down that the owner of land is entitled to claim proprietorship of everything between the sky above and the centre of the earth. No one, therefore, may carry an electric wire overhead, or bore a tunnel underground at whatever distance from the surface, unless he has the authority of a statute or the consent of the landowner whose segment of the globe and adjacent atmosphere is thus spanned or pierced. Railway companies have, moreover, been subjected to this further disadvantage. The interpretation that has been placed upon the general enactments by which they are regulated has hitherto compelled them, when desiring to make a tunnel, not only to purchase the subsoil, which they want to use, but, should the owner so require, they must purchase also the surface of the land, which they do not want, and any buildings standing there. Such buildings being useless for their purpose, they have to dispose of them at a price probably far below what a liberal arbitrator has awarded to the lucky original proprietor. In the construction of some parts of the Metropolitan Railway this principle was infringed upon to the extent of allowing the Company to tunnel under streets without making any payment to the freeholders of the subsoil, in case anybody should be able to establish a claim to such freehold. The Acts obtained in recent years by various companies for making electric railways in London have carried the matter a step further, and have specially authorised these companies "to appropriate and use" the subsoil under private property without purchasing the surface or any buildings standing thereon. But now comes the question—Is this to be appropriated without payment, or must the Company pay for a thing which has no market value, and if so, on what principle is this price to be assessed? The Act of one at least of these companies says distinctly that the land has to be purchased from the owners. That of the Waterloo and City Railway Company has left the question open to debate. The clause in their Act, on which this Company relied in the action we are now commenting upon, is fully set out in our report of the case. The plaintiff there sought to restrain the Company from tunnelling under his land at a great depth until they had purchased the subsoil from him.

A perusal of the clause would not improbably convey to a mind untrammelled by knowledge of the course of previous legislation and judicial interpretation the impression that the Company were intended to have the subsoil for nothing, subject to paying compensation for any actual injury they might do to the owner's interests. Mr. Justice Kekewich has decided differently, and granted the injunction asked for. Since we believe his decision is not likely to be appealed against, we must take it to be an authoritative statement that up to the present time Parliament has not authorised any railway company to appropriate, otherwise than by purchase, anything which technically belongs to a private individual, even although the property be inaccessible to him, and for all practical purposes utterly valueless. The next step in the proceedings, however, is, after all, the most important one. An arbitrator, or more probably a jury, will now be asked to decide what is the price to be paid for this valueless piece of property. The payment will probably be small, too small, we should hope, to prove in itself of serious consequence to the Company. But will the benefit that the owner may get from it be at all proportionate to the attendant expenses which will be cast upon the company, and is it necessary for the purpose of protecting a merely nominal proprietary right to saddle a railway company and, indirectly, the public with the expense of coming to terms with a street full of landowners, whose substantial interests, if any, can be otherwise adequately protected? It is far from our intention, particularly in these days, when doctrines of spoliation are openly discussed by modern democrats, to advocate that any man should be deprived of his property without compensation for any injury done to him. In cases where the subsoil contains minerals or valuable springs of water the legal maxim we have quoted above is doubtless of great importance, and may also be entitled to respect in other cases, where an owner can show that any tangible value attaches to his underground rights. All rights of such a nature are fairly the subject of purchase, but where no such special circumstances exist the right to compensation for any injury actually done seems fully to meet the justice of the case. On the other hand, where the owner of a substratum of soil has no reasonable prospect of obtaining from it any remunerative product whatever, except a possible injunction, we doubt whether it is incumbent on the State to assist him in reaping this kind of harvest.

The promised Bill for facilitating the construction of light railways will probably not affect large towns, but it may well contemplate the construction of tunnels through hills in agricultural districts, where there are no minerals or other valuable underground rights. The judicial decision of last week has come in time to give prominence to the question of what may fairly be required of the railway company in such cases; and Parliament will have the opportunity of considering whether some modification of the present practice of compensating owners of a valueless and, to them, inaccessible subsoil may not be introduced without doing injustice.

OBITUARY.

GEORGE EDWARD PREECE.

We regret to record the death, on Saturday last, of Mr. George Edward Preece, who had nearly completed his fifty-seventh year, having been born in 1838 at Carnarvon.

Mr. G. E. Preece entered the service of the Electric Telegraph Company in 1854, and from 1856 to 1861 was attached to the repairing ship "Monarch." In the latter year he went to Malta in charge of the Mediterranean cables, which formed the commencing link of the present Eastern Telegraph Company's system. He was also employed in laying the cable from Florida to Havana in 1867-8. In 1869 he was connected with the laying of the Persian Gulf cable, and was wrecked in the Peninsular and Oriental steamer "Carnatic" in the Red Sea in September of that year. Subsequently he was employed upon the construction of the French-Atlantic, British-Indian, and Falmouth and Gibraltar cables; also was in charge of the manufacture and submersion of the Jersey and Guernsey Company's cables. He joined the Post Office Telegraph Department at the transfer in 1870, but retired in 1878. He was Secretary to the Society of Telegraph Engineers from 1872 to 1876, and his Paper on underground work read before the Society in 1873 was highly appreciated by the profession. In 1884 he joined the firm of Walter T. Glover and Co., and died in its service. He was a frequent contributor to the technical journals, and was a Vice-President of the Northern Society of Electrical Engineers.

THE ORIGIN AND DEVELOPMENT OF THE TELEPHONE SWITCHBOARD.*

BY J. E. KINGSBURY, ASSOCIATE.

(Concluded from page 397.)

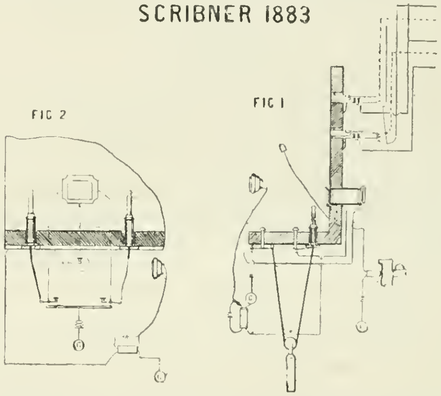
The rapidly-increasing numbers in the exchanges rendered the bar system impracticable, whether of the fixed or revolving pattern. The bar, therefore, was discarded; the cords were lengthened, joined together, and the circuits so arranged that the ringing battery or generator, the operator's telephone, or the clearing-out drop, could be brought into use as required by the easy manipulation of keys placed in the most suitable position. This stage was reached in the switchboard now generally known as the standard switchboard. Its development dates from 1879, the germ being found in the universal jack-knife switch. The keyboard was an entirely new feature in switchboards, and was the logical result of the combination of connecting cords and plugs, with clearing-out drops. The arrangement of the parts was strictly decimal—an obvious advantage hitherto neglected. The decimal arrangement is not shown in Fig. 1 of Scribner, 1879. The standard board was first made for 50 lines with indicators five across, as in the illustration, but 10 deep, and the numbering was in columns downwards That arrangement continued for some time, but was eventually changed to the numbering in lines as now adopted. Some of the keyboard circuits, being also applicable to multiple boards, were patented here, such as that shown in Fig. 2 of Specification No. 3,116, 1883, whereby the operator's telephone is in circuit immediately a plug is inserted in a jack. This is done by means of the other plug of the pair resting on a plate to which the telephone is connected, and accounts for the metallic heel-piece to the plug which then came into use. This board has been greatly altered in the parts of which it is composed; but in general arrangement and in the methods of operation very little, if any, improvement has been found possible, and for small exchanges it has been extensively adopted, or imitated substantially in its original form. Sufficient thought had been bestowed upon it to enable it to assume a form based on sound principles. The board was upright, with a shelf or keys and plugs. What was needed to be seen or handled was placed in the front of the board, but nothing else. All the connecting wires were placed at the back of the board, so that they could be attended to by the mechanic without interrupting the operator. The importance of this arrangement is very apparent now.

The introduction of the standard board probably accounts for the figures which I have already referred to as indicating the change in general estimation of plug and cordboards. Although the flexibility and concentration available with cords must have led to their general adoption, it is of interest to note how the placing of the operator's telephone into the cord circuit overcame one of the principal objections to cords. The existence of a broken cord must become known to the operator in the process of making a connection, and it could therefore be laid aside for another.

Whilst the standard board remains the most effective of what may be called "simple" switchboards—that is to say, those in which a subscriber has only one spring-jack or point of access to his line—it also forms in its constructive and keyboard arrangements the foundation for the more elaborate multiple board, which, although previously invented, soon borrowed the general disposition and the simple and practical mode of operation of the standard board.

The multiple board, as originally designed, employed the Scribner "jack-knife" switch, which was never used in England, I think. It consists of a metallic frame, with a blade pivoted at one end, and resting on an insulated stud at the other. There are two holes. These are for plugs—one for the instrument plug, and the other for the connecting plug. The insertion of either plug will lift the blade from the stud, and so break the earth and indicator contact.

SCRIBNER 1883



The importance of space on the front of a switchboard led to a change in the jack-knife switch at an early date. Instead of lying lengthwise across the front of the board, the blade or spring followed more after the fashion of the spring in the Bell board; *i.e.*, having its length from the rear to the front instead of from side to side. Though entirely different in appearance and construction, the modified switch was the equivalent of the jack-knife electrically. Whilst previous springs, as in the Bell board, were operated by flat plugs, the designer of the new spring-jack retained the round plug as used by Scribner, altering the shape so that it should be retained in position by the tension of the spring. This spring-jack and plug remain in their essential features the patterns now in use. The adoption of a round instead of a flat plug may seem a small matter, but it would require a very considerable amount of calculation to estimate the aggregate saving in time and money which has resulted therefrom.

It may be of interest to state that the inventor is Mr. J. C. Warner, one of the oldest of the expert staff of the Western Electric Company. Mr. Warner designed not only the jack, but also the indicator used on these switchboards. He brought to the design of telephone apparatus a wide experience, and you will probably agree with me that he graduated in a good school. Born in London in 1822, Mr. Warner became engaged in the manufacture of electrical apparatus in the workshop in which instruments were made for Cooke and Wheatstone. Subsequently he made some apparatus for experimental use by Morse on the line between Baltimore and Washington.

Having traced the simple switchboard to the stage in which it is supplied with an indicator and a spring-jack for each line, with pairs of plugs and connecting cords in whose circuit are placed convenient keys, whereby the calling generator and the operator's speaking instruments can be quickly brought into circuit with either subscriber's line, consideration may be given to the more elaborate outfits required for large exchanges. It was on such a foundation that the multiple board was practically introduced, though it was designed at a much earlier period, and was being gradually matured.

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* Paper read before the Institution of Electrical Engineers.

For the purpose of illustrating the prior condition of affairs, I will recall attention to the Edison board, which, as I have mentioned, was installed in 1879. About the middle of 1880, when it had probably about 300 subscribers connected, the Edison Company amalgamated with the Bell Company. Some recommendations were then made for alterations in the switching arrangements. It was suggested that the operating should be divided between talking operators and switching operators, as in the Bell board, with the difference that the subscribers' lines should be continued to the talking table. Seventy-five lines were to be assigned to one talking operator, who was to be assisted by two others as switching operators. On the fall of an indicator the talking operator would depress the key pertaining to that line, would ascertain the number required, and then instruct the switching operator to make the required connections. If it should happen to be with a subscriber in another section—say 200 in the third section—the switching operator would fix the peg in his own board, and then go to No. 3 board, fixing there the proper peg to connect No. 200 of that board with No. 1 of his own, using therefor the special connecting strips set apart for connecting each and every board individually with the other. It was asserted that "by this means an exchange can never become unwieldy." How soon that anticipation became falsified only those concerned with the practical work of exchanges are able to appreciate. The method of connecting separate boards by special "strips," or bars, was very much improved by "transfer" systems, as they were called when applied to the standard boards; but by dire experience it became evident that the rapidly growing exchanges could not be satisfactorily or economically conducted when there was only one connecting point to a subscriber's line, and when communicating conductors had to be made up by sundry operators to enable a connection to be made.

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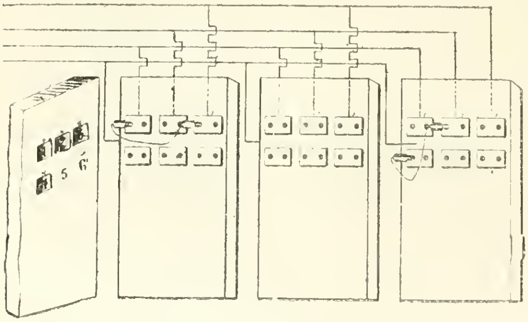
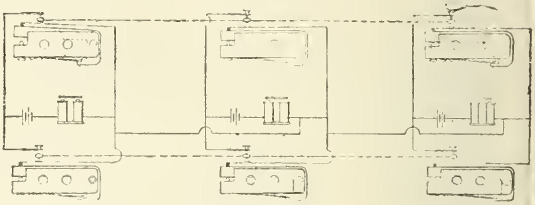
JAN 17 1882



I will show you an attempt to provide a remedy. It is recorded in a United States patent (No. 252,576), which was filed January 7, 1881; and from the wording of the specification I gather that the system was in actual use. The subscribers' lines passed through a number of boards (it was on the "Law" system, and easily done). The subscribers' numbers were inscribed on a signal board placed in a central position. These numbers could be obscured by shutters. When a subscriber was put through, the operator would instruct the attendant at the signal board to obstruct the number. On disconnecting, the reverse instructions would be given. Before connecting a line the operator would look at the signal board to see if the subscriber required were disengaged. This method was crude, but none the less deserves commendation as an attempt to overcome the difficulties which were becoming apparent. It is a multiple board without a test system. I cannot claim it as a link in the chain, because, as a matter of fact, the solution of the problem had already been in the Patent Office for over a year. It is in the specification to which I have already called attention—Scribner's, November, 1879. Numerous connecting points, without some prompt and certain means of indicating whether the line were engaged or disengaged, would be a remedy worse than the disease. A triangular conversation would be likely to produce more bad blood than a triangular duel. Now, in November, 1879, the exchange system in London had just commenced. It had certainly had a longer start, and assumed somewhat larger proportions, in the United States; but even there the necessity was not so great as to give rise to the idea which this invention conveys.

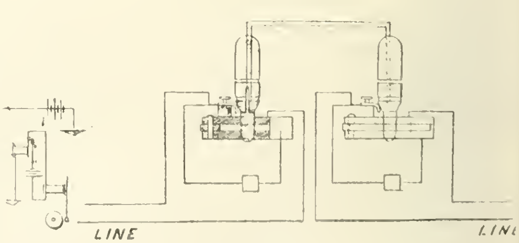
The idea is really twofold—firstly, to enable one operator, whilst answering the calls of a given number of subscribers, to connect them with any other subscriber in the exchange without requiring the aid of any other operator or making up any combination circuit; secondly, to inform the operator of the condition of the line with which connection was desired—whether engaged or disengaged. The first part of the idea was attained by increasing the number of spring-jacks indefinitely according to the number of operators required to carry on the work of the exchange. The second part of the idea is really the establishment of an information bureau in connection with every line, the bureau being supplied with information automatically, and giving up its information on demand. Three ways are shown for giving this information—one is a visual signal electro-pneumatically operated; another is the provision of double connecting blocks; the third is that shown in Fig. 5, which forms the foundation of the multiple-test system as practically developed. In the diagram only the local, or test, circuit is shown. The jack-knife switches illustrate two subscribers on three boards. When a plug is inserted in a jack (as is supposed to be the case in the first one illustrated), a spring, insulated from the blade, and connected with one pole of a battery, is brought into contact with a stud, which is connected by a line to similar studs on every other jack pertaining to the same subscriber. Over the studs are finger keys connected with the other pole of the battery. Depressing the key will close the local circuit and operate a bell or signalling instrument if the line is engaged, otherwise not. The information required was "engaged" or "disengaged." A local circuit partially closed at one jack would be completely closed by depressing the finger key at another jack of the same line—then the line was engaged. Depressing the finger key at one jack would not close the local circuit unless some other jack of the series had a plug inserted in it—then the line was not engaged. There was no talking between operators, no passing of calls, or making up of lines. The information was obtained as the result of testing a local circuit, and hence the term "test circuit" as applied to multiple switchboards. I believe that the invention in the exact form shown in the 1879 specification was only used in one exchange; but it was the subject of continued experiment and study, and was being systematically developed so that it might be ready when required. At this stage it had a test circuit entirely distinct from the line, and a test key for each jack. We might reasonably expect that the development would be likely to take the form of simplification, and such was the case.

FIG. 5.



Scribner, 1879.

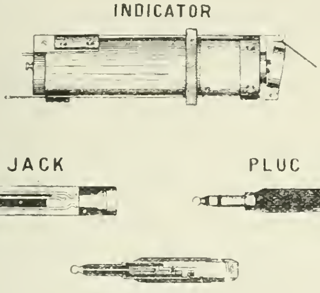
FIG. 11



Scribner, 1879.

Before I relate briefly the line of that simplification, I would like to remind you that we are dealing with a comparatively early period of the telephone industry—not too early to appreciate the advantages of metallic circuit lines, as contemporary records show, but a time when the commercial side of the telephone exchange business practically settled the nature of the lines to be run, so that single lines were the rule. It is possible that some may be surprised to hear that metallic circuit multiple boards are provided for in Scribner's 1879 patent, the necessary modifications to the apparatus being clearly described (Fig. 11) so as to adapt them to metallic circuit use; the plan would not be considered satisfactory now, as only one side of the indicator is cut out. At any rate, switchboards were required to be developed for single lines, and this enabled a simplification to be proceeded with. The separate test line gave way to a much more simple contrivance, which was communicated by C. E. Scribner, and patented here on June 22, 1883 (No. 3,116).

To illustrate this improvement I must again refer to the spring-jack already described in connection with standard switchboards. It consists of three parts—a frame, a spring, and a contact stud. As a standard board jack the spring is in metallic contact with the frame. To make this jack suitable for use on a multiple board it is only necessary to insulate the spring from the frame. Place a number of these jacks in a row, connect a subscriber's line with the spring of the first jack—the spring rests on the contact beneath—connect the contact with the spring on the next jack, and you thus have a line through the board which may be broken at any jack. This is the subscriber's line wire, which continues from section to section through the hammer and anvil contacts of the jacks, which contacts are mechanically sustained by the frame, though they are electrically distinct from it. If all the frames of a series of spring-jacks are connected together by another wire, you have two lines through the board—the subscriber's line and the test line. Insert a plug in any spring-jack and you break the main line, but connect together electrically the spring and the frame. In other words, the test line becomes a branch of the main line. The main line has an earth on it. Touch the frame of a jack (which is electrically a part of the test line) with a plug forming the extremity of a partial circuit including a signalling instrument and a battery earthed at one pole, and it will be seen that you complete the test circuit if the line is engaged, and you don't complete it if the line is disengaged. The same result is attained as by the 1879 system, but by a very much simpler arrangement of parts.



Branching System.

Another simplification was made in the apparatus for testing. The finger key contacts on each jack (1879) were so many branches from one side of a battery. Instead of having numerous branches, the same effect could be attained by having one movable branch. This was attained (1883), one separate test plug being provided for each operator. The test plug illustrated is in the form of a thimble, easy of application to the frame of a jack. The drawings show a bell, or buzzer, as a signal, but a "telephone" is suggested as an alternative; and it needed only a slight change to make a still further improvement, by discarding the separate testing plug, making the operator's telephone the signalling instrument, and the connecting plug the testing medium. On touching the frame of a jack with the connecting plug the operator hears a click in her telephone if the line is already engaged. This method of testing by the operator arrived at the last-mentioned stage before the multiple board was put into practical operation in England, and so it remains to-day, although the electrical circuits are very different.

The early multiple boards were very much like overgrown standard boards, the cords being below the keyboard. As then designed the cords were not long enough, and so in the Liverpool boards (the first used in England) the cords were overhead and longer. A board was supplied to the Globe Company in London at an earlier date, but the subscribers were not numerous, and I think that the jacks were not multipled; so that we generally regard the Liverpool board as the first in actual commercial use here.

After the Liverpool board an important change was made in the introduction of what is variously called the "local section," or the "answering jacks." The latter term seems preferable, since it corresponds so well to the answering plugs used with them. The Liverpool board was arranged for 200 subscribers to a section, the spring-jacks being of the Warner pattern, mounted on wood. The jacks being arranged in blocks of 100, placed in numerical order, it will be seen that, taking, for example, the first section, the 200 subscribers' jacks of that section were all at the operator's left-hand end of the board, and all three operators had to reach those two jack panels. This difficulty was met by adding yet another jack for each subscriber—the answering jack. These answering jacks were spread out along the board, so that the answering was more promptly done, and an operator had not to reach past another in responding to a call. The arrangement of indicators in relation to jacks was rendered uniform in all sections—a great advantage in changing operators from one section to another. This plan was first introduced in the multiple board shown at the Philadelphia Electrical Exhibition. There was a further modification in the design which has sometimes been called a "double-deck" arrangement. At the top of the board were the general jacks, then the clearing-out drops, then a shelf containing half the plugs—one of each pair—then the indicators, below them the answering jacks, then another shelf with the remaining plugs and the keys. This double keyboard arrangement has been retained; but the disadvantage attending the separation of the plugs became speedily apparent. Even so slight a change in the relationship of the plugs slowed down the operating, and their separation also involved a risk of using the wrong plug for completing a connection. The separation of the plugs was, therefore, abandoned. The plugs were both placed on the upper shelf, the clearing-out drops and the answering jacks changed places, and this arrangement of parts is still retained; except in the branching system, where the indicators are at the top of the board, and only one keyboard is required.

Another problem was met in this 1884 board. Exchanges were growing larger and larger. More subscribers had to be provided for. More spring-jacks had to be placed on a section, the face of which could not be enlarged. The limitation of size in a multiple section is easily understood. It is the limit of reach of the outstretched arms. That is about 6ft. The height is a little more variable, as the reach in that direction does not interfere with other operators. If, therefore, it becomes necessary to put an increased number of units in a given area, it can only be done by reducing the size of the units. A reduction in size of parts was then made, and further reductions have since been made. In fact, so far as designs and patterns are concerned, the size has been reduced so as to attain a capacity beyond the requirements of any exchange under existing conditions.

With the reduction in size came a radical change in the method of construction. Instead of each jack being made separately and then mounted on a base, the base and the jacks were incorporated. Twenty jacks were made into a strip, which was a combination of metal springs and insulating material. This was simply a constructive change, carefully carried out so as to make no change in the method of operation; the same round plug being used, and the same bush, carefully shaped so as to make the act of testing easy and the completion of the connection quick. Although various changes in size and construction of parts were introduced after 1884, the general design and the circuits of the board were not materially altered for some years.

During these years the telephone exchange business had been very rapidly extending. Long-distance lines were being erected; overhead wires in some places were having such violent hands laid upon them that burial became necessary; the development of electric lighting and traction, and the production of powerful currents disposed to extend unduly their sphere of influence—all these causes had their effect upon telephone switchboards. Metallic circuit service had to be provided for, and, as the change must necessarily be gradual, mixed service had to be given first. This requirement was met with a minimum of change in existing apparatus. The earth circuit multiple had in the test wire a line which could be made available as a metallic return by a slight change. The engaged test, as you will recollect, depended upon there being an earth connected to the test circuit. Put an earth on a metallic circuit line when engaged, leave it off when not engaged, and you have the necessary dual condition for negative or positive information. This earth was attached to one or both limbs of the cord circuit, and formed a part of the local circuit, which was completed by the plug in the act of testing. Between the earth and the cord is placed a retardation coil, which prevents currents of high frequency from either entering or leaving the telephone line, but is no bar to the simple battery current required for the test. This may be termed a transition board, but it is a very practicable one.

The importance of accurately balancing the talking lines, as well as the certainty of the test signal, showed the advisability of going back to the original 1879 plan of using a test circuit entirely distinct from the line circuit; and I think that this importance was insisted upon by none more strongly than English telephonists. But here a difficulty presented itself. Experience showed that as the jack contacts in a board increased, so did the troubles due to poor contacts between the line spring and its contact stud. Supposing a 4,000-line board of normal dimensions, on the single or mixed circuit system, there would be 21 jack contacts in the line. To adopt the system of cutting out the indicator with metallic returns, and to employ a separate test circuit as well, would require three contacts in each jack, so that a 2,000-line board of such a character would have 33 jack contacts, or about 50 per cent. more than a single or mixed circuit board of twice its number of subscribers.

With the general improvement in the quality of external lines, it is obvious that it would not do to put into the switchboards apparatus of such a design as would lead to defects in the very portion of the circuit under the electrician's immediate control. This consideration led to another new departure—the last to which I shall call attention—and that is the arrangement of the subscribers' lines in an unbroken circuit throughout the board with no contacts whatever in the jacks, and the automatic restoration of the indicator. The branching of the line contacts and the use of bridging indicators in themselves are no new departure in switchboards. The Post Office use branched line contacts and bridging indicators. It is of interest also to note that their indicators need no manual restoration. But the means by which these results are accomplished are not available for the methods of exchange working generally adopted. New means had to be invented. The idea had been "in the air" for a considerable time; but, as usual, lacked the final touches to make it practicable, like the invention of the telephone itself. I will indicate one of the principal difficulties. Let us suppose that two subscribers are connected, say No. 1 and No. 3,000, the connection being made at No. 1 board. The indicator of No. 3,000 is at the other end of the room. On sending a clearing-out signal, both indicators would drop unless cut out, as in the older system, or prevented in some new way. One of the earliest attempts at meeting this requirement was in Scribner's English Patent No. 20,099, December 9, 1890, which was one of the preliminary steps in the branching system so far as the jack contacts were concerned. The desirability of the separate line for test purposes, however, helped the solution. This test circuit might very well bear an additional burden. The application of a locking device on each indicator, and controlled by a battery in the test circuit, was the first stage. The locking was a necessity; but it is only natural that it should have led to the restoration of the shutter to its normal position, thus rendering another of the switchboard operations automatic. The first design for the circuit of this board was by Mr. Bell, one of the switchboard experts of the Western Electric Company. But, in addition to the Western electric staff, the design of the board was so fully discussed by the switchboard committee appointed by various telephone companies, that I am unable to give, as I should like to do, the individual credit for details.

The indicator, spring-jack, and plug are illustrated in the diagram. The indicator consists of two coils mounted on opposite sides of a plate. The longer coil is the operating coil, and it is connected in bridge across the line. The short coil is the restoring part, and is connected in the test circuit. The operating coil, when energised, attracts the armature to which is attached the arm holding up the shutter. The shutter opens out if the test circuit is incomplete. But if the test circuit is completed by having a plug in any jack of its line the restoring coil is energised and the shutter prevented from opening. The spring-jack has three springs, a bush, and a testing ring. The short spring is the contact for one limb of the line, the bush the contacts for the other limb. The two springs of even length are the contact for the test circuit. The plug has three contact surfaces. The point engages with the short spring, the sleeve makes contact with the bush of the jack, and the ring between the sleeve and the tip connects together the two test springs, thus closing the test circuit and restoring the indicator. The advantage of this construction is that there are no make-and-break contacts in the jacks whatever; and in this switchboard we reach the highest development so far in combining the most perfect talking circuit, a mechanism free from the liability of previously existing troubles, and at the same time a reduction in the manual work.

I will not weary you with a detailed account of the evolution of a spring-jack, but will be content to direct your attention to one feature—the testing point. In the first plan (Scribner, 1879, Fig. 5) the testing point was a small stud with a key contact. In the Liverpool board the testing point was the front edge of the body of the jack, which also formed the channel for the plug (Scribner, 1883, diagram). In the Philadelphia Exhibition board (1884) it was still the front edge and the channel for the plug but no longer the framework. In the branching system it is neither the body of the jack nor the channel for the plug, but an additional metallic ring connected with the local circuit by a wire not shown in the diagram, but it still retains the front position because of the prime importance of accessibility.

Comparing 1880 with 1894, it will be observed that in an exchange to which I have already referred, having about 300 subscribers, it was considered necessary to provide a minimum of one operator to 25 subscribers. In the latest London switchboard to which I have referred, fitted for over 3,000 subscribers, there is a maximum provision of one operator for 50 subscribers, and in other places, on boards of the same system, 100 subscribers are attended to by one operator. The number of operators to subscribers is entirely dependent on the load line of the exchange, and there will be necessarily great differences, according to the nature and number of the calls. It will therefore be seen that the development in switchboards has followed the general law of enabling more work to be done with less labour.

The latest switchboards fitted in London are on the branching system, and it is needless to say that they contain many features originated by those who have the responsibility of their fitting up and maintenance. I hope the omission of detailed information on these points and many others will not be construed as an absence of recognition of the value of the work done outside the limited number of persons to whom I have referred.

I have advisedly limited this outline sketch to a record of what has been accomplished in the line of switchboards whose merits are to some extent guaranteed by general recognition; and I have also advisedly omitted any reference to complex problems, such as trunking systems between separate exchanges. I do not propose to anticipate the result of experiments now in progress, or presume to speculate on the possibilities of the future; but I would like to be permitted to make one comparison of the present with the past. The progress of telephony has been the subject of some comment. There are differences in that progress, of course. Local circumstances and conditions will mostly account for them; but let us make a comparison without going away from home. Between the setting up of the first and the last telephone switchboards, to which I have drawn attention, there has been an interval of 15 years. We are accustomed to regard 1837 as the date of the introduction of the electric telegraph, although, of course, active work in a commercial way had not then commenced. Fifteen years after 1837 there was no public telegraphic communication between London and Brighton. The charge for a message of about 100 words to Liverpool was £5. These charges were regarded as high. "But no doubt," says a contemporary record, "these will be diminished when the Company's arrangements get more matured, and they are better able to transact any amount of business which may be offered to them. The Directors appear to be acting on the policy of checking, rather than encouraging, the use of the telegraph by the public until their establishments are everywhere in perfect working order." Now the most maligned telephone companies have never, I think, been accused of turning away customers. Notwithstanding the novelty of their business they have been able to invite additions instead of requesting withdrawals. That is undoubtedly largely due to the extent to which the telegraph had prepared the way. Men experienced in the laying of lines and the management of instruments were already obtainable; but there is one direction in which there had been no previous experience of any moment, and that is in the methods and mechanism of inter-communication. The invention of the telephone was defined by judicial authorities as the creation of a new art. The greatest utility of that new art has been found in the development of that means of inter-communication, the exchange system, and the most important feature in the exchange is the switchboard. It has been a very easy task for me to pick out landmarks and put them together to show the route which was probably traversed; but members of this Institution are too familiar with such matters to need reminding that it was by no means so easy a task to devise and manufacture, or set up and maintain in working order, intricate apparatus which should keep ahead of the ever-growing public demand for telephonic communication. I think, however, there can be no doubt that but for the invention and adoption of the multiple switchboard there would be some parallel between telephonic communication now and telegraphic communication of the date I have mentioned. Its progress would have been checked by the impossibility of doing the work required.

Speakers whose remarks are prefaced by an asterisk have returned their proofs revised.

DISCUSSION.

*The PRESIDENT (Mr. R. E. B. Crompton), in proposing a vote of thanks to Mr. Kingsbury for his instructive and carefully-arranged Paper on a subject of which all of them, he was afraid, knew far too little, said he had to remind them that they owed him an additional vote of thanks for coming forward at a time when they greatly wanted a communication on this subject. It had been a reproach to the Institution for years past that so small an amount of information had been given the members by those individual members who were connected with the telephonic industry, and he thought it was still a reproach that, now they had a Paper, it should have come from Mr. Kingsbury, who was practically the representative of a foreign manufacturing company. But that did not lessen their indebtedness to Mr. Kingsbury. He thought the Paper was one of those that would always be regarded as a reference Paper, the matter in it was so well and so carefully arranged, and it would greatly increase the value of the next number of their journal.

*Mr. PHILLIPS said he did not quite agree with the President that anyone should have brought this subject forward other than Mr. Kingsbury. Those of them who were engaged in telephonic work in London would all agree that there was no one so competent in the Kingdom as Mr. Kingsbury to illustrate the special subject he had taken—the origin and development of the switchboard because there was no one in the country who knew so much of that particular branch of telephonic work. There was one point he wished to draw attention to in the description of the Edison board. Mr. Kingsbury said the subscribers were left to ring each other up. That was, he believed, the original design of the board, but very soon after its coming into use that particular point was improved upon. He thought there was a slight fallacy in Mr. Kingsbury's illustration of two blades of grass growing where but one grew before. He did not quite follow that. In the Bell board they had two operators—one to do the plugging and the other the talking. In the Edison board they had only one operator—that was until the exchange grew rather large—one operator had to do the whole of the work, and that was one point which led to the preference in the beginning for the Edison board over the Bell board. It was a very great feature in a switchboard to give the operator the sole control over the connection ; if she were dependent on someone else doing it she never knew whether that other had done what she desired or not, whereas if it were all in her own hands she would have no doubt about it. With regard to the multiple switchboard, the author was quite right in insisting on the importance of the development of that switchboard. There was not the slightest doubt that was the great feature in the history of the Board, and which had enabled large numbers of subscribers to be dealt with. Everything that could be done to save the smallest possible amount of time in a telephonic exchange was of the utmost importance. The telephone service was made up of a great number of details, and the saving of a few seconds in each connection meant the saving of a certain definite amount of time each day. In connection with the multiple board he might say that in London they had a multiple board before the Liverpool board was used, a board invented by Mr. Hawes, who was at that time in the service of the United Telephone Company. It was invented entirely independently of the American board, of which nothing was known at the time, and it was worked for two or three years in the Chancery-lane exchange. It was rather peculiar in construction, inasmuch as the jacks were placed vertically, and the plugs inserted in that position instead of horizontally. It formed a long table with a box-like trough, and it was known as the "Hawes trough." The branching system was undoubtedly a great improvement on anything they had had before. It came very opportunely, when they were all looking for something of the sort, and so far as they had had experience of it it worked very well. It had only been working from the first Monday in August, but he believed it went very well from the first.

*Mr. HAWES said the reason of his putting his board vertically and the jacks horizontally, to which Mr. Phillips had referred, was to allow of more operators working in each section. That was a great advantage ; but a disadvantage, among others, was that the dust got in between the contacts and insulated the lines occasionally. With regard to the comparison Mr. Kingsbury had drawn between the Edison and Bell boards, or between cord and plug boards, the chief disadvantage of the Bell boards in those days was that they could not get good cords. If Mr. Kingsbury, in his reply, would refer to the present form of cords, he would doubtless be able to give them some useful information. The branching system was an immense advance on the old system, and more attention might have been given to it with advantage.

*Mr. G. L. ADDENBROOKE said the Paper was a very solid one, and he joined with other speakers in acknowledging the lucid way in which it was put together. Upon the subject of switchboards, he had expected to hear something of a board afterwards used in electric lighting. This board had a second set of strips laid underneath the top set, and at right angles, and plugs slotted longitudinally were used, making a spring contact, and passing through holes in both strips. All these boards, of course, were gradually swept away. He had made one or two attempts himself to design boards of one sort or another, but there was no doubt English telephonists were greatly handicapped in comparison with their American brethren. Unfortunately, in the early days of telephony the Telephone Companies seemed to consider that so far as the staff were concerned the finality of things had come, and if any improvements were to be made they must come from outside. There was no want of ability on the part of the servants of the Company, but certainly the management did not encourage any work of an ingenious kind. It was desirable that people should know how differently the Western Electric Company had acted in this matter. He himself was in America about four years ago, and having an introduction to the President of the Company from Mr. Kingsbury, the former showed him over the works of the Company, and explained how they worked. They had a special department dealing with inventions, and that department was in communication as far as possible with telephone companies all over the country, and received information and complaints from them. It was the duty of this department to go through the mass of complaints and suggestions, and to see how far those suggestions could be put into practical form, and there was no doubt that had been a most successful policy. At the present day, when they looked back at all that had been done in the way of telephone switchboards, they might almost say that the progress of telephony had rested with the Western Electric Company and with the affiliated companies whose various superintendents, with their knowledge of practical working, had been able to make suggestions from time to time. It used to be a great sorrow to him that English electricians had not the chance that Americans had. Probably matters were altered now. At any rate, British people ought to take a leaf out of the book of the Western Electric Company in that matter. He did not think Mr. Kingsbury had brought out as far as it might have been brought out the immense complexity, yet simplicity, of the multiple board. It was an enormous problem when they had 4,000 or 5,000 subscribers on each board, with many couplings for each subscriber, the cross-couplings to be got right, and made so that it would stay right. This Paper laid the groundwork upon which an enormous mass of interesting material might be built up. Somebody ought to say something of the exchange systems of London. There was no doubt London presented a different telephone problem from that of any other system, and the officials of the London system had had to deal with problems which were not met with in Paris, New York, Boston or in any other city. Towns like New York or Paris were not sufficiently large to introduce any great difficulty in putting in the lengths of cable necessary to reach out from the dense areas ; but in London there were so many centres that must all be connected together by trunk lines, and they had to carry great masses of trunk lines from one end to the other, three or four miles or more. No doubt the system had been simplified since by the introduction of lower capacity ; but in his time the capacity was such that when they got beyond two or three miles of cable conversation was certainly very deplorable, and they were always receiving complaints about it. In that way they had to meet a problem that he did not think had been met with in the same way anywhere else. To meet these difficulties the central trunk exchange system was decided upon, and was started at Oxford-court, which was very much like the head to the different parts of the body. They had 18 or 22 exchanges in London, a greater number than any other city by a very large proportion, and these had all to be connected together, and arrangements made, so that any one exchange could be connected to any other, and they had a double system for almost everything, as in London by far the greater number of calls went through the trunk system. That problem had been met in London, and he thought if they could have a Paper which would deal with these improvements from some one who was thoroughly up to date it would be an exceedingly interesting communication, and would show that English electricians were not altogether playing a secondary part now in telephonic development.

*Mr. CLAY said Mr. Kingsbury had said what was unfortunately true, that most of our good things came from America ; but, if he might say so, that was only because America was a little in front of us in point of time. There was the germ of the multiple board in the Hawes board, and he had no doubt that was as good a board as the original board in America. Then, with regard to the branching system, there was a system designed by Mr. Watts, of Newcastle, before the American system was heard of here.

*Mr. AITKEN said they had listened to a very interesting historical Paper, but they must all feel sorry that Mr. Kingsbury stopped where he did. They would like to know a little more of the modern switchboards they had in America, the divided switchboard and the visual signal board ; these were things that were new, and to which they were not accustomed. Mr. Kingsbury had spoken of one or two points of development as though they belonged specially to the year 1894. The use of the test ring on the front of the spring-jack was not new and had been known for at least three years, both in this country, experimentally, and also in Stockholm. The branching system, too, as Mr. Clay had said, was not new ; it had been known here for several years, and had been in successful working for at least two years. There were lots of improvements that Mr. Kingsbury had not mentioned. Flat boards had been introduced considerably, the advantage being that with half the number of spring-jacks they could work the same number of subscribers as with the upright board The operators worked from both sides, and therefore there was a considerable saving of cost, and in a given space they could get nearly double the number of subscribers, and as space was very valuable in London that was a serious consideration. Boards worked on the single cord system were speedier in operation, and also there were only half the number of cords in use. Most of the speakers had referred to the difficulty of keeping cords in order, and they must see that when there were only half the number the difficulty was much less.

*Mr. J. G. LORRAIN joined with others in praise of Mr. Kingsbury's Paper, which was one of the best they had had on the subject of telephony, and his hope was that they would have a great deal more upon that subject. On the question of switching arrangements he thought it would be a pity if an historical Paper were allowed to pass without any mention of the old switching arrangements used before the advent of the telephone. It was known to a good many people that in Glasgow, and he believed also in Newcastle, there were two very large exchanges worked by Wheatstone A B C instruments. His recollection of the Glasgow exchange was that there were about 120 subscribers, and that for an A B C instrument exchange was a very large exchange considering the difficulty of working. With regard to one of those early boards, he was rather astonished to hear it spoken of as the Bell board. It had always been known as the Williams-Standard Switchboard. It was, as had been said, a very troublesome arrangement. They could get 75 exchange lines on, but had to employ two operators. Mr. Kingsbury seemed to think the first exchange built in this country was that in Coleman-street, London ; as a matter of fact, the Manchester exchange was about a week or a fortnight before it ; then came the London exchange, and then the Liverpool, or else the Paris, was third. Mr. Kingsbury spoke of the multiple board originally designed never having been used in England ; he rather thought Scribner or Barton in 1880 brought over a model of that board and that it was shown at Clark, Muirhead's. With regard to that metallic circuit arrangement where they had, as on the St. Margaret's Bay line, the double twisting of the wires, spoken of as the Post Office system, and described in the patent of Bottomley, Heys and Moseley, was much earlier even than that, and he would like to find out where it came from. He, Mr. Lorrain, erected a number of exchange lines on that system in Edinburgh in September, 1879 ; he got the idea from Mr. Tracy, an American engineer, who said he had seen it either in Chicago or some other American city. Undoubtedly it was in existence at least early in 1879, perhaps earlier. He was rather sorry Mr. Kingsbury had not referred to some other switchboards. In tracing out the development of switching arrangements it was necessary to bear in mind a large number of other switchboards brought out by other men. He should have liked more information about the Law system and Mann's modification of it. He could not help thinking there was more in the Law system than in the existing system. He had had an opportunity of seeing two typical systems, one the Western Electric in Cincinnati and the Law system at St. Louis, and he must say he never saw any exchange whose working came within measurable distance of the Law system at St. Louis.

Mr. KINGSBURY, in replying, said he was sure if those who had spoken really knew the difficulties which were met with in London they would have more consideration for the people who were running the system. He had only set out to deal with the development of switchboards, and that was the reason he had not in his Paper referred to several things upon which other speakers had spoken. He thought probably Mr. Lorraine was right in saying that Scribner's board was brought to this country in 1880. Mr. Aitken objected to his omission of the single cord and the flat board. The flat board he would put to electric light men in this way: there was an engine they could get at a low price, but which would cost a large amount for fuel. That was the flat board. The single cord board was one of the inventions with which Scribner's name was particularly associated, but it had disadvantages and was not in the line of switchboards which had led to ulterior developments, and therefore was not included in the switchboards he had brought before them that evening. He thought Mr. Aitken had entirely misunderstood the drift of his observations about the ring on the front of the spring-jack. Mr. Clay had put the matter very reasonably in saying that most of the good things in telephony came from America, because America was a little in front of us in point of time. It was a fact that the telephone was born, bred and brought up in America. The problems which had to be overcome arose there first. It was the home of the industry, and they had gone systematically to work to develop the telephone. He did not think we ought to grudge the Americans their success in one department, seeing that for the same reasons we had so many successes of our own. In conclusion, he thanked his audience for their patience and the speakers for their very kind remarks.

The meeting was then adjourned.

THE LONDON COUNTY COUNCIL AND THE TELEPHONE SERVICE.

A deputation from the London County Council had an interview at the General Post Office on Monday afternoon with the Postmaster-General, on the subject of the telephone service in London. The deputation, which was introduced by Mr. Benn, M.P., consisted of Mr. Dickinson, Deputy-Chairman of the London County Council; Mr. Edwin Jones, Chairman of the Telephone Committee of the Council; Mr. J. Thornton, and Mr. N. W. Hubbard. The Postmaster-General was accompanied by Sir Robert Hunter, Mr. Spencer Walpole, and Mr. Lamb.

Mr. BENN stated that the question of telephones was one to which the London County Council had devoted considerable attention. It would probably be remembered that two of their representatives—Sir John Lubbock in the House of Commons and Lord Hobhouse in the House of Lords—protested against what they regarded as the very hurried passing of the Telegraphs Act of 1892. The measure was introduced in May, and within a month it was passed, and then, owing to political circumstances into which he need not enter, there was an interval. The County Council regarded that case as a very important one, because, looking at the figures, they found that London represented one seventh of the whole of the business of the National Telephone Company. They were conscious that the present Postmaster-General was in no sense responsible for the circumstances under which the measure was introduced and passed, and they very much appreciated the fact that during the last Parliament the right hon. gentleman consented to place the draft agreement upon the table of the House of Commons. They attached very great importance to the suggestion of the committee that it should be laid before Parliament. Their interpretation of that proceeding was that they would have some opportunity of discussing the provisions of the Bill, and probably some opportunity of amending its provisions. If the right hon. gentleman decided that no opportunity was to be given for a discussion in Parliament, they considered the matter to be of such vital importance to London that they would ask him for something in the shape of a Committee of Inquiry. Looking at what had been done in other cities with respect to telephone business, they thought it would be most unfortunate if the agreement was passed through without London having some sort of voice in the matter. They would like to be able to show before some such Committee what London could do for itself if it were called upon. They were provided with particulars of what other cities had done. They very much desired to see the advantages of the telephone system placed before the citizens of London with equal facilities and at a price similar to that which prevailed in other towns.

The POSTMASTER-GENERAL asked what other towns the hon. gentleman referred to.

Mr. BENN: Towns in Scotland in particular; towns that have taken up the telephone on their own account; Galashiels, for instance.

The POSTMASTER-GENERAL: The telephone in Galashiels is the National system.

Mr. BENN (continuing) said that some restrictions ought to be imposed upon the National Telephone Company, because it was evident that in the arrangements in question a monopoly practically was being established, and unless some protection were afforded to the citizens with regard to price, they might probably be helpless as regarded this important point.

Mr. DICKINSON observed that Mr. Benn had referred to the Act of 1892, and had stated that on that occasion the County Council made a very strong protest against the passing of that measure, which was accomplished in a very short space of time. The provisions of that Act made a very considerable change in the position of affairs with regard to the Telephone Companies. The measure practically gave the Post Office power to hand over to the National Telephone Company, if they liked, the right which Parliament had conferred on the Department to break up streets and to enter on private property, subject to restrictions and appeal to the Railway Commissioners. The Council foresaw that that was a proposal which ought to receive very careful consideration on the part of Parliament. That the Act was known to be beneficial to the telephone companies appeared to be evident from the prospectus of the New Company (from which he quoted). The New Company was now practically defunct as a separate company; but it asked for capital on the basis of the advantages given to the telephone companies by the Act of 1892. Since the Act was passed they had been waiting to see the agreements that were prepared by Sir James Fergusson on behalf of the late Government, which the Committee of the House of Commons stated ought to be laid on the table of the House, and when they were presented at the close of last Session, the Postmaster-General very kindly acceded to the request which was made on the part of the County Council to postpone finally signing the agreements until Parliament and the Council had had an opportunity of perusing them. They had now read them carefully, and the Council had come to the conclusion that if they were carried into effect as they at present stood, they would be detrimental to the interests of London. The position of London with regard to the telephone companies was a very serious one. They were practically in the hands now of a gigantic monopoly—a monopoly which had practically destroyed, not only all competition, but all chances of future competition.

The POSTMASTER-GENERAL inquired whether the speaker advocated competition in the telephone service.

Mr. DICKINSON replied that he advocated competition in any business that a concern took up unrestricted by limitations which Parliament always placed on a private concern which was a monopoly. It might be advisable that the gas company should have a monopoly, but their dividends had to rise and fall with the price of gas; and in the same way the profits of the water companies were restricted. Parliament had never given a monopoly to any private concern and given them full power to make what charge they pleased. One large telephone company had been able to absorb the others, and get rid of the competition which would otherwise have existed, and this brought about a state of circumstances which required serious consideration whether the Company should be restricted or the State should take over the system.

The POSTMASTER-GENERAL pointed out that the licences under which the National Company worked did not terminate for 17 years. There was a provision by which it might be terminated in seven years, but it was a continuing licence.

Mr. DICKINSON, resuming, said that they were in the hands of a monopoly—a Company which, as far as London was concerned, did its business very badly. Its service was conducted almost entirely on the single-wire system, although recently they had endeavoured to improve it; and, moreover, the Company gave its service at a very high rate of charge. There was no place in which telephonic communication was so expensive as it was in London.

The POSTMASTER-GENERAL said he really could not allow such a statement to go uncontradicted, because it was not the case.

Mr. DICKINSON stated that they were very desirous to place their arguments before a parliamentary committee or other tribunal. As far as they had learnt, the cost of the telephone service in London was the highest; it was certainly very high. The cost varied from £12 to £20 per subscriber, and the cost elsewhere was very much less. In Canada it was £4, in parts of Australia £6, in Stockholm £4, in Glasgow the same Company charged only £10, and in Manchester it was £6. As far as they could learn, although their information might be incorrect, London subscribers paid very highly for the telephone service, and they could not see that there was any chance of escaping from such high charges. The Telephone Company had a capital of £4,500,000, of which, he believed, at least £2,000,000 represented promotion money, and not any cash that had been invested in the concern; and they were convinced, after investigating the matter, that a telephone service could be provided for all the existing subscribers in London at less cost than at present. In fact, they could see their way to providing it at a maximum cost of £10 per subscriber. These were what the County Council looked upon as the facts of the position, and they attended there to ask the Postmaster-General if he could assist them to have these matters thoroughly thrashed out by a committee of the House of Commons, and with special reference to the agreement alluded to. They had gone as carefully into the agreement as they could with such a complicated document, and they gathered from it that the effects of the agreement would be practically to place the telephone companies in a much stronger position as monopolists than that which they occupied at the present moment. In fact, it must have been contemplated that they would almost become monopolists when the Treasury granted the minute of May 23, 1892, in which the question of fresh licences was dealt with. Having read the minute the speaker said that it must have contemplated the bringing about of a state of affairs in which the National Company, which was now the only telephone company that was concerned, would meet with no further opposition on the part of other licensees: and in the agreement itself they found provisions which would practically render it almost impossible for competitors to carry on business. There was, for instance, an elaborate provision about terminal charges. The agreements, in the opinion of the Council, afforded such great facilities to the National Telephone Company that the latter was placed in a most advantageous position for carrying on its business and increasing its profits, which, he maintained, must be much more assured than they had hitherto been. If that were so there ought to be conditions in the agreement, or any other agreement, which would limit the charges or profits of the National Company in the same way as the charges and profits of other companies had been treated hitherto. The agreement really enabled the telephone company to carry on its work practically with the same offices and facilities as the Post Office; and rights which had been given by Parliament to the Post Office were allowed by the Act of 1892 to be handed over to the telephone companies.

The POSTMASTER-GENERAL stated that the Post Office had no power to hand over powers which would in any way conflict with the powers of the Local Authority or of the County Council in London.

Mr. DICKINSON said he was aware that a clause was put in the Bill providing that the powers must be subject to the consent of the County Council. The Post Office, in the opinion of the Council, ought not to hand over rights which had been conferred upon them by Parliament unless the Company gave some equivalent in the shape of reduced charges or other limitations

The POSTMASTER GENERAL remarked that these points were rather complicated, but he had been under the impression that all powers which were conferred and which could be conferred under the Act of 1892 were subject to the veto of the Local Authority and in London of the County Council, and that it conferred no powers as to private property which did not exist before.

Mr. DICKINSON replied that the impression which he had been under was that the Telegraphs Act of 1892 did give power to the Post Office to hand over rights to the Telephone Company which the latter had not before. If Sir Robert Hunter said that that was not so he would, of course, at once withdraw his statement on this point. However, whatever Parliament had done, the agreement itself did contemplate handing over to the National Telephone Company the right of entering on private property.

The POSTMASTER-GENERAL said he believed it would be found that the powers under the Act which the Department could hand over to a licensee of the Post Office did not affect private property. They affected the right of laying wires underground, but in every case subject to the permission of the Local Authority. The ordinary wayleaves powers were upon the roads, and these powers were subject to the approval and sanction of the Local Authority. The right hon. gentleman referred to and quoted Sub-section *b* of Section 2 of Clause 5 of the Act of 1892.

Mr. DICKINSON said that the consent referred to was a very weak power. He did not think it would be considered reasonable if the County Council were to oppose an order, and say that they would give no permission to the Telephone Company for fear it would enhance the value of the latter's property.

The POSTMASTER-GENERAL pointed out that none of these powers could be exercised without the consent of the County Council being previously obtained.

Mr. DICKINSON, continuing, said that they felt that the whole proceeding of entering into the agreements in question with the Telephone Company was too advantageous to the latter. They therefore approached the Postmaster-General now because they felt that the State was sharing its monopoly with a private company, and they asked that such a proceeding should be reconsidered. The State was proposing to pay for the trunk wires at their cost price, plus 10 per cent. for compulsory purchase, and it was well known that this was the least paying portion of the Company's undertaking, so that the Company would be in a better position when it got rid of the trunk wires to carry on the local work than it was at present. In all these respects they thought that facilities were given to the National Telephone Company, who, they maintained, ought to be placed under some restriction as to their charges and profits. There was one matter in regard to these agreements which they could not pass over, namely, that the agreement itself contemplated not a reduction in the costs of the Telephone Company, but, wherever there was any change, an addition. A charge was to be made for the use of the trunk wires. Towns at a distance varying from 20 to 25 miles would, under the agreement, pay 6d. for a trunk message instead of 3d., as at present; towns between 40 and 50 miles would pay 1s. instead of 6d.; towns between 50 and 75 miles would pay 1s. instead of 9d.; towns between 80 and 100 miles would pay 1s. 6d. instead of 1s.; and towns between 120 and 125 miles would pay 2s. instead of 1s. 6d. Originally the Government intended to enter into similar agreements with the National and the New Companies, and there would then have been two companies undertaking to supply London. The New Company had, however, disappeared, and had been bought up by the National Telephone Company; and they ventured to submit that the circumstances were different now to what they were in the time of the Postmaster-General's predecessor. The Post Office would now be entering into an agreement with one company—a company which possessed so large a capital that it could not, he said, make its profits except by charging most extravagantly high rates to its subscribers. They thought that this was a dangerous state of things; and, on behalf of a considerable number of telephone subscribers in London, and in the interest of the future of telephony in London, they asked that the agreement should not be entered into until Parliament had held an inquiry into the whole question of the telephonic communication of the country.

Mr. BENN desired to point out that certain powers were granted to the Telephone Company through the medium of the Post Office, and the public had a right to look for a *quid pro quo* from the Company.

Mr. E. JONES stated that the service rendered by the National Company was inefficient. He had repeatedly had the greatest difficulty, and had had to use the telegraph service because he could not get on the telephone. The Company's charges, too, were exorbitant, and, although it had been established for over 12 years, it had only been able to attract 7,000 subscribers. The percentage of subscribers to the population was smaller probably in London than in any other town. The question was a most important one for London. He had no doubt that the County Council could supply a more efficient service for about half the present price. In fact, they had had an estimate from their engineer, and, having gone into the matter as closely as they could, they calculated that they could provide a far more efficient service—with double wires instead of single wires, as at present—for about half the charge now made to the public.

Mr. BENN remarked that the Postmaster-General had stated that the licence of the Company had about 17 years still to run. As far, however, as the patents were concerned, most of them had expired or were nearly expiring, so that there would be nothing to present the County Council from carrying out some scheme as had been hinted at of doing the telephone business themselves.

The POSTMASTER-GENERAL, in reply, stated that the question from the point of view of the Department resolved itself into a very narrow issue. The arguments of Mr. Benn and Mr. Dickinson would no doubt have been strong and effective arguments in the spring and early summer of 1892, but what they were asking or suggesting at the present time was that the Government—and the fact of the change of Government did not affect the question—should go back, not only upon the policy approved by Parliament in 1892, but also upon an agreement signed by the Government of that day with the National and the New Telephone Companies. The signatures given to the agreements were as solemn as any signatures between two parties could possibly be. Sir James Fergusson signed on behalf of the Department, and the Chairmen of the two Companies signed on behalf of the latter, and the work upon which he (Mr. Arnold Morley) had been engaged ever since—and it had been no easy work—had been embodying in formal legal documents the agreements come to between the Government and the two Companies in 1892. He did not, however, want to rest the case merely on this, as he thought there had been a great deal of misapprehension as to the real position of affairs, and the effect which the agreements would have upon the telephone system and service of the country. He had pointed out that the Company now had a licence which extended over the whole of the United Kingdom, and lasted for 17 years, and he was sure that no one present would suggest that the Government could arbitrarily take away that licence, having granted it for a definite period, unless the Company failed in some respects to carry out the obligations which the holding of the license and its terms imposed on them. What they were proposing to do under these agreements—or, rather, what the late Government determined to do, with the sanction of Parliament—was to take over a great portion of the work from the Telephone Company—that was to say, to take over the whole of the trunk system, and leave the licensees of the Post Office to work the telephone system in restricted areas, their powers being entirely taken away with respect to all districts of the country outside the restricted areas. That was the main, substantial portion of the agreement. Mr. Dickinson, he believed, had referred to a possible solution of this somewhat technical and highly complicated subject by the taking over of the whole system by the State. In the agreements in question they were, at all events, making a long stride in that direction. He had had to consider the whole question of purchase. After discussing the whole subject, and in view of the experience they had gained since 1870, when the telegraphs were taken over, the Government came to the conclusion that it was impossible for them seriously to consider the question of the compulsory purchase of the telephones under Act of Parliament at the present time; but what they had been doing was, by agreement, taking over a large and substantial portion of the telephone service of the country. Mr. Dickinson had alluded to the subject of competition, and he had put it to that gentleman whether he approved of competition in the telephone service. For his own part, he confessed that nothing could be more detrimental to the telephone service than to have the systems of two companies in one area. The Government had, however, alwas taken this view—that no monopoly had been conferred. If the National Telephone Company failed to provide a reasonably efficient service in any particular area, the Post Office had the right to set up a system of their own in that area, or of granting to another body a licence to carry on a competitive system. Speaking generally, however, and from a good deal of experience of telephone work, he was confident that a competing system was a bad arrangement for an effective telephone service in any given area, It must be remembered that the telephone was a luxury; it could never be brought down like the penny post.

Mr. JONES: It is a necessity for commercial purposes.

The POSTMASTER-GENERAL: Yes, but it was the luxury of the commercial and the wealthy classes. It could never be made the ordinary medium of communication for the great mass of the people; and, therefore, quite apart from the question of general policy, he should doubt the wisdom of a municipality in taking up a matter and imposing the liability on the rates, which, after all, did not effect the enormous mass of the ratepayers, but was confined to practically a small minority. With respect to the question how far the agreements alluded to affected London—and, after all, the deputation, representing London, through the County Council, no doubt looked at the matter mainly from this point of view—he was prepared to state that, after the agreements were ratified, London would be practically in the same position with respect to this question that it was in before. As he had said, they had safeguarded the position of local authorities by powers which were amply sufficient to prevent anything from being done without the previously obtained sanction of the County Council; and, therefore, with respect to the wayleaves question and other powers, he thought he could assure them that their position would be absolutely safeguarded. Something had been said about the charges for the telephone service in London, and he believed that Mr. Dickinson said that they were higher in London than anywhere else. He (the Postmaster-General) had a list of the towns in America where the telephone was in operation, and he took it that America was the country where the telephone service had perhaps developed more rapidly than anywhere else, He found that in Boston the charge was £33 per annum; in Chicago it was £36; in New York, which was a larger town, the charge was £50, and so far as he knew the profits were not enormous there. In Philadelphia the charge was £33, in San Francisco £19, and in Washington, £33. He admitted that these charges were with the double-wire system, but the National Telephone Company was now spreading that system, and he believed that three-fourths of London was so supplied. The Company now charged £17. 10s. for a business telephone, £12 for what was called a private house telephone, and down to £10 where the subscriber entered into an agreement for five years.

Mr. JONES said that he paid £20 a year, and he believed that that was the charge unless a subscriber entered into an agreement with the Company for five years.

The POSTMASTER-GENERAL said he ought to have stated that the charge was £17 if an agreement was made for five years, and on a yearly agreement the charge was £20. With regard to the increased charge which would result from the Post Office taking over the trunk wires, he believed it was a fact that under the scale of charge proposed, which was based on a uniform rate and increased mileage, there were cases where an increase would result, but in other cases the charge would be less. It had, however, to be borne in mind, that with the Post Office having control over the trunk wires, the public had the safeguard of Parliamentary pressure if the Department made the charges unreasonable, whereas against the National Company for the remainder of their licence there was no such control. He understood that some of the charges for trunk wire communication had been below what the Company considered reasonable, and in all probability if they had continued the system they would have had to charge more. The public had much greater safety if the trunk wires were in the hands of the State.

Mr. DICKINSON: We have no control over the terminals.

The POSTMASTER-GENERAL: Nor have you now. He was not going to defend the action of the Government 15 years ago in handing over these powers to a Company. He thought it was doubtful policy, but the Government were now doing something to bring about a position under which telephone subscribers would be generally better off. Along with other advantages, telephone subscribers would have the great benefit of a largely increased system of trunk wires He could assure them that the position of London in this matter would be at least as good as it was before, with the advantages of communicating through the Post Office and of increased trunk wires. In any case, however, the policy settled in 1892 must be adhered to by the Government, and the question whether modifications might be necessary must be left for subsequent consideration and what experience might teach them.

Mr. DICKINSON stated that a good deal of what he had said had been based on the assumption that the agreements had not actually been entered into. Of course, they did not suggest for a moment that the Government should go back from what had been agreed upon. If that were the case would the right hon. gentleman at a future period, if they asked for a licence, grant the County Council a licence, and also the same facilities which the National Telephone Company had under the agreement alluded to?

The POSTMASTER-GENERAL said he was afraid that this was a question which he could not answer offhand at present. He would, however, undertake this—that the fact that the agreements had become operative, after the legal documents were drawn up, should not alter the question at all; the question of municipal licences should not be prejudiced by this fact. He had constantly maintained in the negotiations with the telephone companies, who would have liked to get a monopoly, that they had no monopoly of the telephone service. He had strictly adhered to the position that the Government was perfectly free to carry on the telephone in competition with them, or to grant licences to others.

Mr. BENN asked whether there would be any opportunity before the final signing of the agreement to discuss it in Parliament, and whether the laying of the agreement on the table implied an opportunity of discussing its provisions.

The POSTMASTER-GENERAL replied that this was rather a question for the leader of the House, but he could not imagine that the Government would be able to find time for a long discussion of the agreement. It might give an opportunity of having a discussion, and might listen to any representations on the question which did not conflict with the general policy.

Mr. BENN then thanked the right hon. gentleman on behalf of the deputation, which then withdrew.

THE SOUTHWARK BRIDGE EXPLOSIONS.

BOARD OF TRADE INQUIRY.

The Board of Trade inquiry into the circumstances attending the explosions which occurred on Southwark Bridge, on Friday last, the 1st inst., was opened at the Guildhall by Major Cardew on Monday at 11 a.m.

The City Solicitor appeared on behalf of the Bridge House Estates Committee, who have care of the bridge. Mr. Frank Bailey appeared on behalf of the City of London Electric Lighting Company. Mr. Frank Livesey appeared for the South London Gas Company.

The City Solicitor put in a plan showing the culvert for draining surface water from the bridge, and the catch pits thereto, &c. Mr. Frank Bailey put in a general plan showing the Electric Lighting Company's mains crossing the bridge and its boxes, &c. Mr. Livesey furnished a plan of the gas pipes at the place of the first explosion. [*See Sketch reproduced.*]

The first witness called was Police-constable LEA. He said he was on the west side of the bridge going towards the City at 1.50 p.m. on Friday. He heard an explosion behind him. He turned round and heard another explosion, and saw a cloud of smoke on the east side of the bridge, which he indicated on the plan of the bridge as coming from the Electric Light Company's boxes. He saw a man blown six or seven feet in the air and fall into the Electric Lighting Company's box. He assisted the man out and took him to the hospital. The first explosion was at the south west corner of the bridge. He identified the position by the sound.

Miss HEATH, of Greencroft-gardens, South Hampstead, typewriter and shorthand writer, said she was crossing the bridge on the east side about 1.45 p.m. on Friday. She heard a report and saw a cloud of smoke on the south-west corner of the bridge. A few seconds afterwards there was an explosion close in front of her on the east side and a great deal of blue smoke. A stone struck her eye. She turned round and then saw another explosion. She afterwards saw a man being lifted out of a box. The explosions were very sharp.

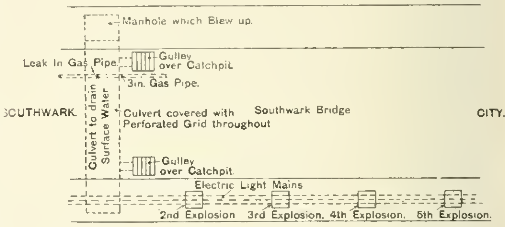
JAMES SMITH said on Friday, at 1.45 p.m., he was crossing the bridge on the east side. He heard the first explosion and saw the smoke. A moment afterwards he was on the lid of the Electric Lighting Company's box. He heard a noise, and was thrown in the air and fell into the box. He was taken to the hospital; his head was bruised.

EDWARD REDDINGTON said he was at work on the bridge, throwing snow over. He was on a box-lid, and was lifted into the air. He heard no noise.

JOHN LYONS said he was close to Reddington, and saw him knocked down. He assisted him. He saw a little smoke from the first explosion.

Mr. PALMER, a grocer, said he was driving across the bridge from the City. When he was close to the Surrey end of the bridge he heard a loud explosion on the off side, and saw the flagstones thrown up. He saw a woman thrown into the road. His pony shied over to the other side of the bridge. He then heard two explosions behind him, with two or three seconds in between each. He took the woman to the hospital.

After other witnesses had given evidence, Inspector EVE (City Police) said he was informed of the occurrence about 2 p.m., and went to the bridge. He saw the Electric Lighting Company's officials. He went to a box at the south-east corner of the bridge, and when the lid was lifted up there was a strong smell of gas. The box contained a gas meter. He went to a box on the opposite side of the bridge and smelt gas very strongly. Gas was also coming out of of the gully in the carriageway in a continuous steam. The flagstones on the west side were displaced.



WILLIAM CUPIT, outdoor foreman to the South Metropolitan Gas Company, said he opened the road by the drain which goes across the bridge at the south-west corner. He began the work at 3 p.m.; about 9 p.m. they found a fractured 3in. main. It was cracked about half-way round, and split lengthways. The crack made an opening about the thickness of a sheet of paper. He would not call the pipe a very old one, but a well-worn one. The pipe had been in use more than eight years. The metal was thin on the uppermost side where the crack occurred. He produced the piece of pipe. He said the cross crack seemed fresh, and was just above the perforated cover of the gulley, from which a lot of gas was coming. He did not think there was any escape from the longitudiual crack. He felt the gas with his finger coming out of the cross crack.

R. THOMPSON said he was employed by the City Electric Lighting Company to lift covers for gas. On Friday he was working on the same approach to Southwark Bridge, and had opened the box on that side next to the one which blew up. There was no smell of gas from it. In two or three minutes he would have lifted the cover of the box which blew up. When he got within a few yards of the south-west corner of the bridge he saw the first explosion, and afterwards the explosion on the other side of the bridge. He opened and examined all the boxes on Southwark Bridge on January 25th, and he noticed no gas then. He indeed noticed it on the bridge. He examined the boxes on the bridge after the explosion and they smelt of gas. It took him six days to get round all the boxes under his charge. Two of the boxes are ventilated. He never noticed any smell of gas in a ventilated box.

Mr. BUCK, Superintendent of Streets for the City Electric Lighting Company, said he went to Southwark Bridge after the explosion. He smelt gas coming from the culverts, manholes, and from the gulley gratings. He sent for the Gas Company, but they did not come for more than one hour. The Gas Company found the leak about 9 p.m. The ground was very loose under the pipe, and frozen on the top of the pipe. There was no injury to mains except one or two dents caused by falling stones. His company employed 13 men regularly opening boxes. He had never had any gas leakage reported in Southwark. He had ventilated 18 boxes where they had trouble with gas leakage. The ventilating pipes have gauges to prevent the firing back. He had not tried fitting up boxes with incombustible material. The pipes were not plugged at boxes. Plugs in this case might have prevented the succession of explosions. He fired three "stink rockets" in the boxwork of the culvert. A few minutes after a stream of smoke came out over the gulley from the interstices between the iron pipes. None of the pipes are injured, and he thought there was passage enough between the pipes for the gas to fire back. He saw a match floating on the water in the catch-pit of the gulley. He smelt gas very strongly at the south end of the bridge. The bricks of which the boxes on the bridge were built were not glazed, but were hard blue bricks. He did not think anything more could be done to prevent gas getting into boxes.

THOMAS BLYTH, foreman to Messrs. Mowlem and Co., said on January 14th last he was employed to make two new catch-pits to the culvert crossing Southwark-bridge. The pits were wanted because the culvert used to get stopped up. On Friday, January 18th, he had a lighted paper put down the culvert from the new catch-pit in order to show him a light in the culvert. On Wednesday, 23rd, while working on the iron pipe leading from the culvert through the parapet wall, he had a lamp and paper put in through the pipe towards the manhole. There was no explosion, and no smell of gas. In the course of their excavation they came across the gas main. The crack in the gas main was outside their excavation.

Mr. PEARD, in charge of the Testing Department of the City Company, said on Friday evening he tested the mains on Southwark Bridge, which had been alive at the time of the explosion, and the results were very good. The mains not alive are also in good order. There are no arc-lighting mains on the bridge.

Mr. F. H. JACKSON, station engineer to the City Company, showed the automatic record of pressure taken on Friday, and no disturbance was to be observed at the time of the explosion,

Mr. FRANK LIVESEY, of the South Metropolitan Gas Company's said it was impossible to prevent the escapes of gas. They lost no time in sending men. He said that any cavity which the Gas Company made under the footway was ordered to be filled with sand or coke-dust. In answer to Major Cardew he thought it possible that pipes might be fixed over the gas mains to indicate leakage into the soil.

The inquiry was concluded.

LEGAL INTELLIGENCE.

Farmer v. The Waterloo and City Railway Company.

The above action came before Mr. Justice Kekewich on Friday last. This case, as *The Times* points out, raised a question of very great importance to owners of property in the metropolis—namely, whether the numerous companies now being projected for constructing underground railways are entitled, under what appears to be a common form clause now introduced into underground railway Acts, to tunnel through the subsoil under houses without being required to purchase the land and houses above. In the present case the defendant Company were incorporated by the Waterloo and City Railway Act, 1893 (which incorporated the Lands Clauses Consolidation Act, 1845), for the purpose of constructing an underground railway from the neighbourhood of Waterloo Station to Mansion House-street, City, and by Section 5 they were empowered to "enter upon, take and use" such of the lands described in the deposited plans and books of reference as might be required for that purpose. Under Section 7 the mode of construction was required to be by tunnels, and by Section 7 the motive power for the traffic was to be either electricity or cable traction. Then Section 36 provided that all persons empowered by the Lands Clauses Consolidation Act, 1845, to convey lands might grant easements. By Section 84 landowners might be required to sell parts only of lands and buildings. Then Section 85 enacted as follows:—

"With respect to the lands described in the second schedule to this Act which the Company are by the provisions of this Act authorised to enter on, take, and use for the purposes of the railway and works, the Company shall not be required wholly to take those lands, or any part of the surface thereof, or any houses, buildings, manufactories, and premises therein, or any cellar, vault, or other construction held or connected therewith, but the Company may appropriate and use the subsoil and under-surface of any such lands, and if the Company require to take, use, pull down, or open any such vault, cellar, or arches, as aforesaid, they may purchase, take, and use, and the owners of and other persons interested in any such vault, cellar, or arches, shall sell the same for the purposes of the railway and works, and the purchase of any such cellar, vault, or construction shall not in any case be deemed the purchase of a part of a house or other building or manufactory within the said section 92 of the Lands Clauses Consolidation Act, 1845. But nothing in this section contained, nor any dealing with the lands in pursuance of this section, shall relieve the Company from the liability to compensation under the 68th section of the Lands Clauses Consolidation Act, 1845, and every case of compensation to be ascertained under this Act shall be ascertained according to the provisions contained in the Lands Clauses Consolidation Acts."

The object of this section was to create an exception to the general law that an owner of land is entitled not only to the surface, but down "to the centre of the earth," as well as "*usque ad calum,*" and therefore cannot be compelled to sell any part of a vertical stratum of his land without being paid for the entire stratum; and also partially to repeal the law as laid down by the Lands Clauses Consolidation Act, 1845, and the numerous decisions upon it, that a railway company requiring to take land having a house upon it is bound to take and purchase not only the land, both surface and subsoil, but the house upon it, and every part of the house. The second schedule referred to in Section 85 described "lands, &c., in respect of which easements only may be taken," the "lands, &c.," being lands and the houses on them situate in the parish of Christchurch, Southwark, and some of which belonged to the plaintiff as tenant for life. In July last the plaintiff received from the Company a notice that they required to "appropriate and use" the subsoil under his property, as shown on the accompanying plan, and at a depth not less than there indicated. The plan showed that the Company proposed to construct their tunnel at a considerable depth below the cellars of the houses above. Beyond this notice the Company had not served any notice to treat or paid or deposited any compensation, or given a bond, as provided by section 85 of the Lands Clauses Act. The Company having recently commenced borings under the plaintiff's land for the purpose of constructing their tunnel the plaintiff commenced this action, and now moved for an interim injunction to restrain the Company from entering upon or under the premises described in the notice, or any other property in the said parish of Christchurch, Southwark, belonging to him until the Company had complied with the provisions of the Lands Clauses Act and the special Act.

Mr. CHANNELL, Q.C., and Mr. METHOLD, for the plaintiff, contended that the word "appropriate" in section 85 of the special Act did not mean appropriate without payment, and that so to construe the section would be contrary to every principle upon which Railway Acts were passed. The Company were bound under the Lands Clauses Act to buy the necessary vertical slice of the plaintiff's land before they could use any part of the subsoil for their tunnel.

Mr. CRIPPS, Q.C., and Mr. INGLE JOYCE, for the defendant Company, contended that section 85 of the special Act had introduced a new procedure applicable to such cases as the present, and intended to supersede the cumbrous machinery of the Lands Clauses Act, while protecting the landowner; that the tunnel would be at a great depth, so that the injury (if any) caused by it would be merely nominal. If, however, any injury should result to the plaintiff, he could obtain compensation under section 68 of the Lands Clauses Act. So that the Company might take the subsoil under their special Act, and leave the plaintiff to compensation under that section.

Mr. Justice KEKEWICH said that provisions drafted by way of exceptions on such a code as the Lands Clauses Act were certain to give rise to difficulties which could not ordinarily be settled without more than one decision. But upon the present case his Lordship confessed he felt no doubt whatever. The defendants, the railway company, were incorporated by a special Act in the usual way, which Act incorporated the Lands Clauses Act. They were authorised to take certain lands, including lands of which a lateral stratum only was required by them in the present instance. Instead of leaving the rights of the Company and the landowner to the operation of the Lands Clauses Act, it seemed good to the Legislature to introduce into the special Act a special provision; but his Lordship thought that this special provision must have reference to the general provisions which were none the less applicable because of the special provision. This special provision was comprised in section 85 of the Company's Act, which began thus:—"With respect to the lands described in the second schedule to this Act, which the Company are by the provisions of this Act authorised to enter on, take, and use for the purposes of the railway and works." Stopping there, that was the ordinary form of language in an Act of this kind. If the Company desired to enter upon any part of these lands in the ordinary way they must proceed in the ordinary way, by notice to treat, to be followed by agreement or otherwise. But the section went on to say that the Company were to be entitled for their benefit not to take the lands in that way, notwithstanding that they required to use those lands for the purposes of their undertaking. The section said, "the Company shall not be required wholly to take those lands or any part of the surface thereof, or any houses, buildings, manufactories, and premises thereon, or any cellar, vault, or other construction held or connected therewith." All those exceptions were directed to the provisions of the Lands Clauses Act which were well known and to which, therefore, his Lordship did not intend to refer, and to the decisions which had construed those provisions. In this section there were no provisions as to what the Company were to do if they did less than "take and use." Mr. Cripps said that this was a question of procedure. As at present advised his Lordship was of opinion that the procedure was precisely the same whether the Company entered on and took and used the lands, or whether they took any part of the lands, which they could not do but for the provisions of this section. He was of opinion that the provisions of the Lands Clauses Act must be treated as incorporated into the special Act for the one purpose quite as much as for the other. But this was only one point made by Mr. Cripps. The section went on to say, "the Company may appropriate and use the subsoil and under-surface of any such lands." It was unnecessary to refer to the next clause, as to vaults, cellars, and arches. Independently of that special provision it was quite clear that the Company could not take any part of the subsoil and under-surface from an unwilling landowner. He might say, "The land is mine from the centre of the earth to the heaven, and if you take any part of the subsoil you must take the whole of the land." In consequence of that right of the landowner this modification of the law was here introduced. The question was—What was the meaning of the words "appropriate and use?" Without referring to the definition of the word "appropriate" in the "Century Dictionary," his Lordship found, what was still better, a definition of it in "Metropolitan Railway Company *v.* Fowler" (App. Ca., 1893, page 416). It was defined by Lord Watson as follows (page 426):—"To appropriate, according to its natural meaning, is to take and keep a thing by exclusive right; and, as I construe their Act, the authority which it confers upon the Company is to take and exclusively possess as much of the subsoil below highways as may be required for the purposes of the undertaking." And it would be observed that the House of Lords held that what the Company took in that case was "land." In taking so much of the subsoil they required, they excluded all other persons, and made it their own. There was no possibility of reverter; it was to belong to the Company exclusively. Leaving the question of procedure, his Lordship would apply the much earlier principle of law, that no one was allowed to take another man's property, notwithstanding it might be required for the general purposes of a public undertaking, without paying for it. Then Mr. Cripps said that the plaintiff might be "injuriously affected" within the meaning of the Lands Clauses Act, so as to entitle him to compensation under section 68. That section covered purchase-money, and was therefore directly applicable to a case of this kind. Unless the Legislature had distinctly said that the

Company might take the subsoil without paying for it, they could not be allowed to do so. On both these grounds his Lordship was of opinion that the Company could not be allowed in any way to deal with this property except upon the terms of their paying a sum into Court. Then arose a question whether the word "appropriate" came within the "possession" clauses in the Lands Clauses Act. As at present advised his Lordship thought it did, though he would not now pronounce an actual decision upon it; but perhaps the parties might not think it worth while to discuss that question. Upon the whole his Lordship held that the plaintiff was entitled to an injunction.

As the parties consented to treat the hearing of the motion as the trial of the action,

His LORDSHIP made a declaration that the defendant Company was not entitled to appropriate and use the subsoil under the plaintiff's property, or any part thereof, until they had complied with the provisions of the Lands Clauses Consolidation Act, 1845, in reference to the compulsory purchase of land. The defendant Company to pay the costs of the action.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

New York, Jan. 25, 1895.

The Great Brooklyn Trolley Strike.—As I write, the strike on the Brooklyn trolley roads, inaugurated ten days ago, seems to be nearing its end, more than half of the cars on the lines concerned now being in operation. The strike affected over 5,000 employés of the various roads, and 7,000 militiamen have been under arms for a week protecting the property of the street railways. The Brooklyn street railway system comprises 48 lines running 1,300 cars, but the trouble after the first few days was confined to three of the larger companies, running normally somewhat over 600 cars. Considerable damage has been done to the cars by the strikers, and the wires have been also cut frequently during the last week, while many motors have been burned out by inexperienced motormen. The real cause of the differences between the strikers and the companies was the demand of the former to be paid a higher proportionate rate for extra than for regular trips. They claimed that the extra duty men were required to be on hand 12 hours and more daily awaiting calls, and yet might only receive pay for a couple of trips at regular rates; furthermore, that by the system of distribution of trips between regular ones and extra trips during the busy hours, their earnings were always less than regular rates. Notwithstanding many excesses committed by the strikers, the sympathy of the public has been largely on their side, but for reasons not directly connected with the present issue. That the immensely valuable franchises possessed by these companies were obtained without proper compensation to the public, or none at all in some cases, through corrupt influences brought to bear on municipal authorities, has been a matter of common notoriety. In addition, the stock of the companies has been so watered, amounting, it is claimed, to as much as 85 per cent. in some cases, that the public, suffering as it does from the inconveniences of the strike, has no sympathy with the claim of these same companies that if the strikers' demands are complied with their dividends will be reduced. The absolute refusal of the street railway authorities to consent to arbitrate the points at issue had also had the effect of increasing the feeling against them. One result of the strike will be to bring prominently to the front the question of municipalisation of urban means of communication. One of the arguments now much used in this connection arises from the enormous expense to the public of such strikes, in this case amounting to over $20,000 per day for militia and other direct expenses, and altogether, computing losses in trade and otherwise, to $100,000 daily, or as much each day as it would cost the companies yearly if they acceded to the demands of the men.

The Law Courts and Patents.—The last several years have witnessed a great change in the interpretation of patent law by the Federal bench, which is illustrated by the annulment of the feeder-and-main and the Berliner patents, the Field and Adams street railway patents, and, more recently, the Thomson-Houston arc regulator patent. In the Berliner patent the law applied which was recently established by the Supreme Court, to the effect that a patent could not be legally granted on claims that referred to an invention previously patented, no matter how much more broad the later ones might be. This decision at once swept away the former practice of multiplicity of claims and patents on the same subject matter. In the Field and Adams cases it was decided that the obvious combination of well known elements to constitute a street railway system did not imply invention. In the feeder-and-main and arc regulator decisions it was held that the inventors' claims were merely adaptations of known means to particular ends, and not new conceptions of either principles or mechanisms.

Resuscitation from Electric Shock.—The Warden of Sing Sing prison has asked Dr. A. H. Goelet and Mr. A. E Kennelly to be present at the next electrocution in that prison, in order that they may obtain the necessary data for a report bearing on the claims of d'Arsonval and some sensational American followers to the effect that electrocution as practised in New York State merely produces apparent and not true death.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "**THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK** will be **READY ON MONDAY NEXT.** Subscription orders can be received up to that date. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Although about 100 pages are added to the book, no addition is made to the price, which is 5s. (by post 5s. 9d., abroad 7s.) before publication; after publication 7s. 6d. post free 8s. 3d., abroad 9s.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices*:—

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is just out, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

THE LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, presented with our issue of January 4th, can be obtained mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s.—each post free. The Map showing positions of Supply Stations is mounted on the back of the Table. The Coloured Map issued with the January 18th number and the Electricity Supply Statistics issued with the present number, are also mounted on some copies, and the price of these, complete, post free, is 5s.

LABORATORY NOTES AND FORMS.—With the above title, we have in the press a set of Elementary (now ready) and Advanced Exercises (ready shortly) for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. net., is now ready.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

TENDERS INVITED.—The Vestry of the parish of St. John, Hampstead, London, N.W., require tenders for works and materials for their Electric Supply Station for one year from March 26th next. Some particulars will be found in our advertisement columns. Tenders must be sent in by Feb. 14th. Mr. A. P. Johnson, Vestry Hall, Hampstead, is vestry clerk.

Tenders Invited.—The Vestry of St. Mary, Islington, London, invite tenders for the supply of alternate-current meters and converters. Full particulars can be obtained on application to Mr. Albert Gay, electrical engineer, 50, Eden-grove, Holloway, N., on or after the 13th inst. Some further particulars appear in our advertisement columns.

—— Our advertisement columns contain a notice that the Weybridge Urban District Council invite tenders for the public lighting of the district on and after September 29th next. Tenders, stating the number of public lights proposed, the illuminating power and price per light, must reach Mr. George Wheeler, the clerk *pro tem.* to the Council, before February 20th.

Tenders Accepted.—The Bristol Corporation have received 17 tenders for the electric lighting of the Guildhall, and, upon the recommendation of Mr. H. Faraday Proctor, the Corporation's electrical engineer, have accepted that of Messrs. Ball and Co. The following were the tenders received :—

F. W. Ball and Co., Unity-street, Bristol	£438
Waring and Son, Manchester	440
Fowler, Lancaster and Co., Birmingham	444
Manchester Edison-Swan Company, Manchester	444
Willway, Bristol	463
Palmer, Bristol	475
Baker, Newport	489

Other tenders above the last-mentioned sum were as follows :— £500, £517, £569, £585, £626, £645, £693, £778, £812, and £1,120.

—— The Metropolitan Asylum Board have received the following tenders for lighting the North Western Hospital by electricity :—

F. A. Glover and Co....	£2,667	18	0
Crompton and Co. (Limited)	2,575	0	0
T. Potter and Sons (Limited)	2,198	0	0
Brush Electrical Engineering Company (Limited)	1,900	0	0
Strode and Co.	1,827	0	0
Gilbert and Co.	1,567	0	0
Fowler, Lancaster and Co. (Limited)	1,467	19	6
Roger Dawson (Limited)	1,450	0	0
Graham and Biddle	1,392	10	0
Paterson and Cooper	1,355	0	0
J. Sax and Co. (Limited)	1,335	0	0
Vaughan and Brown (accepted)	1,239	0	0
H. Thorpe and Waring	1,180	10	0

In addition to the amounts shown, a short schedule of prices is added to each tender, arranged in accordance with the advice of the consulting engineer (Prof. Ayrton), whose estimate for the whole work was £2,116, including about £900 for the laying of some of the mains which the Vestry of Hampstead have now undertaken to do, and for wiring buildings not yet erected.

—— The Committee of the Free Library Museum of the Newport Corporation have received the following tenders for an installation of the electric light in the new museum building :—

Fergus and Co., Cardiff	£141	5	6
Hatcher and Co., Cardiff ...	95	0	0
Newport Electric Lighting Company	93	0	0
John Davis and Son, Derby	88	0	0
Alger and Son, Newport	83	10	0
Arnold and Co., Newport	80	0	0
W. A. Baker and Co., Newport	74	0	0
Allam and Co., Cardiff (accepted)	46	10	0

—— The tender of Messrs. Spagnoletti and Crookes (Burnley branch) has been accepted for lighting by electricity the Stanley-street Chapel, Nelson, Lancs. Fifteen tenders were sent in.

Works for Sale.—Messrs. Wheatley Kirk, Price and Goulty, of Albert-square, Manchester, have for disposal by private treaty a small engineering works in Salford, some particulars of which will be found in our advertisement columns.

Vacant Appointment.—The Gas and Electricity Committee of the County Borough of Salford require two switchboard attendants for their central station. Applications must be sent in before 5 p.m. on Thursday, the 14th. Further particulars are given in our advertisement columns.

Bankruptcy.—A receiving order has been issued in the estate of Walter Andrea, trading as Walter Andrea and Co., 132, Hurlingham-road, Fulham, and 62, Vauxhall Bridge-road, London, S.W., electrical engineer.

—— A receiving order was last week made against Mr. J. Torr Todman, electrician, late of 11, Queen Victoria-street, and Bermondsey-street, London. Mr. Todman is now in Colombo, Ceylon, and no particulars of his affairs has transpired.

—— A supplementary dividend of 3d. in the pound has been declared in the estate of Messrs. Austin and Myers, 7, Florence-terrace, Armley, near Leeds, manufacturing electricians.

Bankruptcy.—In the bankruptcy of Messrs. Woilliard, Scarborough and Co., lately trading at Wade-street, Halifax, as electrical engineers, a first and final dividend of 2s. 10¾d. in the pound will be payable at the Official Receiver's, Halifax, to-morrow (Saturday).

Liquidation.—An order was made in the High Court on Monday last, for the winding up of Priestman Bros. (Limited), under the supervision of the Court.

Removal.—We are asked by the Electrical Accessories Company (Limited) to notify that their sole address for works and offices is Teddington, Middlesex. Arrangements have been made with Messrs. Swinburne and Co. to represent the firm in London at 66, Victoria-street, S.W., where samples and stock will be kept.

Business Changes.—Mr. D. F. Adamson has disposed of his electrical engineering business carried on at 72, Finsbury-pavement, London, E.C., to Messrs. E. P. Allam and Co., of 49, Finsbury-pavement, and 16, Albert-chambers, Cardiff.——Owing to increase of business, Mr. Salisbury Jones, of 33, Old Broad-street, London, E.C., has taken into partnership Mr. Guy L. Bidwell, and the business will in future be carried on under the style of "Salisbury Jones and Bidwell."

Business Notice.—Messrs. W. T. Glover and Co. have appointed Mr. Walter Blenkarn to represent them in the western, southern and eastern counties of England. Mr. Hartford takes the northern counties.

Sheba Mines Electric Transmission Plant.—Messrs. Johnson and Phillips have just issued an illustrated account of the power transmission plant installed for the Sheba Mines in South Africa. Included in the pamphlet are a number of illustrations of the machine shops at Charlton.

Mr. W. H. Preece, C.B., F.R.S.—An interesting account of the career of Mr. W. H. Preece, with portrait, appears in *Lloyd's Weekly Newspaper* for February 3rd.

Brush Central Stations.—We have received from the Brush Company a well-printed and fully illustrated account of five central stations which have been supplied with Brush plant and apparatus. These include Huddersfield, Hanley, Lancaster, Worcester, and Windermere.

Lamp-Holders.—Messrs. Evered and Co. forward a sample of their new patent revolving switch lamp-holders, the advantages of which are that there are no keys projecting; they are small in size; the switch action is easy and simple, a milled ebonite ring taking the place of the usual key; the ring works in one direction; the break is quick; and the wiring is very simple.

Electric Hot-Plates.—Messrs. Crompton and Co. have added to their Brompton-road specialities the supply to hotels, restaurants, &c., of electrical hot-plate for keeping food warm when supplied to customers. One restaurant in the West End proposes to adopt the system, and to supply an electric hot-plate to each customer. By the present system the plates get gradually colder and colder, and the latter part of the meal is seldom as satisfactory as the first; this the electric hot-plate will rectify. It is found that a circular hot-plate 8in. in diameter may be maintained at 212°F. for an expenditure of one ampere at 100 volts at a cost of less than ½d. per hour. As the plates are not strained in reaching this comparatively low temperature, their durability should be great. Another method is sometimes adopted—that of using a quick heating-plate, which is connected-up when the order is given. The plate becomes hot in a couple of minutes, and is then used in the same manner as a hot-water plate. In the latter case no connecting wires are required on the table, the plate being previously heated from some convenient spot. It is found that the plates retain their heat for a considerable time.

D. P." Batteries.—Messrs. Johnson and Phillips have just issued a new illustrated price list of D.P. batteries, giving full particulars of the advantages claimed. The list includes prices of storage battery accessories. It may be mentioned in regard to the prices of these batteries that the firm have decided to pay carriage to any part of Great Britain, which is, of course, equivalent to a reduction in price. Owing to improvements recently made, the discharge rates of these cells are claimed to be nearly 20 per cent. better than formerly. It has been decided in future to associate the word "Durability" with these batteries, "six miles of which have been supplied during the last three years."

Aberdeen.—The Town Council have forwarded a memorial to the Secretary for Scotland on the question of the telephone service. It is pointed out that the question of applying for a licence to empower the Council to establish a telephone exchange service for the city is now under consideration of a Committee specially appointed. The Council asked the Government to estimate the working of the telephone service, or to allow municipal authorities to obtain a licence to establish exchanges within the areas under their control. If, however, arrangements are to be entered into by the Government with the Telephone Company, the Council submit that due provision should be made:—(*a*) for safeguarding the rights of municipal authorities, and preventing any telephone company from interfering with the streets in any way, or to any extent, without the express consent of the municipal authority; (*b*) for the protection of the public with reference to obligation as to supply, maximum charges, and maximum dividends; (*c*) for enabling the municipal authority to inspect the works of the licencees, and see that they are maintained in proper order; (*d*) for requiring telephone companies to adopt the system of twin wires or metallic circuits.——Mr. A. S. Blackman is at present supervising the working of the central station, and is one of the applicants for the position of electrical engineer rendered vacant by the appointment of Mr. E. T. Ruthven Murray to Worcester.

Birkenhead.—The Parliamentary Committee of the Town Council have decided to recommend that opposition be made to the Bill now before Parliament, authorising the Mersey Railway Company to work the traffic of their railways by electrical or other motive power.

Birmingham.—At the meeting of the City Council on Tuesday the report of the Technical School Committee was presented, and a proposal made that the sum of £6,080 be provided for electric lighting and fittings, and motive power for the institution, and that for this purpose and for the purchase of additional apparatus and appliances, &c., a sum of £27,420 be borrowed. With regard to the tenders received for lighting the school, Mr. Bradley proposed that the committee be instructed to accept the lowest tender. He complained that a tender not the lowest had been accepted, although the lowest received was from a Birmingham firm. A further amendment that the consideration of the committee's report be adjourned, and that the committee be instructed to report further upon the various tenders received for the supply of electric power was discussed, and was ultimately agreed to.

Burnley.—At the Town Council meeting on Wednesday, Councillor Bayne asked if there was any probability of the charge for the electric current being reduced. Alderman Colling replied that he could hold out no hope of reduction, as the works had only just begun to pay their way. He pointed out that in all neighbouring districts the charges were much heavier than at Burnley. Neither was it proposed to reduce the price of gas for power purposes. The finances were not in a position such as to warrant any reduction.

Cardiff.—It was announced at the last meeting of the Corporation that Messrs. Siemens Bros. and Co., contractors for the plant and machinery at the electric lighting station, will be prepared to hand over the station to the local authorities in from three to four weeks' time. Mr. Harpur, the borough engineer, applied to be relieved of his duties at the Canton station, leaving him only the work of supervision. This was agreed to, and Mr. Franklyn, at present acting for Messrs. Siemens Bros. and Co., is to be approached, with the object of securing his services at a salary of £200 per annum.

Chester.—The Mayor, Mr. W. H. Churton, took the opportunity at a recent dinner, in replying to the toast of "The Mayor and Corporation," to reply to some criticisms by Mr. Alderman Gilbert on the Corporation's electric lighting scheme. He complained that Mr. Gilbert, instead of giving his views and assisting the Electric Lighting Committee to arrive at a satisfactory understanding in regard to the scheme, reserved his remarks for the interviewer, and in this manner robbed his fellow-Committeemen of the opportunity of replying to his adverse comments. He further complained that the position of Chairman of the Finance Committee tended to narrow a man's views on all questions affecting the Corporation's expenditure. No doubt it was very necessary to consider the question of pounds, shillings and pence; but this was not all. They ought to approach important questions like those of lighting and sanitation from a broader point of view. The Mayor's opinion was that in the early stages of their electric lighting undertaking it would not prove a paying concern, but that it would ultimately pay he felt no doubt. So far as electric light was concerned, there was, however, another view to be taken. It was a healthy light, and its adoption tended to the general benefit. The points urged against the electric light had, years ago, been adopted in reference to gas, and that was why the gas works at Chester were not under the control of the Corporation. The electric light question was one which should be dealt with by the Corporation alone. The Council, and especially the Electric Lighting Committee, had devoted great attention to the whole subject, and he hoped before another winter came upon them that the citizens would be enjoying the many advantages of the electric light. These advantages were so palpable that he did not propose to dwell upon them. With regard to the incandescent gas light, some people thought this would obviate the necessity for the electric light. He did not think so. He had the incandescent gas light in his own house; but it was very delicate, and would not stand regular wear.

Church Lighting.—The Mission church at South Quay, Yarmouth, is now lighted by electricity, the work being carried out by Mr. A. T. Durrant, of Great Yarmouth.——The Roman Catholic Church of SS. Peter and Paul, North-street, Wolverhampton, is now lighted electrically.——The First Presbyterian Church, Rosemary-street, Belfast, a fine old building, around which many interesting historical associations cluster, was lighted for the first time by electricity on Sunday last. This is the first church in Belfast into which the electric light has been introduced.

Country House Lighting.—Elveden Hall, the Norfolk residence of Lord Iveagh, has been fitted throughout for the electric light by Messrs. Edmondsons (Limited) under the superintendence, as consulting engineer, of Mr. A. A. C. Swinton. The installation comprises about 500 incandescents, and the plant includes a double battery of accumulators. The plant, in addition to the lighting, supplies power for working a pump for supplying the house with water.

Derby.—The Town Council have recently placed an order fo 100 electricity meters and five additional transformers.

Devonport.—The extensive engineering works of Messrs. Bickle and Co. (Limited), at Western Docks, have recently been fitted throughout for the electric light by Mr. John Harris, of Devonport. The lamps are fitted so as to give the workmen the full advantage of the light, and can be utilised also as pedestal or hand lamps.

Eccles.—At the last Town Council meeting, Mr. Alderman Kendall moved the adoption of the report of the Town Hall, Tramways, and Electric Lighting Committee, which stated that "having carefully considered the question of the advisability or otherwise of carrying out the powers conferred upon the Council by the Eccles Electric Lighting Order, 1893, and the information and advice which they have received on the subject, the Committee are of opinion that the time has arrived when the Council may safely proceed with a scheme for electric lighting in the borough." At present between £1,200 and £1,400 a year was spent in lighting the streets of the borough by gas, equal to a rate of about 3½d. in the pound. An eminent authority said that a saving of something like £300 a year in the cost of street lighting would follow the adoption of electricity. Many other towns were adopting the electric light, and he thought Eccles should follow the example. A long discussion ensued, and ultimately the minutes were approved.

Eton.—A meeting of the Urban District Council was held last week to discuss the question of giving consent to the application of the Windsor Corporation for an Electric Light Provisional Order, which gives power to the Corporation to include the Eton area in the district of supply. The Eton authorities have taken counsel with their legal advisers, who recommend that sanction be given. In connection with this Order, the Windsor Corporation will, of course, at the exiration of 42 years, be called upon to transfer to the Eton Local Authorities its interest in the Eton section of the lighting scheme. This is, we think, the first occasion when a Corporation has, by obtaining a Provisional Order, placed itself in a position coincident with that of a public supply company, so far as the transfer clauses of the Provisional Order are concerned. Consent to the application was unanimously accorded.

Exeter.—The Museum Committee of the Corporation desire that the art galleries shall be lighted by electricity at an estimated cost of £330. The matter has, however, been referred back in order that a report may be presented showing the difference of cost between gas and electric light.

Fareham.—The resolutions recently passed by the Urban District Council in reference to the cancellation of the offer to purchase the undertaking of the Fareham Electric Light Company have been forwarded to the Local Government Board as a reply to the letter from the Board referred to in our last issue. At the last meeting a resolution was passed confirming the offer to the Company of an additional £150 per annum for lighting the town until the termination of the Company's existing contract in September, 1896. After a discussion the motion was rejected on the casting vote of the Chairman.

Fire.—The electric lighting plant at the docks at Penarth, the property of Messrs. J. B. Saunders & Co., was destroyed by fire on Wednesday.

Folkestone.—The Local Authority of this town seem to be gradually approaching a little nearer the final consideration of an electric lighting scheme. Some time back Mr. F. H. Medhurst was consulted by the newly-appointed Electric Lighting Committee, and has now submitted a scheme for their consideration. It is estimated that this scheme will involve an outlay of £19,000, which sum includes the erection of a dust destructor by which a considerable saving is to be effected in the treatment of the town refuse.

HAMPSTEAD (LONDON, N.W.).—It has been decided to light the town clock by electricity at an annual cost of £31. 10s. It has also been decided to purchase 73 electricity meters, at an estimated cost of £320. 3s., and further supplies of cable, connection boxes, automatic clock switch, &c., making a total outlay of £624. 13s. 10d.

ISLINGTON (LONDON, N.).—At the last meeting of the Vestry a motion was made covering a formidable set of nine questions on electric lighting subjects. This motion was made by Mr. Varley, one of the members, and a candidate for the appointment of electrical engineer to the Vestry which was secured in competition by Mr. Gay. The questions included in the motion covered the items of finance, building construction, engine, boiler and dynamo capacities, and generally a detailed statement and description of the electric plant which it is proposed to put down. It was pointed out to Mr. Varley that the Vestry had no officer, except Mr. Gay, who could prepare such a report as was asked for in the motion, and Mr. Gay was fully employed in superintending the heavy work now in progress. Mr. Cussans pointed out that a very small percentage of the members of the Vestry knew anything about electricity, and if Mr. Varley's motion were carried a great expense would be incurred without any adequate return. "Providing them with such a report would be like presenting a gold chronometer to a periwinkle." The motion was ultimately negatived, only six members supporting it. The Chairman of the Electric Lighting Committee estimated that the cost of preparing the report would be about £130, and that it would probably take four months to prepare.

KILLARNEY.—A meeting was to have been held of the Town Commissioners to consider the verdict given by Judge Shaw in an action brought by the Killarney Electric Lighting Company for the amount of their account, and which resulted in a judgment in favour of the Company's claim. It would appear, however, that the members of the Commission who were responsible for a defence being lodged against the claim are not anxious to discuss the matter. They were absent from the meeting of the Commissioners, and a quorum, on that account, could not be formed. The ratepayers are dying for an opportunity of exhausting of the indignation they feel in the matter, and it is not unlikely that there will be an unpleasant quarter of an hour for somebody at the next meeting. In the meantime it is stated that proceedings are about to be instituted by "a professional electrician" against one of the leading local public men "for having alleged that the electric light had proved a failure in a northern city, where at the time it had not even been brought into operation."

LANCASTER.—Mr. Alderman Smith, at the last meeting of the Town Council, reported that satisfactory arrangements had been made with the representatives of the Brush Company, under which the Company were prepared to arrange for the continuance of their contract. The notice from the Corporation to the Company, dated October, 1894, with reference to the completion of the works, is withdrawn.

LECTURES.—The first of a course of lectures by Mr. A. P. Trotter to the pupils and staff of Messrs. Crompton and Co. was given at Chelmsford on Monday last. The subject was "Accuracies and Errors."——A lecture was last week delivered at Walkden by Mr. G. R. Pears on "Electricity and Mining" before the members of the mining class in connection with the Walkden Technical Instruction Committee. A large audience appreciated the lecturer's efforts.——Mr. H. Kilgour, electrical engineer to the Cheltenham Corporation, recently lectured at the Working Men's College on "Electrical Energy and its Distribution." Great interest was taken in the lecture by a large audience, and at the close the lecturer explained the working of the apparatus he had brought to illustrate his remarks. A cordial vote of thanks was accorded.

LEEDS CITY COUNCIL AND THE TRAMWAYS.—A special meeting of the Leeds City Council was held on Wednesday afternoon for the purpose of confirming the decision arrived at by the Corporation a month ago to promote "a Bill to empower the Mayor, Aldermen, and citizens of the city of Leeds to construct additional tramways, and for other purposes." The resolution was carried by 46 votes to 1.

LIVERPOOL.—At the meeting of the City Council on Wednesday Mr. Williamson moved, and Mr. Alderman Hughes seconded, the following recommendation of the Special Lighting Committee:—"That the Council consent to the application by the Liverpool Electric Supply Company (Limited) for a Provisional Order to carry out the arrangement made with the Company at the inquiry on the proposed extension of the city boundaries, provided such Order is withdrawn if the Order for the extension of the city boundaries is not confirmed by Parliament in the ensuing session, and that the Council object to the application for any other purpose."—Alderman Smith, the Chairman of the Lighting Committee, opposed the motion, which was, however, adopted by the Council. Subsequently Mr. A. Taylor raised an objection to the resolution passed by the Lighting Committee that the Council should enter into competition with the Liverpool Electric Supply Company within its own area. He moved that the proceedings of the Committee be approved with the exception of the resolutions of January 14th and 21st, and that the Lord Mayor be requested to countermand the summons for a special meeting of the Council on March 6th, as previously announced. Mr. Williamson considered the action of the Committee in proposing to compete with the Company in the supply of electric current to private consumers a most unfortunate step, in view of the negotiations for purchase of the Company's undertaking which were then in progress. After some discussion the amendment was carried, and the offending resolutions of January 14th and 21st are therefore quashed. There will be no proposal made for application for a Provisional Order, and therefore no meeting on March 6th to discuss the subject.

MANCHESTER.—At the meeting of the City Council on Wednesday, Mr Alderman Gibson, Chairman of the Gas and Electric Lighting Committee, presented recommendations for the abolition of gas meter rents, and the reduction of the price of gas for other than illuminating purposes from 2s. 6d. to 2s. per thousand. The Committee (said the speaker) were desirous of making the electric current as cheap to shopkeepers as it could possibly be made. That was one great object of the Committee, but on this occasion he asked that the Committee should not be handicapped by being compelled to make the charge for electric current 6d. per unit all round. He was desirous of attracting a larger number of customers to the use of the electric light, and thus enabling the Committee at a future date to supply shopkeepers and other larger consumers with current at a reduced price. It would be the turn of the shopkeepers and other large users of gas and electric current for lighting purposes, he hoped, at an early future occasion. Mr. Alderman Higginbottom, in seconding the adoption of the Committee's recommendations, pointed out that the demand for the electric current had been so great that the Committee were authorised to borrow a further £100,000 for the extension of the plant. The revenue for the past year in the electricity department has gone up by leaps and bounds, and had amounted to no less than £26,629, and this notwithstanding that the works had only been supplying current for about 20 months. Already this left a net profit to go to the reduction of the city rates of the large sum of £7,730. Mr. Richards moved an amendment reducing the price of gas 3d. per thousand for all purposes. This led to a long discussion, and the amendment was ultimately carried by 63 to 14, after Mr. Alderman Gibson had pointed out that the passing of such an amendment would have a serious effect upon the consumption of electric currents, and that, instead of gas and electricity working side by side in a friendly way, to the general benefit, the large reduction proposed in the former would lead, he felt, to undue and injurious competition between the two illuminants.

OFFICE LIGHTING.—Messrs. Drake and Gorham have received an order to fit up the North-Eastern Railway Company's new London offices at Great George-street, Westminster, for the electric light, current being taken from the Westminster Company's mains.

PALACE LIGHTING.—Great alterations have recently been made in the Berlin Royal Palace. The White Hall has been enlarged and several new exits added, and the electric light has been installed throughout. The Ritter Hall is now lighted throughout by electricity, and the work has called for the exercise of exceptional taste in designing the fittings to suit the magnificent services with which the hall is furnished. The throne is now specially lighted by incandescent lamps in the form of crowns. The work is said to have given the Emperor the greatest satisfaction, and it is admitted that many of the alterations and improvements effected would have been impossible without the aid of the electric light.

PORTSMOUTH.—The annual meeting of the Portsmouth Incorporated Chamber of Commerce was held last week, and an important discussion arose on the question of the disturbances to the telephone service caused by the Corporation's electric lighting system. Mr. J. Brickwood, the president, pointed out that the matter was a serious one for the subscribers to the telephone, and it was estimated that between £400 and £500 would have to be spent in order to make the telephone service effective; and the question now under discussion was, who was to bear the expense. Experiments had been made at Portsea with satisfactory results, and it was hoped that before long subscribers would again have an effective service at their command. It was decided to defer the further consideration of the subject for the present.——The Town Hall Committee have agreed to recommend the Portsmouth Corporation to accept the offer of £200 for the machinery formerly used for the electric lighting of the Town Hall. The cost of the plant originally was over £1,900.

Southampton.—The County Council have received a letter from the legal advisers of the Southampton Electric Light Company, and a draft of the Provisional Order now being applied for. It will be remembered that sanction was given by the Council to the Company's application, with a condition that the period for negotiations for the purchase of the Company's undertaking should be extended from six to twelve months. This condition the Company cannot agree to, but have decided that if, at the end of six months, there is a fair prospect of the purchase being carried out, additional time shall be allowed to bring the negotiations to a successful issue.——The Hartley Institution has been presented by Mr. W. H. Preece with a valuable set of electrical apparatus as a first instalment of a collection promised by him some time ago. Mr. Preece proposes to complete the collection in due course.

Stafford.—At Tuesday's meeting of the Town Council, Alderman Peach stated that the Electric Lighting Committee had decided to recommend the Brighton system of charging for electric current—*i.e*, 8d. per unit for the maximum hours in which the current was used, and 4d. per unit after this maximum had been passed.

St. Pancras (London, N.W.)—The Electricity Committee at the last meeting of the Vestry urgently recommended the extension of the arc lighting to additional thoroughfares, and the work is to be carried out forthwith.

Tiverton.—At Wednesday's meeting of the Town Council, Mr. J. Thorne, Chairman of the Electric Lighting Committee, proposed the purchase of the gas works from Messrs. Heathcote and Co. for the sum of £20,000. The proposal was adopted by 19 votes to two.

Westmoreland (South).—The District Council discussed an application from the Windermere Company for the Council's consent to the application of the Company for a Provisional Order for lighting a portion of their district by electricity. Opposition was raised to the proposal by several members, it being pointed out that the authorities of Kendal (a neighbouring district) were considering the advisability of themselves putting down an electric lighting installation, which would probably enable the South Westmoreland District Council to obtain current under better conditions than those offered by the Company. The matter was left for further discussion at the next meeting.

Weston-super-Mare.—In the report presented by Mr. F. H. Medhurst to the Local Authority of Weston-super-Mare he points out that by combining a dust destructor with the scheme for electric supply the two schemes combined "will actually come cheaper to the ratepayers than that of electric supply alone." Mr. Medhurst is stated to be confident that the combined scheme will prove a profitable one from the commencement. As the town already possesses a Provisional Order, it is likely that Mr. Medhurst's suggestions will receive the support of the Town Council.

Wigan.—A long discussion took place at the last meeting of the Town Council on the recommendation of the Sub-Committee appointed to make inquiries as to the best system of electric supply for the borough. The Sub-Committee recommended that the scheme of Messrs. John Fowler and Co., of Leeds, should be adopted, the cost of the plant being put down at £7,931. Objection was taken to this recommendation on the ground that the work should be kept in the town. Ultimately the Committee's recommendation was referred back for reconsideration.

Worcester.—At the monthly meeting of the City Council Mr. Williamson stated that the total loss on the electric lighting works for the first quarter was less than £100, and held out strong hopes that by next winter the scheme would be actually earning a profit. The statement was received with loud applause.

COMPANIES' MEETINGS AND REPORTS.

City and South London Railway Company.

The twenty-first ordinary general meeting of the proprietors of this Company was held at Winchester House, Old Broad-street on the 1st inst., under the presidency of Mr. Charles Grey Mott.

The SECRETARY (Mr. W. F. Knight) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN: It now becomes my duty to move the adoption of the report and accounts. I think you will agree with me that during the past half-year the line has made, on the whole, very satisfactory progress. During that time the ordinary passengers, exclusive of season ticket holders, have increased by 182,298 over the same period of the previous year, and, in addition to that, there are 163 more season ticket holders, which, taken at 350 journeys each, gives us 57,200, or a total of about 240,000 passengers. That is a considerable increase in the traffic on this line. You know that in the early stages of this undertaking we had a very great deal of prejudice to overcome. There was the prejudice, in the first place, that the railway was so far underground that people would be frightened to travel by it; and it was also pointed out that it was worked by an unknown and unusual power, and that the people using it had to go up and down in lifts. All these combined together seriously to affect the traffic which we ought to have. Year by year since that time it has been our endeavour to get rid of that prejudice as regards all these questions, and I am glad that, although it is not gone, it has immensely diminished, for we have been able to show that the line was perfectly safe, that it was a comfortable mode of conveyance, that it was absolutely punctual, that the lifts were perfectly safe, and that there was no danger whatever from the electrical power. The result has been that people, finding the advantage of this railway, have come to live in the districts served by it, and where there were formerly rows of empty houses you now find them occupied. Where formerly one house stood with a garden are now streets with hundreds of houses; and the increase of our season ticket holders shows distinctly the permanence which they attach to the line. One of the most important questions, and one of the most anxious questions with us, has always been in connection with the lifts. Of course, an ordinary railway has nothing whatever to do with such a question, but with us nearly the whole of our passengers travel up and down by means of our lifts. When I tell you that since the opening of the line our lifts have gone up and down two and a-half million times and carried nearly 25 millions of people with safety and ease, and without the fatigue of their going up and down stairs, you will see what an enormous benefit these lifts are to those using the line; but they involve constant and careful watching. We have more than 100 ropes, which must be carefully inspected every day, and we have valves without end. All these things are matters of constant attention and careful watching on the part of our officers; and the fact that our lifts have gone up and down two and a half million times without the slightest accident or difficulty of any kind reflects the greatest possible credit on our officers who have them in charge. In regard to the question of the traffic on a line of this kind, one of the great questions of electrical traction has been, as I have told you before, that the locomotives, the machinery used in producing and working it, requires very little wear and tear. Many of our electrical locomotives have already run more than 150,000 miles each, and they are practically little or no worse than they were on the day they started. Of course, there are small repairs to be done, but, to all intents and purposes, they show very little sign of permanent wear. If, however, you had run a steam locomotive 150,000 miles, it would want a great deal of repair, and very heavy repair. This will show you one of the advantages which we shall derive in the future in regard to this railway from its electric working. Before I say anything further respecting our affairs I will deal with the accounts. First, as regards the capital account, we have paid off £9,100 of our debenture bonds during the half year, as well as a loan of £1,000 which we had on our books at the commencement of the half-year. These debenture bonds have been substituted by debenture stock, which was practically issued at a trifle over 3 per cent. In addition to that we have issued Preference shares to the amount of £4,100, and Debenture stock to the extent of £2,841, and we have received in premiums on the issue of the stock £3,238, making a total of £10,179. We have spent in the half-year £2,396, which has chiefly been expended on rolling stock and the new motor-power trains. Out of the balance of £7,783 we have increased the balance at our bankers' by £5,850, we have paid off the loan of £1,000, and we have reduced outstanding accounts by £1,574, which more than accounts for the capital raised. The increased balance at our bankers' was provided for the purpose of paying off the old Five per Cent. Debentures, a good many of which have been paid off in the past month, and we are borrowing the money at a little over 3 per cent. The capital account is this time also reduced by the transference of the balance of an account called construction reserve. This has been standing for some time in the books, and it has been decided by our auditors that the better plan would be to write it off the capital account, which has been done, so that this account has only increased by a few hundred pounds in the half year. Taking the revenue account, the receipts from passengers show an increase of £1,332 compared with those of the corresponding period of last year, and season tickets exhibit an increase of £140, making the total improvement in our passenger receipts £1,472. Receipts from parcels show an increase of £24 and from transfer fees £13. On the other hand, there is a decrease of £51 in rents received on account of one or two of the shops being only partially tenanted, and a decrease of £27 in sundry receipts. This leaves a net increase in the receipts of £1,431. The expenditure, on the other hand, shows a decrease in maintenance of £37, and in the locomotive department there is a saving of £23. Traffic expenses have been less by £43, carriage repairs are down £73, and law charges show a saving of £9. On the other hand there is an increase of £26 in general charges. There is thus a net decrease of £159 in ordinary expenditure. Unfortunately, that advantage is entirely absorbed by an increase in rates and taxes. That is an item which, as you all know, is going on constantly increasing in all undertakings. Where it is going to stop I do not know; but it is getting to be a very heavy burden indeed. It is, however, a matter that we are powerless to deal with. The result of all this is that there is a balance carried to net revenue of £9,490. Then, interest account has given us £62, and the balance brought forward was £1,367, making a total available balance of £10,919. The debenture interest absorbed £4,148, leaving a balance available for dividend of £6,771. Out of that we pay the Preference shareholders 5 per cent., or £1,884, and the Consolidated stockholders it is recommended should receive a dividend at the rate of 1¼ per cent. per annum, or £3,937, leaving a balance to carry forward of £950, which compares with the balance carried forward a year ago of £1,064, when, however, the dividend, as I daresay you are aware, was exactly half the amount which we pay this time. The result is that our working expenses, which were at this time last year 64·6 per cent., have been reduced to 60·9 per cent., or if you take off, as we usually do, so as to compare ourselves with other railways, the cost of the lifts, our working expenses are reduced to about

51 per cent. The locomotive expenses per train mile have come down now to 6d., against 6·22d., or if, in order to compare with the large lines coming to London, we take off the carriage of coal, and reckon it at its cost at the pit's mouth, our locomotive expenses per train mile are reduced to 4¼d., compared with 8¾d. on the large steam railways. Our trains, however, are small. All these amounts, both working and locomotive expenses, I hope we shall get down still further. The number of trains run during the past half year has been 73,208, against 71,143 last year, or an increase of 2,065 trains, and the miles run have increased to 230,604, from 224,101 last year, or 6.503 train miles more. Despite the increase of train mileage, I am happy to say the receipts per train mile have increased from 2s. 0½d. to 2s. 1⅕d., and the receipts per passenger have increased from 1·66d. to 1·77d. this year. We have, therefore, the satisfactory conditions of increased receipts and diminished expenses of working. I may also tell you that our increased number of passengers this half-year of 240,000 would have been larger by tens of thousands had we not raised our fares. We raised them about two months before the close of the half-year, with the result I have mentioned—that we sent away tens of thousands of people. The question with us is, What are we going to do in the future? It is clear that if we cannot carry our passengers—they are mostly residential—and cannot carry them to the City between the hours of 8 and 10 o'clock in the morning, they will be compelled to go and reside somewhere else where they can reach the City between those hours, and the result will be that we shall not only lose these passengers, and the receipts from them, but also the traffic during the rest of the day which we now get from their families, their friends, and all who, for business reasons, go to and from these houses. This traffic, too, forms our mid-day traffic. It is, therefore, essential that something should be done in order to provide accommodation for these people, who are coming more and more to reside in our district, in order that they may be able to get to their business every morning. We have altered our signals and done all we can to increase the number of our trains; but now, under the regulations of the Board of Trade, and under the peculiar circumstances of having a terminal station with only one line of rails and with two lines of rail converging into it, we cannot see our way to increase the number of trains run. The question then arising is, can we not increase the size of the trains? With that view we have been endeavouring to get rid of the locomotive and to get another carriage on the train. We were met with very great difficulty in this matter, for although it is very easy to put on motive power to a carriage when it is running in the open air, when you have to put it on to a carriage which is lower down than usual, and which, on account of the size of the tunnels, cannot be raised at all, the matter assumes a different aspect. It has only been by constant experiments and great ingenuity on the part of our engineer that he has been able to devise a system by which, without raising the carriage, he has been able to put under it the motive power which was required. I am glad to say that after many experiments we have at last got a train successfully completed. The Board of Trade officers have approved it with some very slight alterations, which are now being made, and we hope to be able to put it into running, so as to test it completely with passengers, in the course of a few days. The advantage of that train will be that we shall get another carriage; but we do not get a full carriage load of passengers in addition, because we have to take off each of the carriages at the end a space for the engine driver and his assistant, and for the mechanism by which the motor is worked. We have 32 seats in each carriage; but we shall by this additional carriage, only add 20 seats to the whole train. The question, of course, is the dealing with the traffic between 8 and 10 o'clock in the morning. We have 35 trains which run into the City between these hours, and 20 additional seats in each train will give accommodation for 700 passengers; but as I have intimated already, we sent away by the increase in our fares far more than 700. I have little doubt myself that the future of this line and its dividend-paying power is not to be found in increasing the fares, but in carrying at low fares a very large traffic. You will see at once that when we get the motor power trains put into form we shall be able to accommodate 700 more passengers between 8 and 10 o'clock in the morning, but that is an inadequate number to look forward to for any considerable time. The effect of our raising the fares was not satisfactory. We found that we practically stopped a great deal of the growth of our traffic, and we lost money on the whole, although we got an increased fare. It was, too, a very small addition—only ½d., and it shows how careful one must be in dealing with any increase of fares when the result of such a small addition as that sent away tens of thousands of people in two months. It shows clearly to us that although we may keep down the traffic temporarily by raising our fares, we cannot permanently look to a dividend by that process, and that we can only look to such a result by our being able to fully utilise our railway. We have got an excellent line in excellent condition, and all our stations excepting that of King William-street are capable of taking much longer trains and of taking two or three times as many trains as we now run. It is a pity to see a valuable line of this kind practically only utilised to about one-third of its capacity simply on account of the existence of the King William-street station. I have mentioned this matter at different times. I have also told you that we would not come before you with any proposition about the extension of the line or the outlay of capital till we felt that we had such a case that it was practically unanswerable. We desired to act in the most cautious possible spirit, and I am afraid that that caution has been exercised a little too far in this respect that before we can have any relief this line will suffer heavy loss. At the same time the Directors feel that they cannot go on with that caution, and measures ought to be at once taken for an extension of the line under the Act which we obtained with your consent. We are still exercising extreme caution in the matter, and we are only proposing that you should go as far as Finsbury-pavement; that is to say, opposite Moorgate-street station. After indicating on the map the existing system of the Company, he proceeded: The line we now propose to make will start from the Borough Station as a branch in order to get a station close to the London Bridge Station, where the Brighton Company have promised to connect with an underground passage on to their platforms. We then make two additional tunnels on the Surrey side of London Bridge, and go up King William-street, making a station at the corner of Lombard-street, where the church now stands, which, I suppose, is one of the finest sites for a passenger station in all the world. Further than that, we propose to go on to Moorgate-street just opposite the station of the Metropolitan Railway Company. We shall also be in direct connection with the trains of the Great Northern and City Railway Company, whose prospectus has just come out. I hope they will obtain their money and construct their line down to that point, so that we shall have an exchange with them; and all our passengers from the south would thus be able to go right on to the Great Northern system, and we should tap the enormous population along the route of that railway. We should also get an underground connection with the Metropolitan Company at Moorgate-street, where we should not be very far off from the Liverpool-street and Broad-street termini. There is also a Bill for what is called the Central London Railway, which is to come all the way from Bayswater, under Oxford-street, Newgate-street, and Cheapside, with a station opposite the Mansion House, and then go on to the Liverpool-street station of the Great Eastern Company. They are going to have a station which will adjoin ours at the corner of Lombard-street. We should, therefore, be in connection with a complete network of railways, drawing traffic from every part of London; and in addition we should have passing our doors almost the entire omnibus service of the whole of this great city. Nothing can well be conceived more likely to afford us an enormous traffic than the position which we should occupy there. The London Bridge traffic alone, from London Bridge station, will be a very large one, and we shall have a station, I think, which will be very well connected for the purpose of dealing with this traffic. You will recognise at once that the sites I have named for the stations might involve us in a very large outlay, but we believe that if you will give us the authority we ask you for to-day we shall be able, from what we know, to negotiate for those sites upon terms which will, I feel sure, be satisfactory to every shareholder. In order, however, to do that we must have time. We must not go hastily about our work, because that might involve us in a very large expenditure. We propose, therefore, that you should give us authority practically to proceed for the acquisition of these sites for the ultimate purpose of carrying on this extension. We should not for one moment propose to enter into any agreement which would involve any very large expenditure without your authority; in fact, we could not do so, because we do not propose to ask you to-day to create the capital necessary to pay for them; but if we can negotiate these sites at moderate cost, as we anticipate, then we want your authority to conclude the necessary arrangements. Of course, the reason why we do not ask you to create the capital to-day, or to determine the whole arrangements about carrying out these works, is that we do not know how long these negotiations will take. They may take six, nine, or twelve months; we know that they will not take any very short time. We therefore propose to leave the question of the mode in which we should create the capital, as that must depend on the relative value of our stocks, the condition of the money market, and other things we cannot now see. In the same way it is no use to enter into any contract for the construction of works at present, because the acquisition of these sites and the knowledge of when we can get into possession of them are essential to any contract which we might enter into. We therefore ask for your authority now on the grounds I have stated to negotiate, and if we find that we can purchase these sites at a small cost to do so. I think I have now dealt with most of the questions set out in the report. The seventh paragraph, relating to Mr. Court's motion, will come on after we have dealt with the report and the accounts and other business. The only other question I have to speak about is the Bill in Parliament for the construction of the Clapham extension. That Bill we have had for some little time, but we felt that it was useless to proceed with the Clapham extension as long as we were unable to deal with the traffic which that extension would bring us. It is a good extension and will bring us a large amount of traffic; but we are not in a position to deal with that matter until the line is extended as we now propose. As the powers for the purchase of land under the Clapham Extension Act of 1890 expire this year it has been necessary to promote a Bill for extending the time specified in that Act, and we have put into the Bill two things—first the power to hold our meeting a little earlier than we do at present. Our business is an absolutely cash one, and having no interchange of accounts with other companies, we can get our accounts ready sooner than most of them, and there is no reason why we should delay this meeting and the payment of our dividend longer than necessary. The second point is a small amount of capital which we have put in the Bill, which it is necessary to raise in connection with the proposed additional sidings we must construct; in fact, some of these sidings will be constructed under the Clapham Extension Act. These sidings, however, must be extended because the motor trains involve longer sidings than locomotive trains, and they require to be inspected at one time. They will, therefore, occupy a considerable length of siding, and we must construct some further sidings at the cost of a few thousand pounds at Stockwell. I have now to move the adoption of the report and accounts.

Mr. SAMPSON HANBURY seconded the motion.

Mr. THOMAS HANBURY said he had to propose an amendment that it was not prudent to proceed at present with the proposed extension of the line. He brought forward this motion with some diffidence, as he was not a resident in England; but he had travelled 1,000 miles to attend the meeting, and he was one of the largest shareholders in the Company. His opinion was so far unprejudiced that he had no further interest than that of being a shareholder in the undertaking. Paragraph 6 of the report asked them to authorise the taking of preliminary steps which would cause an expenditure of £280,000. The Company had been at work for four years, and adding together the dividends paid in that time they would be sufficient to give them $\frac{1}{2}$ per cent. per annum on the Ordinary shares. That was a very moderate measure of success. The dividend, too, for the past year amounted to only $1\frac{1}{8}$ per cent., which was also a very small return. Their position, therefore, was one of extreme delicacy—that was to say, they had their expenditure and their receipts so nearly balanced that they really had only a dividend of $1\frac{1}{8}$ per cent. to go upon, as shown by the accounts in the past year. It must be a matter of congratulation to all the shareholders to notice that the barometer of public opinion in regard to the price of their stock had been in the Company's favour in the past year in a marked degree, especially in the past few weeks. He maintained that this advance was attributable to the fact that the public thought that the concern was being managed by prudent people, who were keeping steadily to their work, but he proceeded to argue that they were asked that day to authorise a measure which would shake the confidence of the public. If the proposed extension from London Bridge Station towards Finsbury-pavement was so desirable, why did not the Brighton Company give them a guarantee of 2 per cent. or 3 per cent. on the capital outlay? He saw nothing in the present position of the Company to warrant the proposed expenditure, but he did not say that the time might not come when it would not be desirable to carry out what was proposed.

Mr. W. B. JEFFRIES regretted that the Directors had thought it right to raise the fare from Stockwell to the City. He also complained of the increase in the expenses.

Mr. J. T. MIDDLETON seconded the amendment.

Sir R. EDGCUMBE protested against the amendment. He was convinced that the Board felt that they were advising the shareholders to pursue a right course. He regarded the net result of the remarks of Mr. Thomas Hanbury in this light—that he wondered how that gentleman could ever have invested in an electric railway. Their friend had expressed the opinion that the proposal submitted to the shareholders by the Directors would lead to a diminution in the market value of their property; but what was the fact? On the day their report came out their shares were at 42, whereas they were now quoted at about 50; and it was because of that report and of what the public knew it was proposed to do that there had been such a magnificent increase in the market value of their stocks. The matter, however, was one which could not really be properly discussed at a general meeting, it being really a question of confidence in the Board.

Mr. J. P. COURT supported the amendment, and Mr. DRAKE opposed it, as did also Mr. MOCATTA, who, speaking as a member for many years of the Stock Exchange, supported the Directors' proposals, to which, he maintained, the recent advance in the Company's stocks was attributable.

The CHAIRMAN: I am very sorry that Mr. Thomas Hanbury differs from us. He lives in a nice, warm comfortable climate in Italy, and is therefore hardly up to the civilisation of modern times with us. The idea that there is a line of omnibuses along our route, and that therefore we should not make a railway alongside it is something like the story about railways *versus* coaches. That was exactly the argument raised originally in regard to the construction of railways, and it was precisely the same argument that was used against our proposed line to Clapham. There is an enormous service of omnibuses along the route we run, but we have created an absolutely new traffic, which has nothing to do with omnibus traffic at all. There is not in my mind any doubt that this line from London Bridge Station to Moorgate-street must get an enormous amount of traffic. My own experience of railways has been very large and long, and I say that there is no doubt at all that the traffic we shall get over that portion of the line will be immensely larger per mile than the traffic we get over the line which we at present work. It is that knowledge, derived from long experience of similar cases, that makes me perfectly certain of the wisdom of advising you to go on with this extension. I would not for one instant recommend you to go on with it were I not certain that it would pay the cost of the extension, and add enormously to the profits of your existing line. It is by that extension and that extension alone that you will make this one of the most profitable lines in this country. It is so late that I will not deal with all the points that have been raised in the discussion.

He then put the amendment, in favour of which six shareholders voted, and he declared it negatived by a large majority.

A poll was demanded, whereupon

The CHAIRMAN mentioned the number of proxies received by the Directors, and pointed out that the votes received by them were so absolutely overwhelming that there was no possible chance of the supporters of the amendment succeeding. He then put the motion for the adoption of the report and accounts, which was carried.

The CHAIRMAN next proposed the payment of the full dividend on the Preference shares, which was seconded by Mr. C. SEYMOUR GRENFELL and agreed to; and on the motion of the CHAIRMAN, seconded by Mr. EDWIN TATE, the dividend on the Consolidated Ordinary stock was also approved.

Mr. COURT afterwards proposed the re-election of Mr. Mott to his seat at the Board, remarking that he had complete confidence in the Directors, although he might differ from them on certain points. After what the Chairman had stated regarding the proxies he would not propose the resolution of which he had given notice with respect to the remuneration of the Directors.

Mr. MIDDLETON seconded the motion, which was unanimously adopted.

Messrs. Turquand, Youngs, Bishop, and Clarke were afterwards re-elected auditors of the Company.

A special general meeting was subsequently held to consider the Company's Bill in Parliament to extend the time for purchasing lands for the purposes of the Company's Act of 1890, for completing the underground railway thereby authorised, for empowering the Company to raise additional capital, and for other purposes.

The SOLICITOR (Mr. D. McMILLAN) explained the salient points in the Bill, and

On the motion of the CHAIRMAN, seconded by Mr. S. BARCLAY HEWARD, a resolution was passed approving it.

The proceedings then terminated with a vote of thanks to the Directors and officers.

Waterloo and City Railway Company.

The second half-yearly general meeting of this Company was held on Thursday at Waterloo-station, London, Mr. W. S. Portal (Chairman) presiding.

The SECRETARY (Mr. Fred. J. Macaulay) read the notice calling the meeting.

The CHAIRMAN, after stating that the number of shareholders had increased slightly during the year, being now 494, said: The accounts show that the amount of capital authorised is £720,000, and the amount created £540,000, of which £108,000 has been received. The amount expended during the half-year was £5,269, the details of which are set out in table No. 4 of the accounts. This sum, with the £6,163 expended in the half-year ended 30th June, 1894, makes a capital expenditure for the twelve months of £11,432. During the past half-year there was spent on construction of way and stations, including engineering, £1,535; for law and Parliamentary charges, £2,248; for interest on paid-up capital, at 3 per cent. per annum, £1,620, and smaller amounts for various other items. The first call of £2 per share has covered all the expenditure so far, and left a balance of £96,000 odd, of which £71,000 is deposited at the bankers', and £25,000 invested in Consols for Parliamentary deposit. As far as one could tell at present it does not appear likely that any further call upon the shareholders will be necessary during the current half-year, but probably a call will have to be made in the subsequent half-year, of which due notice will be given. Concerning the works of the railway we have a report up to date from the engineer giving a satisfactory account of everything. It states that the contractors commenced operations by constructing a large timber stage in the river Thames above Blackfriars Bridge, on which they have erected all their engines and machinery for the construction of the tunnels, including air compressing machinery for driving through water-bearing strata, electrical appliances for lighting the tunnel and running the excavations to the shafts, &c. From this stage two large circular shafts 16ft. in diameter, were sunk on the line of each of the tunnels, and the driving of the up tunnel in each direction was commenced on November 28th last. The material through which the tunnel is being constructed is a solid clay, entirely free from water; and in the Waterloo direction it has cleared the river and is now underneath the wharf on the south bank of the same. Towards the City, the tunnel is also making rapid progress, and is approaching the northern bank of the Thames. Altogether, 670 feet has been driven and lined with cast iron. A little delay has been experienced in the delivery of the iron, so that it was not until last week that the down-tunnel—that is, from the City to Waterloo—was started. This, however, is now in progress at both faces, and, as the iron-work is coming in much more rapidly, there is every prospect that the work of the down-tunnel will progress as favourably as that of the up-tunnel. The work is carried on without cessation day and night, except between 6 o'clock on Saturday evening and midnight on Sunday, and, so far, everything has gone on satisfactorily and without mishap. The question of the terminal stations in the City and at Waterloo are under consideration, and when the plans are settled the necessary contracts will be made and the works commenced in due course. As the shareholders are probably aware, the total length of the line will be about a mile and a-half. Under our Act one-third of the Directors retire each year and those doing so on the present occasion are Lt.-Col. the Hon. H. W. Campbell, Mr. A. F. Govett, and Mr. A. E. Guest, all of whom are eligible and offer themselves for re-election. I now have to move the following resolution:

"That the report of the Directors and the statement of accounts for the half-year ended December 31st, 1894, be and are hereby received and adopted."

Lt.-Col. The Hon. H. W. CAMPBELL (Deputy Chairman) seconded the resolution.

Mr. ARCHIBALD SCOTT hardly agreed that the work was proceeding as quickly as possible in view of the fact that only £5,269 was spent during the past half-year on capital account. He suggested that the Board should carefully consider, without loss of time, the appointment of an electrical engineer, as a great deal depended upon it. He thought the prosperity of their Company was very much bound up in the question as to whether their railway was to be merely a competitive underground line with the existing railway between Waterloo Station and Cannon-street Station. If that was to be the case he could not help regarding it as a dangerous policy. A very important part of the City of London was west, south west, and north-west of Cannon-street, as, for instance, St. Paul's Churchyard, Fleet-street, and Holborn, and those places could be reached by having a station on the northern side of Blackfriars Bridge, in the neighbourhood of St. Paul's Station, Ludgate hill, or Blackfriars Station. He did not want to do anything to at once commit the Board to making stations at those points, but he thought while the line was being made it would be wise to make provision for the opening of such stations if it were afterwards thought desirable to do so. It would be exceedingly difficult to do anything of the sort without stopping the traffic if the work were left until the line was opened.

The CHAIRMAN, in reply, said: The Board will consider the points raised by Mr. Scott. The question of appointing an electrical engineer is before the Directors at the present time, and they will make an appointment at the proper time. As to our railway being a competitive line, I will not enter into that on this occasion.

The resolution was then carried unanimously.

The retiring Directors, mentioned by the Chairman, were re-elected, and the auditor (Mr. F. Hartnell) was re-appointed.

A vote of thanks to the Chairman terminated the proceedings.

Edison and Swan United Electric Light Company (Limited).

An extraordinary general meeting of this Company was held at the Cannon-street Hotel on Tuesday, to consider, and, if approved, to pass resolutions making certain alterations in the Articles of Association of the Company. Mr J. S. Forbes presided.

The SECRETARY (Mr. H. Charles Gover) having read the notice calling the meeting,

The CHAIRMAN remarked that it might appear from the notice that it was a very long story, but it was really a very simple one. The fact was that the Articles of Association, which it was proposed now to alter, had become a little old-fashioned, and the Stock Exchange had got an improved form of these particular articles. As a condition for giving them a quotation, the Stock Exchange desired them to adopt these articles, as other Companies had done. The object was a perfectly legitimate and proper one, and was in the interest of the shareholders. He explained the nature of the alterations, and proposed resolutions approving them *seriatim*.

Major FLOOD PAGE seconded them, and they were adopted unanimously.

The CHAIRMAN pointed out that one of the principal advantages they expected to secure by the fusion of the two companies was that they might get a quotation on the Stock Exchange for the various classes of shares. He had previously pointed out the great anomaly which had existed in respect of the Swan Company's shares; namely, that although some of the shares were £5 fully paid, and others £5 shares with £3. 10s. partly paid—there was no quotation for the former, and shareholders, in their ignorance, parted with a £5 fully-paid share for less than £3. 10s.; in fact, they took what they could get. That was an anomaly. They had a quotation for the Swan Company's partly-paid shares, but not for the fully-paid shares. The Edison Company had no quotation for either class of shares. He thought, however, that under the resolutions which had now been passed, they would get a quotation for all the ordinary shares of the Edison and Swan Company. Then there was another difficulty. In the Swan Company as it had existed, the fully-paid shareholder who had paid £5 participated up to that amount for dividend *pro rata*; that was to say, if the Company paid 5 per cent. dividend, he received 5s., while those who paid £3. 10s. on the partly-paid got 3s. 6d. When the dividend exceeded 5 per cent., instead of the balance receiving in the same proportion on the amount paid up, they received each alike, both fully-paid and partly-paid shares ranking as £3. 10s. paid. That, of course, was rather in the interests of the ordinary shareholder; but it was a very complicated matter. If they were to get a quotation for the fully-paid shares the gentlemen who held the fully-paid shares which had been allotted to the Swan Company which were subject to the restriction described, and those who held the fully-paid shares which had been allotted to the Edison Company must agree amongst themselves how those two sets of shares were to be put upon an absolute equality in the participation of profits, because the Stock Exchange would not bother themselves about two kinds of fully-paid shares in the new Company having different rights. The difficulty could only be overcome by an agreement between the two sets of holders. The matter was being considered on behalf of the holders of shares which had been allotted to the Edison Company by Lord Lichfield and Sir John Lubbock, in conjunction with Mr. Quilter and Mr. J. W. Swan, on behalf of holders of shares which had been allotted to the Swan Company, and he thought that in the end it might be adjusted.

In answer to a shareholder,

The CHAIRMAN said they had emerged from protection into the freer air of competition. Competition was something which was supposed to be very good for the public, although it was not always good for the shareholders. He thought he might say that the consequences of competition had not been so disastrous to their Company as many people had predicted. There was something which one appreciated even in these days of struggle and self-advertisement, and that was merit and character; and the Company did succeed in establishing a certain reputation for their business, and this trade mark still had its beneficial influence on their business. They had, of course, been obliged to lower their price, but when the result of the first year's working under the new order of things was submitted, he did not think the shareholders would have cause to be greatly depressed.

Yorkshire House-to-House Electricity Company (Limited).

An ordinary general meeting of the shareholders of this Company was held on Tuesday, at the offices of the Company, in Whitehall-road Leeds, Mr. Grosvenor Talbot (Chairman of Directors) presiding.

The CHAIRMAN, in moving the adoption of the report and statement of accounts, said the Directors felt a certain amount of satisfaction in appearing before the shareholders. They had been able to earn a dividend of 4 per cent., but what was even more satisfactory to them was that, in addition to the dividend, they had also earned almost an equal amount which they were applying to other purposes. They were writing off this year the entire balance of their preliminary expenses, so that now the working capital would be available for earning a dividend in the future. They had also been able to add to the reserve fund, which, now that their preliminary expenses were worked off, they would be able to increase, he trusted, much more largely in the following year. He believed that the result of the last year's working, which was the first complete year of their Company, was equal to the result of almost any country station, at all events in England. Perhaps two of the most prosperous companies were the Liverpool and the Newcastle and District Companies. Both of them had earned in 1893 almost identically the same amount which they had earned in their first year, and both of them had been in existence many years. The supply during the whole time of their working had been efficient and practically unbroken, which he believed was a unique record, no other company having been able from its commencement to work without some sort of breakdown. That their customers had full confidence in the Company was perfectly apparent, because almost all the new buildings which were being erected, or which had recently been erected in Leeds, were dependent entirely upon the electric light as an illuminant. On December 31, 1893, as the result of eight months' working, they had installed what was equal to 10,647 8-c.p. lamps. At the close of last year they had 19,858 lamps installed. They delivered, in units, in the eight months of 1893, 125,000; and in the twelve months of 1894 they delivered 291,113—that was to say, in 1893 they delivered 15,620 units per month, and in 1894 24,260 units per month. They had now, in immediate prospect, the whole of the lighting of the Leeds Town Hall and municipal buildings, equal to about 6,000 8-candle lamps. They had also offered to the Corporation to light any portion of the streets or markets which they chose, with arc lamps, and he trusted that that would be considered by the Corporation, for they must remember that arc lighting, in the quantity of light given, was extremely cheap, and that they could place more lights in the streets by arc lamps at the same price that they could by lighting the district with gas. They were supplying electric light to churches, chapels, and the Jewish synagogue, and they had also endeavoured to do what they could to establish the use of electricity for other purposes. They had placed the price per unit at 3d., because for those purposes to which he had referred, electricity was principally used in the daytime. Messrs. Fowler had agreed to take their 100-horse power engine, and to replace it with a 400-horse power engine, and that was now about to be done, which would be of enormous advantage to them next winter. As to the future, the Directors felt that the price of the current was one of the great objects which they had to deal with, and they felt sure that by reducing the price they would immensely increase the sale. They had decided that from the 1st July next the maximum price should be reduced from 7d. to 6d. per unit, with certain simplifications and modifications of their discount system. The question of extending their plant was one which the Directors would have to consider before very long. He felt sure that with an enlightened and courageous policy the shareholders need have no fear of the stability or usefulness of the property which they held.

Mr. R. W. EDDISON seconded the resolution, which was adopted.

On the motion of the CHAIRMAN, seconded by Mr. G. H. CROWTHER (Huddersfield), a dividend at the rate of 4 per cent. per annum was declared upon the Ordinary shares of the Company.

Mr. J. T. Pearson and Mr. R. W. Eddison, the retiring Directors, were re-elected: and Mr. John Gordon, jun., was re-elected as auditor; and the meeting closed with a vote of thanks to the Directors.

Cuba Submarine Telegraph Company (Limited).

The following is the report of the Directors of this Company for the half-year ended December 31st last, to be presented at the forty-seventh ordinary general meeting to be held at the office, 58, Old Broad-street, E.C., on Wednesday, the 13th inst., at 12 o'clock:—

The gross receipts amount to £20,769. 15s., and the gross expenditure to £5,633. 10s. 2d., leaving a sum of £15,136. 4s. 10d., which, added to the balance brought from the last account, £3,429. 5s. 11d., leaves £18,565. 10s. 9d. at the credit of revenue account. Of this the sum of £1,000 has been set aside as a further reserve against any loss from the deposits with banks, and £4,785. 7s. 3d. added to the reserve fund, which now stands at £100,000. The dividend on the Preference shares will absorb £3,000, and leave £9,780. 3s. 6d., out of which the Directors recommend the payment of a dividend on the Ordinary shares at the rate of 8 per cent. per annum, free of income-tax, the balance, £3,380. 3s. 6d. being carried forward to the next account.

The cables have continued in good order throughout the half-year. The new cable between Batabano and Cienfuegos, referred to in paragraph 7 of the last report, is now being laid, and the Directors are in daily expectation of a telegram announcing the completion of the work. The instalments already paid have been deducted from the reserve fund, which will also be charged with the balance of the contract price. The position of the Company's suit against the Spanish Government at Madrid remains the same as at the date of the last report.

National Telephone Company (Limited).

Report of the Directors of the Company for the half-year ended 31st December last, to be presented to the meeting to be held at the Cannon-street Hotel, London, E.C., on Thursday next, at 1 o'clock:—

This is the first occasion upon which it has become the duty of the Board to call a half-yearly meeting to present a report and accounts. In order that a comparison of the state of the business and its general results may be seen, it has been necessary to recast the Abstract of Accounts given at the foot of the report, so that the half-year now under review may be readily contrasted with that ending 31st December, 1893. The income accrued in respect of the business of the half-year amounts to £378,789. 4s., as compared with £337,927. 9s. 5d. for the corresponding period of 1893, being an increase of £40,861. 14s. 7d. The working expenses for the half-year amount to £205,192. 12s. 10d., as compared with £163,853. 4s. 10d.

for the corresponding period of 1893, being an increase of £41,339. 8s. The former figure, however, covers a sum of £15,000 specially set aside to meet the heavy exceptional cost involved in replacing and repairing plant destroyed or damaged by the recent storms.

The net result for the half-year (after deducting the Post Office Royalties, amounting to £34,953 16s. 8d.) is a profit balance of £138,642. 14s. 6d., as compared with £142,530. 19s. for the corresponding period of 1893, being a decrease of £3,938. 4s. 6d., subject, however, to the exceptional provision referred to in the preceding paragraph. The rentals carried forward for unexpired terms of running contracts amount to £313,979. 3s. 4d., as compared with £282,948. 9s. 5d. at the corresponding period of 1893, or an increase of £31,030. 13s. 11d. Out of the available balance of £122,858. 2s. 1d. shown by the net revenue account (No. 3) the Board will recommend a payment of a dividend at the rate of 6 per cent. per annum on the First and Second Preference shares, and 5 per cent. per annum on the Third Preference and Ordinary shares. The Board also propose to transfer £35,000 to the reserve fund, and to carry forward the balance of £3,379. 4s. 7d.

Agreement with the Post Office.—The proprietors were informed in the last report that the more formal agreement necessary to embody all the details involved under the "Heads of Agreement," signed on the 11th August, 1892, by the Postmaster-General and the President of the Company, on behalf of the respective contracting parties, had been completed, and that in accordance with a promise of the Postmaster-General, it would be laid upon the table of the House of Commons in due course. This was done; but in consequence, as it may be presumed, of the pressure of more important business, the consideration of the agreement by the House was postponed till the present session. The delay is to be regretted, as it gives rise to a condition of uncertainty in the relations between the Post Office and the Company, very prejudicial to the development of the telephonic service of the country, and inflicts much loss and inconvenience upon the Company and large numbers of its subscribers. It is only right to say that the serious disadvantages of the position have been as far as possible mitigated by the courteous and friendly co-operation of the Post Office authorities, who have shown every disposition to aid the Company in minimising the drawbacks resulting from delay.

Further Issue of Debenture Stock.—A reference to the capital account will show that the amount expended upon the construction of exchange, trunk, and private lines for the six months was £134,959. 18s. 2d. This class of expenditure is a necessary condition of the expansion of the business in each year, and must be provided for. The Board consider that, looking to the wants of the Company and the state of the money market, the time has come for a further issue of the Three and a-Half per Cent. Debenture Stock of the Company, and they have therefore determined to allot to the ordinary shareholders such an amount of the unissued remainder of this Stock at £103 per £100 stock as will represent 15 per cent. of their holdings.

St. James' and Pall Mall Electric Light Company (Limited).

The following report of the Directors of this Company will be presented to the ordinary general meeting, to be held at the offices of the Company, Carnaby-street Central Station, Golden-square, W., on Tuesday, the 12th inst., at 3 o'clock :—

The Directors congratulate the shareholders on the improvement shown in the result of the year's trading. The business of the Company is steadily increasing, and the building extension in Carnaby-street, now almost completed, has been made none too early. It has become necessary to add to the plant at Carnaby-street, and orders involving an expenditure beyond the amount already at the disposal of the Directors will be involved, which they propose to meet by a further issue of a part of the £100,000 Four per Cent. Debenture stock created last year, and of which £30.000 has already been issued. The Directors regret that the item of expenditure under the head of "Rates and Taxes" has so considerably increased. This is owing to a re-valuation of the premises by the vestry, which has been upheld by the Assessment Committee. An action has been instituted by the Attorney-General on behalf of the parish, alleging a nuisance from the plant at Mason's-yard Station. This station is now only used as auxiliary to the main station at Carnaby-street.

The net earnings of the Company during the past year have amounted to £13,468. 4s. 10d. Of this sum £5,498 was distributed in August last in payment of an interim dividend at the rate of 4 per cent. per annum for the half-year ended June 30, 1894, on the Ordinary shares, and at 7 per cent. per annum on the Preference shares. The balance, £7,970. 4s. 10d., together with the undivided profit of £120. 8s. 9d. from last year's account, leaves £8.090. 13s. 7d. now to be dealt with. The Directors propose to divide this amount as follows:—(*a*) By a dividend at the rate of 7 per cent. per annum on the Preference shares for the second half of the year, £3,500; (*b*) by a dividend at the rate of 9 per cent. per annum for the second half-year on the Ordinary shares, making, with interim dividend, 6½ per cent. for the year, £4,495. 10s.; (*c*) carried forward to Ordinary shareholders' undivided profit account (£90. 14s. 5d.) and (*d*) to Founders' undivided profit account (£4. 9s. 2d.), £95. 3s. 7d. £8,090. 13s. 7d.

Mr. H. Woodburn Kirby has recently resigned his seat on the Board, to the great regret of his colleagues. Sir John H. Morris, K.C.S.I., and Mr. Gerald W. Balfour, M.P., are the Directors who retire by rotation, and offer themselves for re-election, as do the auditors, Messrs. Deloitte, Dever, Griffiths and Co.

The following is a brief outline of the Company's output for the past year:

Number of units sold to customers during 1894 ...	1,569,884
Number of 8 c.p. lamps connected at end of 1893 ...	60.037
Number of lamps connected at end of 1894 (8 c.p.) ...	75,217

House-to-House Electric Light Supply Company (Limited).

The following is the annual report of the Directors of this Company for the year ended December 31st last, to be presented at the meeting to be held at the Central Station, Richmond-road, Earl's Court, London, S.W., this day (Friday), at 3 o'clock :—

The revenue account shows a credit balance (with the balance of £43. 8s. 3d. brought forward from the previous year) of £6,307. 3s. 3d. After deducting £1,898. 11s. 10d. for interest paid on £30,000 debentures and on temporary loans, the Directors recommend that the balance be dealt with as follows:—

In reduction of preliminary expenses	£500	0	0
In extinction of suspense renewals account	200	0	0
Depreciation account..	1,450	0	0
Dividend of 7 per cent. on £25,000 Cumulative Preference Shares	1,750	0	0
In reduction of construction business development account	400	0	0
Balance carried forward to next account	108	11	5
	£4,408	11	5

The following table shows the progress of the Company's electric lighting business during the last five years:—

Yr.	Equivalent of 35-watt lamps connected.	Inc. in 35-watt lamps.	No. of houses connected	Gross revenue.			Expenditure			Net revenue.		
				£	s.	d.	£	s.	d.	£	s.	d.
1890	13,665	9.145	248	5,010	9	2	4,624	6	5	386	2	9
1891	19,388	5.723	373	8,328	3	11	6,077	14	10	2,250	9	1
1892	23.700	4.312	471	10,688	18	6	7,351	19	6	2,836	19	0
1893	28,429	4.729	599	12.063	10	10	7.832	6	8	4.231	4	2
1894	35,858	7,429	755	13,695	11	8	7,431	16	8	6,263	15	0

The increase in the lights connected during 1894 was equivalent to 7,429 8-c.p. (35 watt) lamps, being the largest increase since the year 1890, and the Directors consider that the shareholders are to be congratulated upon the fact that, notwithstanding an increase in revenue of £1,632. 0s. 10d. as compared with that received in 1893, the working expenses as compared with the same period show a decrease of £400. 10s. Since the issue of the last report additional mains have been laid in various parts of the area, and, to meet the continual increase in the Company's business, arrangements are being made for laying down further plant and mains during the current year. As the amount of ordinary capital appropriated to construction business development account stands at £15,000, the Directors propose to gradually write down the account to that amount and to this end they have applied £400 out of the profits of this year. The Directors regret to report that they have been advised by the Secretary of the Leeds and London Electrical Engineering Company, Limited (to whom this business has been leased), that their accounts for the year ended March 31, 1894, will not admit of the distribution of any profit. The £30,000 Six per Cent. First Mortgage Debenture Bonds, which were redeemable on January 1, 1895, have been paid off, and £50.000 of Four and a-Half per Cent. Mortgage Debenture Stock has been created, of which £40,000 has been issued. By this operation the Company is provided with an additional £10,000 without any increase in the annual amount required for interest.

The Directors, having had every reason to be satisfied with the manner in which Mr. Henry W. Bowden discharged the duties of chief engineer, have appointed him to the post of manager.

Mr. H. R. Beeton and Mr. W. Page retire and offer themselves for re-election as Directors, as do Messrs. Theobald Brothers, Miall and Co., the auditors.

City of Bath Electric Lighting and Engineering Company (Limited).

The following is the report of the Directors to be presented at the fourth annual general meeting, to be held at the works, Dorchester-street, Bath, on Wednesday, the 13th inst., at 2.30 p.m. :—

The Directors think there is every reason for satisfaction in the improved position of the Company's affairs. The profit on the year's working, after charging all repairs to plant, mains, and machinery to revenue is £702. 8s. 7d., which compares very favourably with the loss of £306. 15s. 11d., made in 1892, and the profit of £188 1s. 4d. made in 1893. The Directors have thought it right to clear from the books all long outstanding debts, and believe that ample provision has been made for every possible contingency. The items, bad debts £49. 16s. 4d., and the balance, £89. 11s. 6d., at the debit of profit and loss from the past year have reduced the available balance to £363. 0s. 9d., which would have sufficed to pay a small dividend. After consideration, however, it has been deemed best in the interests of the Company to carry this balance forward.

Considerable sums have been spent on maintaining everything in first-class working order, and this expenditure has been charged against the current year's revenue. It will be noticed that a large amount has been expended during the year on capital account. A new engine has been purchased for the public lighting plant, and the dynamos for that service have been entirely re-arranged. New switch boards for the private incandescent services have been erected, and some of the furnaces have been fitted to burn oil fuel. Additional transformers and meters, &c., have been purchased and service lines laid down. The Directors have every reason to be satisfied with the expenditure, the good results of which will be more clearly shown in next year's balance-sheet.

It is anticipated that by Christmas the existing station plant will be fully loaded, and in this event there is no doubt that the accounts will show most excellent results, and that the Company will be in a very satisfactory financial position. The confidence of the citizens of Bath in the Company is shown in the most satisfactory increase in the number of lamps connected with the mains. During the last three months these have equalled 658 8-c.p. lamps, so that at the end of the year there were 8,327 lamps wired, a very large proportion of which are in use at one time. The plant is sufficient for the supply of current to 10,000 lamps, allowing one spare set of machinery complete; the Company, therefore, can safely add 1,673 lamps without any further expenditure.

The shareholders have every reason to be satisfied with the working of the Company during the late disastrous floods. For four days the public were dependent on this Company solely for the supply of artificial light, and your Directors believe that the signal success attending their operations during that period will not be forgotten by the inhabitants. The Board desire to put on record their appreciation of the energy of their Manager, and of the cordial assistance given him by his staff during this trying time.

The plant, machinery, and mains are in excellent condition, and at no period of the Company's history have they been in so thoroughly efficient and satisfactory a state.

The Directors are of the opinion that the efficiency of the station and its economical working can be still further secured by a moderate additional expenditure of capital. This expenditure will probably be made early this summer, and there will be no difficulty in raising whatever money is necessary for it.

In accordance with the policy settled at the special meeting of the shareholders held on September 13th, 1894, application was duly made to the Board of Trade for a provisional order in substitution of the license now held, and the consent of the Local Authority was applied for, but withheld. A meeting of the Town Council was summoned at the last moment and held on the 14th January, at which it was resolved to oppose our application, and a resolution was passed that the Corporation themselves apply for a provisional order for the district in question. The interests of the Company will be well looked after by E. B. Titley, Esq., with whom will be associated as Parliamentary agent, Sidney Morse, Esq., the most experienced adviser in questions relating to the Electric Lighting Acts. The Directors have full confidence in the fairness and justice of the Board of Trade, and as the matter is now in their hands it is unnecessary to discuss it.

The Directors having waived all remuneration during the past two years, propose to appropriate out of the profits the sum of £175 as Directors' fees for the year 1894.

Mr. T. O. Callender and Mr. C. J. Wharton are the Directors who retire by rotation, and, being eligible, they offer themselves for re-election.

Liverpool Electric Supply Company (Limited).

The following is the report of the Directors to be submitted to the shareholders at the ordinary general meeting of the Company, to be held at the Sale Room, Exchange Station Buildings, Tithebarn-street, Liverpool, to-day (Friday), the 8th inst., at noon:—

The Directors are again able to report a steady increase in the demand for electric light. The total number of lamps connected to the Company's supply mains on January 1st, 1894, was 25,784, and on December 31st, 31,792. The amount to the credit of Profit and Loss Account, including the balance brought forward from last year, is £15,601. 7s. 4d. Out of this sum, an interim dividend at the rate of 5 per cent. per annum was paid for the half year ending June 30th, and the Directors recommend the payment of a dividend at the rate of 6 per cent per annum free of income tax, for the half year ending December 31st, 1894. They also recommend that the sum of £1,359 5s. be added to the reserve fund, carrying forward the balance of £1,136 8s. 10d. to next year's account. The expenditure on capital account during the year, including a proportionate charge for general expenses, has been £40,786.

Considerable additions have been made to the plant at the Highfield-street and Oldham-place Stations, and the mains have been extended where necessary to meet the demand. Applications for the light from the residential districts served from the Company's Lark-lane Station, have come in slowly, owing no doubt to the depressed state of trade, but the Directors anticipate that in the future, this district will form a very valuable section of the Company's supply area, without requiring any large capital expenditure.

The shareholders are aware that under the Liverpool Electric Lighting Order of 1891 the Corporation have the option of purchasing the Company's Liverpool business as a going concern in the year 1898. On the inquiry by the Local Government Board as to the extension of the City boundaries, it was agreed that this date should be altered to the year 1900, and that the option should include the Toxteth undertaking also. The Corporation have approached the Board with a view to the immediate purchase of the Company's business, and as they have the right to acquire it at so early a date, the Directors do not wish to adopt any obstructive policy, due regard being paid to the interests of the Shareholders. The matter is one that naturally demands very careful treatment, and the Directors would ask the Shareholders to leave it for the present entirely in their hands. Should the Corporation offer terms which appear to the Directors to be acceptable, the matter will be laid before the Shareholders for their approval.

Two Directors, Mr. Th. Von Sobbe and Mr. D. de Ybarrondo, retire by rotation, and being eligible, offer themselves for re-election.

Newcastle and District Electric Lighting Company (Limited).

The following report is issued by the Directors of this Company and will be presented at the meeting to be held at 57, Westgate road, Newcastle-on-Tyne, on Monday, the 11th inst., at 2:30 o'clock:

The supply of current continues to give satisfaction to the Company's consumers. The installations connected to the Company's mains during the year were equal to 3,000 10-c.p. lamps, bringing the total up to about 21,500, and 431,239 units of electrical energy have been supplied, as against 388,422 units supplied in 1893. During the past year 2,327 yards of main and branch piping have been laid, together with 7,657 yards of main and branch cable. The condensing plant referred to in last year's report is now constantly at work, and the large saviog effected in the cost of fuel and water has more than justified the amount spent upon its erection.

The gross earnings during the year amount to £3,792. 11s. 8d., and after paying interest, and making provision for depreciation, and writing off £200 from formation expenses, the Directors are able to recommend a dividend at the rate of 3½ per cent. for the half-year ended December 31st (less income tax), which, together with the interim dividend paid in July last, makes the dividend 6 per cent. for the year.

Col. W. M. Angus and Mr. John B. Simpson retire, and offer themselves or re-election as Directors, as do the auditors, Messrs. Strachan and Co.

India Rubber, Gutta Percha and Telegraph Works Company (Limited).

The Directors' report for the year ended Dec. 31 last, to be presented to the thirty-first ordinary general meeting at the Cannon-street Hotel, London, E.C., on Thursday, the 14th inst, at 12 o'clock, is as follows:

The accounts show the net profit for the past year to be £41,961. 15s. 9d. Adding £28,952. 1s. 7d. brought forward, and deducting £25,000, interim dividend paid in July, there remains a disposable balance of £45,913 17s. 4d. The Directors recommend the distribution of a dividend of 10s. a share, free of income tax, amounting to £25,000, making, with the interim dividend, a total payment for the year of 10 per cent., and leaving £20,913. 17s. 4d. to be carried forward. The trading for the year has been comparatively unsatisfactory, Competition has reduced both the volume of general business and the rate of profit; and there have been but few orders for cables. The Silvertown and Persan factories are in good order.

The Hon. R. Marsham and Mr. Jarvis, the Directors retiring by rotation, offer themselves for re-election.

CITY NOTES.

CAPITAL EXPENDED IN ELECTRIC SUPPLY.—In the table given in our last issue, owing to the difficulty of obtaining information, and the hurry in completing the tables, several errors occurred. In the capital expended by the House to House Electric Light Supply Company, the figure is given as £350,000; the amount should be £83,848, and the figures in this case should have appeared in italics. This, of course, somewhat alters the total, which should properly read "Capital expended by Companies, £5,156,753; Local Authorities, £2,032,420; total, £7,189,173."

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED). The traffic returns of this Company for the week ended February 3rd were £1,021, as against £951 in the corresponding period of 1894, being an increase of £70. The total receipts for the half-year amount to £5,020, as against £4,790 for the corresponding period of 1894, an increase of £230.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of January are £4,000, as compared with £3,935 in the corresponding month of last year.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts for the month of January, 1895, amounted to £1,878, as against £1,909 in the corresponding period of last year.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the month of January, 1895, amounted to £70,674, as against £64,851 in the corresponding period last year, or an increase of £5,823.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of January amounted to £41,315, and for the corresponding period of 1894 to £39,677, an increase of £1,638.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company for the month of January, 1895, amount to £32,200. In the corresponding months of 1893 and 1894 the amounts were £20,800 and £21,000 respectively.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 3rd inst. amounted to £924. The amount for the corresponding week last year was £632.

STOCK EXCHANGE NOTICES. Application has been made to the Committee to appoint a special settling day in and to grant a quotation to a further issue of 8,000 Ordinary shares, Nos. 60,001 to 68,000, of the Westminster Electric Supply Company (Limited).

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—The Directors of this Company recommend a balance dividend of 15 per cent., making 20 per cent for the year 1894.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended February 1st, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,272.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Jan. 30.		**Price Wednesday, Feb. 6.**		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 6.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	14/0	Anglo-American xd	41	42	40	41	4 17 7	Jan., Apr., July, Oct.	40½	40
£2,993,660	Stock	28/0	Do. Preferred	77	78	75½	76½	5 4 7	" "	76½	75¾
£2,993,560	Stock	5/0	Do. Deferred	6½	7	6¾	7	..	..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 17 1	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	11½	12	11½	12	5 8 4	Mar., June, Oct., Dec.	11 15/16	11 13/16
£76,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	109	113	109	113	4 8 11	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	147	152	147	152	4 12 1	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	20½	..
12,931	5	1/8	Direct Spanish (fully paid)	4	4½	4	4½	4 8 11	April and October —	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9½	10	8½	9	5 11 1	" "	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8½	9	8½	9	5 0 0	Jan., Apr., July, Oct.	8 13/16	8¾
400,000	10	2/6	Eastern	16¼	16¾	16¼	16½	3 18 9	" "	16⅝	16¼
70,000	10	6%	Do. 6 per Cent. Preference	17½	17¾	17½	18	3 6 8	" "	17¾	17½
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	123	126	124	127	3 3 0	May and November	125	124
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899 xd	106	110	104	106	4 14 4	February & August	..	..
250,000	10	2/6	Eastern Extension	16½	16¾	16¾	17	4 2 4	Jan., Apr., July, Oct.	17	15¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock xd	123	126	123	126	3 3 6	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	106	102	106	4 14 9	January and July ..	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	106	102	106	4 14 9	" "	..	—
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.) xd	106	109	106	109	3 13 5	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	111%	114%	112%	115%	3 10 2	May and November	..	..
180,227	10	1/6	Globe Telegraph and Trust	9¼	9½	9⅜	9⅝	4 13 6	Jan., Apr., July, Oct.	9½	9⅜
180,042	10	6%	Do. 6 per Cent. Preference	16¼	16½	16⅛	16⅝	3 12 3	" "	16⅝	..
150,000	10	5/0	Great Northern	21¾	22¼	21¾	22¼	3 17 2	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	..	—
17,000	25	12/6	Indo-European	50	52	50	52	4 16 2	May and November	52	51½
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	105	109	105	109	5 12 8	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	105	108	3 14 3	..	..	—
11,839	8	4/0	Reuter's	3	4	3	4	..	April and October —	..	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	118	123	117	122	4 10 4	" "	..	..
15,609	10	6/0	West African Telegraph	4	5	4	5	..	January and July ..	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	102	105	102	105	4 17 4	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July .	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	98	103	7 15 4	June and December	99	..
88,321	10	6d.	West India and Panama	1	1¼	1	1¼	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	5 6 8	May and November	11⅛	10 15/16
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 10 6	June and December	110½	110½
64,242	15	3/0	Western and Brazilian	10¾	11¼	10¼	10¾	3 5 1	May and November	11	10⅝
33,129	7½	3/0	Do. 6 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	..	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	4¼	4¾	4½	4¾	..	..	4 9/16	4 5/16
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910 .. xd	103	107	100	104	5 15 5	February & August	103½	101
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910 xd	103	107	100	104	6 15 6	" "	102½	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115	120	115	120	5 18 5	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 18 5	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2½	3½	—	..	3	2¾
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	—
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	½	⅝	½	⅝	..	Yearly	—	..
484,597	5	3/4	National	5½	5¾	5⅜	5⅝	4 8 11	June and December	5¾	5⅜
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 15 0	" "	16⅞	16¼
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	" "	15 15/16	15¼
119,234	5	3/4	Do. 6% Non-Cumulative 3rd Pref.	6	6½	6	6½	4 0 0	—	6½	6
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	105	107	105	107	3 5 5	January and July —	106¾	106½
58,000	6	1/0	United River Plate	1	2	1	2	..	" "	1 5/16	—
£146,733	Stock	5%	Do. 6 per Cent. Debenture Stock (red.)	86	91	86	91	5 9 11	" "	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	14½	15½	14	15	..	—	14 13/16	14⅜
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15¼	16¼	15¼	15¾	3 16 2	..	16 1/16	15 7/16
£100,000	Stock	6%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	4½	5½	5	5½	3 12 9	—	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	—
8,322	£5	..	House-to-House Electric	..		..		—	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		—	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		—	January and July —	—	—
45,000	£5	2/6	Liverpool Electric Supply (fully paid)	7 5/16	7 7/16	7 5/16	7 7/16	—	—	..	—
111,000	5	..	London Electric Supply	¼	½	¼	½	..	..	..	—
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	9¾	10¼	9¾	10¼	2 8 9	..	10 1/16	9 15/16
£150,000	Stock	4½%	* Do. 4½% Debs.	117	120	118	120	3 15 2	June and December	120	118½
6,452	£10	..	Notting Hill Electric	7	7½	7	7½	..	..	..	..
19,980	£5	2/0	St. James and Pall Mall	7¾	8¼	7¾	8¼	..	..	7¾	..
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 15 8	—	..	..
69,900	6	2/0	Westminster Electric Supply (fully paid)	7½	8	..		2 16 3	—	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅝	2¾	2⅝	2¾	5 5 3	..	2¾	2 11/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2⅜	2¼	2⅜	4 11 5	—	2 5/16	2¼
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	113	116	115	118	3 17 7	March & September	118	116
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	3	3½	3	3½	—	January and July —	..	..
12,139	5	..	Edison and Swan United	—		—		—	—	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		..	—	—	..
120,000	2	..	Electric Construction	¼	½	¼	½	—	—	..	..
12,845	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	1¼	2	1¼	2	..	—	—	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1½	1⅝	1½	1⅝	..	—	—	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	—	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	24½	25½	22	23	5 8 1	February & August	24½	20¾
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 8 3	March & September	..	—
15,995	£10	6/4	International Okonite Ordinary	..		—		—	—	..	—
16,000	£10	..	Do. 8 per Cent. Preference	—		—		—	December and June	..	—
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	½	—	—	½	—	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	41	43	41	43	5 11 6	March and July... —	42¾	42
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 13 6	January and July —	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	—		—		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	—		—		..	—	..	..
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	9	10	9½	10½	4 15 3	..	10⅜	10¼
£30,000	10	..	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1%	City and South London Railway	48	50	48	50	2 0 0	May and November	50	48½
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	14¾	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	128	130	128	130	3 1 7	May and November	..	..
37,500	£10	1%	Liverpool Overhead Railway	8½	8¾	8½	8¾	1 3 2	..	—	..
6,295	10	5%	Do. 5% Preference	13	13½	13	13½	3 15 6	..	—	—
125,000	Stock	4%	Do. 4% Debenture	110	112	112	114	3 10 2	January and July ..	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

THE ELECTRICIAN:

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NOTES.

Dr. Fleming breaks fresh ground this week in his investigation of the curves of alternate-current supply. Hitherto the curves of alternators alone have been examined. That is a very different thing. The analysis of milk in a dairy, milked straight into a test tube, is not the same thing as the analysis of milk poured out from the breakfast-table milk jug. A nice sine curve from an alternator with little or no armature reactions is a capital "pretext for integrals," as Prof. Eric Gérard so neatly expresses it, but the sort of curve which finds its way into our office is a very different sort of thing. It sometimes has a flat bottom, five minutes long, and at other times bobs like an angry parrot. The Joubert sampling apparatus is to be found in every technological laboratory, and is attached to an alternator, but Dr. Fleming has constructed an instrument which can be carried about to any part of a district which is supplied by alternating currents, and though a mile away from the station, will record the curve, not only of an alternator but of all the alternators running in parallel, and clearly shows the result, not only of the load on them, but of the load between them and the instrument, of the capacity or other influence of the mains, of the presence of transformers, and, in short, of the practical everyday conditions. Transformers must, after all, be designed to meet such conditions, and we are glad to learn that a large number of curves have been taken, and hope that valuable practical results may be obtained from them.

Mr. Partridge's communication on the losses in transformer cores has resulted in the carrying-out of several sets of experiments, and in the publication of several researches which had been already begun. Mr. Ernest Wilson, of King's College, has attacked the question of core losses, both by experiment and by some rather alarming mathematics. The article which he contributes to our present issue was received in the first week of the present year; but owing to pressure of current matter we have been hitherto unable to find room for it. Although Mr. Wilson's research does not bear directly upon the gradual change which occurs in transformer cores, any light which can be thrown upon the dissipation of energy in transformers is of considerable interest.

Sportsmen who fall to and discuss the interesting question of the proper apportionment of the bear's skin before they have terminated the quadruped's mortal career, are not perhaps more open to unkind remarks than an English electrical journal which discusses the *pros* and *cons* of the latest American electric tramway device. The three-wire system applied to tramways has, however, an interest altogether apart from its possible use in this country; and it is on this account, and in the hopes that at some not too distant date there may be English exemplars of three-wire trolley lines, that we publish elsewhere in the present issue an account of an application of this system to some tramways at St, Louis.

As will be seen, the three-wire device is being tried at St. Louis on a tolerably large scale and under peculiarly severe conditions; but it is very evident that the engineers responsible have carefully thought out those little details which make all the difference between success and failure, so that there is every likelihood of the first glow of self-satisfaction not being followed by the after-glow of an irritated public. There is a charming flexibility about the St, Louis plan. The trolley line is divided up into sections, insulated from one another, and fed alternately by positive and negative feeders. Should an insulator threaten to give out, a turn of a feeder-switch makes two adjacent sections of the same polarity. At a pinch a little switching will convert the whole system back into a two-wire network; and at night-time the "owl cars" are always run off two wires. At the crossings a dangerous contiguity of + and − wires at a potential difference of 1,000 volts is avoided by the simple contrivance of making all wires at crossings, &c., either positive or negative. Since the three-wire system does not, as its name would seem to the uniniated to imply, involve any more overhead wires and since it reduces electrolytic troubles to a minimum, we trust that it has come to stay, and that long practical experience will not reveal unforeseen defects.

Whatever may be said about the possibilities or impossibilities of running certain kinds of alternators in parallel when driven by steam, there is now but little room for doubt that they cannot be run in this way when driven by gas engines. This system of supply has received ample trial at the gas engine station at Coatbridge, and it has proved itself so untrustworthy and defective that the owners of that station have at length decided to clear out the whole of the gas plant and run the station entirely by steam. While we cannot but deplore the failure of what was a plucky and interesting experiment, we also cannot refrain from observing that it is a result which might well have been expected by anyone familiar with the difficulties of running alternators, especially those of a certain type, in parallel. There is no need whatever to deduce from the Coatbridge failure that gas engines are unfitted for driving electric supply stations. There is abundant evidence that electric energy can be supplied both economically and steadily from batteries of gas engines, for such stations are to be found both in this country and abroad. The lesson which Coatbridge teaches is that the parallel running of alternators must not be adopted in stations of this type.

A serious street gas explosion which took place recently in Fulham has almost escaped observation because there happened to be no electric conduits anywhere in the neighbourhood, and it seems to have been recorded only in local newspapers. It closely resembles the Southwark Bridge explosion, which was carefully investigated by the Board of Trade, but so investigated only because some electric mains happen to be there. In the present case, two men, probably plumbers, were pushing a handcart, below which was slung a pail of hot coals. On passing over a gulley grating a violent explosion took place, hurling both men and cart into the air, and inflicting serious injuries.

A first-class gas explosion may be looked for near Queen's Gate-gardens. The Kensington and Knightsbridge Company find such a copious discharge of gas in this district that they have to raise the covers of their boxes every day. The basements of several houses are seriously charged with gas, and servants living in them have been made sick. We are informed that if an iron bar be driven into the roadway in this district, and then withdrawn, a match applied to the hole will light a gas flame. The shortcomings of lazy people should not be readily excused, but the Gas Light and Coke Company have been, perhaps, too busily employed in garnishing their new office in Kensington to attend to such trifles. They have recently erected an extraordinary corner building in High-street, its exuberant decoration of a gingerbread-Christmas-card-oil-cloth style being a positive eyesore to the neighbourhood. Between large plate-glass windows and plush curtains is a row of stoves, and the edifice, which might be mistaken for a *fin de siècle* public-house, ought to bear the sign of the "Song of the Dying Swan."

One of the many practical lessons to be learned from the fire at Kensington Court, which is described in another column, is the advantage of having a battery station entirely separated from the main works, for a battery can be easily damaged by fire. Although glass cells would have given way much sooner than the lead cells used in this case, inspection shows that the flames not only melted the heavy lead connections, and thus disarranged the plates, but even the cells have had large pieces bitten out of their sides. The battery at Queen's Gate-mews, though called upon to discharge about a thousand amperes for a short time, was fully charged during the night by means of a temporary connection with the Knightsbridge station. The Notting Hill, Kensington and Knightsbridge, and the Westminster districts all being continuous-current systems, can, in case of need, help each other. The St. Pancras district could hardly be assisted by the Westminster Company. The House-to-House is isolated, and having no battery is, of course, liable to complete extinction. The chain of alternate-current systems of the Metropolitan Company has from the beginning been linked together; but as far as we are aware little or no parallel running is practised, and assistance could only be given by elaborate re-districting.

We can vouch for the fact that at least one resident in Kensington, finding there was a fog on Wednesday morning, breakfasted by a 16-c.p. lamp with some reluctance, not wishing to trouble the Company more than was necessary. But others seemed to wish to see how much machinery was left, and to see how much the Company could do; the result was that four engines ran all day on the heaviest day load that has been met with since Christmas, and this, with a large part of the station a mere wreck.

Institution of Civil Engineers.—At the last monthly ballot Capt. M. H. P. Riall Sankey (late R.E.) was elected a member.

Personal.—Dr. von Stephan, Secretary of State for the Imperial German Postal Department, has been promoted to the rank of Minister of State.

A Cable to the Canary Islands.—A Madrid telegram says that the "Dacia" has successfully spliced the two ends of the cable from Cadiz to the Canary Islands.

Utilisation of Water Power in Switzerland.—According to a recent estimate, 52 per cent. of the central stations in Switzerland are driven by water-power.

Helmholtz's Library.—The library of the late Prof. von Helmholtz has been purchased by the German Government for the State Physico-Technical Institute in Berlin.

The Northern Society of Electrical Engineers.—At the last meeting of this Society the following members were admitted:—Messrs. W, F. D. Duncan, A. B. Mountain, John Platt, R. O. Ritchie, R. Shaw, Chas. Turner.

German Royal Academy of Sciences.—A sum of £75,000 has been presented to the German Royal Academy of Sciences by a widow lady, Frau Wenzel. The sum is to remain as a foundation, and the interest is to be used to assist scientific research.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
San Thoue—Loanda	Jan. 22, 1895.	Feb. 9, 1885.
*Gibraltar—Cadiz	Jan. 14, 1895.	Feb. 12, 1895.
Cadiz—Teueriffe	Dec. 26, 1894.	Feb. 13, 1895.
Latakia—Cyprus	Nov. 27, 1894.	—
Hongkong—Macao	Dec. 31, 1894.	—

* The announcement in our last issue of the restoration of this cable on the 4th inst. was made in error.

The Paris Gas Consumption.—The gas consumption of Paris for 1894 amounted to 9,178 million cubic feet, against 9,284 millions for 1893; if the extramural gas consumption be taken into account the total diminution amounted to over 100 million cubic feet.

French Cable Extensions.—The Governor of Obock, M. Lagarde, has asked the French Government to lay a submarine telegraph cable across the Bay of Tadjura, linking Djibuti with Obock, where the Obock-Perim cable of the Eastern Telegraph Company now terminates. The cost, according to experts, would be only 180,000fr. To this end the Minister of the Colonies, M. Chautemps, has asked the Chamber for a special credit to form part of the 1895 Budget.

The Proposed Pacific Cable.—The Ottawa correspondent of *The Times*, under date February 12th, cables as follows:—Matters in connection with the proposed Pacific cable have progressed so rapidly recently that Canada has submitted a proposal for the appointment of a joint commission, to meet in England, to discuss the details of the project. It is suggested that the commission shall consist of three representatives, one of Great Britain, one of Canada, and one of Australia."

London and Paris Telephone.—In answer to a question by Mr. Henniker Heaton, in the House of Commons, on Tuesday, Mr. A. Morley stated that during the business hours of the day the telephone to Paris was in constant use, and he thought there could be no doubt that it thoroughly met a public demand on the part of the classes whose business was facilitated by such a means of communication. The charge was a subject of international agreement, and he did not see his way at present to propose any reduction. The expenditure and the revenue were so mixed up with the general telephone service of the country that it was difficult to state them separately.

The Junction-Box Explosions and the Gas Companies.—In answer to several questions in the House of Commons, Mr. Bryce stated that inquiries had been held into the causes of the recent explosions in street boxes in Cannon-street, the Euston-road, and Southwark, and reports would be laid upon the table. The regulations of the Board for securing the safety of the public provided that all street boxes should be efficiently protected against any accumulation of gas or water, and the Board were earnestly pressing upon the electric lighting companies the necessity for full compliance with these regulations. It was most desirable that the *gas* companies should adopt the best means at their disposal to detect and remedy any defects in their mains, and he was now taking steps to call their attention to the matter.

Municipalisation of the Tramways.—At the meeting of the London County Council on Tuesday the Highways Committee reported that, in response to their advertisement inviting tenders for the lease of the portion of tramways about to be transferred to the Council, they had only received one offer, and that was from the London Street Tramways Company itself. The term of the lease was to expire on December 31, 1900, and the Company offered to pay an annual rental of £5,729; but there was a doubt as to the Company's power to take a lease. Taking into consideration all the circumstances of the case and the absence of competition, the Committee thought the Company's offer reasonable and recommended its acceptance, conditional upon the Company's obtaining powers to take a lease, to which the Council agreed.

Obituary.—The death is announced at Washington on the 23rd ult. of Mr. Rudolf Eickemeyer. Mr. Eickemeyer, says the *Electrical Review* of New York, was born in Bavaria and fought in the revolution of 1848. In 1850 he came to the United States and settled at Yonkers, where he lived up to the time of his death. Soon after his arrival he established a tool repairing factory. He became familiar with the hat trade, and set to work making machinery for the manufacture of hats. The royalties received from his inventions of hat machinery made him a very wealthy man. Mr. Eickemeyer was also an electrical inventor of ability. The Eickemeyer armature winding is a very ingenious and mechanical piece of construction, and has been used, under royalty, in a large number of machines both in America and England. In connection with Mr. Stephen D. Field, Mr. Eickemeyer developed an electric railway system of considerable merit. For many years Mr. Charles Proteus Steinmetz, now of Schenectady, New York, worked with Mr. Eickemeyer, especially in connection with his work on alternating-current apparatus.——The death is also announced of Dr. Martin Kiliani, head of the Aluminium-Industrie-Aktiengesellschaft, of Neuhausen.

Technical Education.—Addressing the Association of Technical Institutions at the Drapers' Hall the president, Mr. W. Mather, M.P., said that the returns of 1894-5 show that out of a total of 110 counties and county boroughs in England, 96 are giving the whole, and 13 part, of their grants to educational purposes. There is only one county borough in England which devotes the whole of its grant to reduction of rates; but happily in that borough (Preston) private munificence has provided a splendid technical school. In London, though only tardy progress has been made, probably the whole of the grant, viz.: £171,000, will be bestowed very shortly for educational purposes. There will probably remain only about £30,000 of the total sum of £780,000 devoted to the relief of local rates after this year, and the few Local Authorities who use the money for this purpose will, it is to be hoped, follow the lead of the country generally before long, and devote it to technical education.——At a meeting of the Manchester Council, on Wednesday, Alderman Hoy proposed a resolution which involved the acceptance of a tender for over £140,000 for the erection of a technical school. Alderman Clay moved an amendment confining the technical education committee to a total expenditure of £100,000. The amendment was defeated by 41 votes to 27, and the resolution was carried.

Science Degrees at Oxford.—Congregation has been occupied in considering part of a series of amendments on the statute for conferring degrees for research in letters and natural science, of which the principle was accepted by a large majority of congregation last November. The chief of these amendments was a proposal of the Provost of Oriel, Mr. Strachan-Davidson, and Prof. Odling to grant the ordinary B.A. degree in such cases, instead of creating new degrees—the Bachelor of Letters and the Bachelor of Science. They contended that this would equally answer the purpose sought, which was to find an issue from the necessary narrowness of a system of examination. The amendment was thrown out by 147 votes to 33. An amendment by Prof. Case, that "science should be taken to include mathematics, natural science, mental and moral science," though opposed by Mr. Gardiner on the ground that moral science could not be included and historical science excluded, was accepted by 137 votes to 34. An amendment by Mr. Cannan, directed against the creation of a special delegacy, was supported on the ground that much of what it was proposed to leave to the delegacy ought to be settled by the University, and that what remained should be the work of the several existing boards of faculties and of the professors. This amendment was carried by 110 votes to 49. An amendment by Prof. Holland, requiring from all candidates the possession of a degree of some University, was thrown out by 107 to 39. The discussion was adjourned by the Vice-Chancellor to Thursday, February 21st.

The Electric Lighting of the City of London.—Tuesday's *Financial Times* contained the following note, with which it is impossible not to sympathise. We can only trust that others who are put to constant inconvenience by these repeated collapses will take the matters equally philosophically and treat it equally humorously:—"Yesterday evening the electric light in our office and throughout the City generally went out. While candles, paraffin lamps and other substitutes for the new illuminant were being got ready, we made attempts to communicate by telephone with the City of London Electric Lighting Company. Whether owing to the failure of the telephone service—which is by no means unusual—or for other reasons, we were unable to obtain from the electric company's office boy anything further than the statement that their light had gone out also. A minute or two later the electric light was again available, and the first letter in the batch which had been in course of perusal when the light went out was the announcement by the City of London Electric Lighting Company, Limited, of a dividend of 6 per cent. on the Preference shares and of 5s. per share on the ordinary. We can assure the directors and shareholders of the City of London Electric Lighting Company, Limited, that the prospect of continuing this dividend will be very small unless they can provide a service which can be relied upon not to fail at critical moments. It is a pity that the title of 'The Light that Failed,' has been appropriated by Mr. Rudyard Kipling, seeing how admirably it would suit such circumstances as above referred to, which caused considerable inconvenience in the City yesterday, and on more than one previous occasion. The electric light is in some respects superior to gas, but is more expensive, and the expense is further increased when the gas has to be retained as a stand-by."

ON THE DELINEATION OF ALTERNATING CURRENT CURVES WHEN THE ALTERNATOR IS NOT ACCESSIBLE.

BY DR. J. A. FLEMING, F.R.S.

A large number of investigators have at various times put in practice the well-known method of delineating alternating current curves by attaching to the shaft of the alternator a revolving contact piece arranged in such a manner that a contact is closed for a very short fraction of a second at any assigned position of the armature coils with respect to the pole pieces of the alternator, and the precautions to be taken in obtaining correct results by this method are now well understood.

More than a year and a half ago, it became evident, however, to the writer that a number of interesting problems could only be solved if it were possible to obtain the current or electromotive force curve of any alternating current circuit without having access to the alternator or alternators producing the alternating current. For instance, supposing that an alternating current station is furnishing a supply of current at a high pressure through concentric cables to a number of sub-stations several miles distant from the generating station, it becomes an interesting question to determine whether the capacity of the cables has any effect upon the form of the curve of the electromotive force of the current, and in this case it is obvious that a revolving contact on the dynamo or dynamos is out of the question. After a good deal of experimenting, the writer has succeeded in constructing a simple arrangement which enables these curves to be taken with the utmost facility at any place and on any circuit. The principle adopted is a sufficiently obvious one, but the success of the apparatus depends entirely upon the details of construction. The method employed is to construct a small alternating-current motor, of a synchronous type, this motor being made to take up as little power as possible and to run with the most perfect freedom. On the shaft of this motor is fixed a contact arrangement, presently to be described, which contact is made to close a circuit at any assigned instant during the phase cycle, and this instantaneous contact puts into communication the source of alternating electromotive force and an electrostatic voltmeter which is employed to measure the fall of potential down a non-inductive resistance, which is placed either across the supply mains or in series with them. The general details of the machine are as follows, a sketch of it being given in Fig. 1.

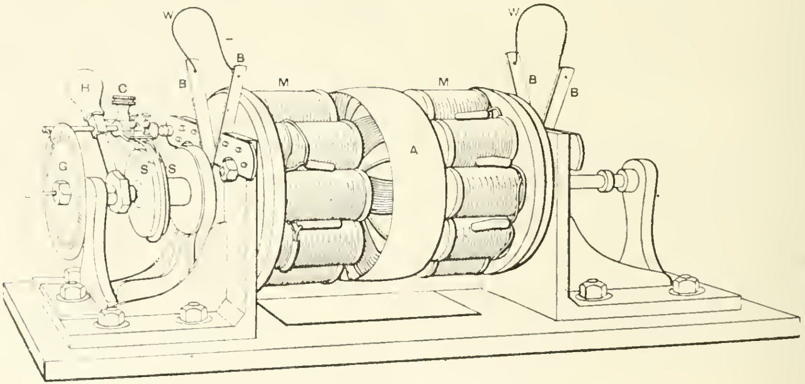

Fig. 1.—The Alternating Current Curve Tracer.

The motor part consists of two sets of field magnets, M M, which are secured to two cast-iron discs. Between these field magnets revolves a small armature, A, the iron core of which is formed of a strip of very thin transformer iron, wound up into a ring, the armature coils being wound upon this ring. The armature coils are joined up in series with one another, so as to give a series of contrary polarities round the iron ring. The diameter of this armature is about 6in. The field magnets have eight poles, and the armature eight coils. The field-magnet cores are bobbins about 2in. long, and $1\frac{1}{2}$in. in diameter, and when joined up in series in the proper manner the field magnets take a current of about four amperes to give them the proper amount of saturation. The armatures is carried upon a hard wood boss fixed to a steel shaft. This steel shaft is carried through small ball bearings like bicycle bearings, the shaft being borne upon seven or eight balls carried in gun-metal cells. In order to prevent any side shake of the armature, there are at the opposite ends of the base cast-iron pillars with a gun-metal screw at each end, against which the rounded end of the shaft bears. The shaft can thus be adjusted with great nicety, and runs with great freedom from friction. The ends of the armature coils are brought to two small insulated collars, fixed on the shaft, against which press two light brass brushes, marked B B, kept gently against the collars by mean of an expanding steel wire, W. On the armature shaft is an ebonite disc, which carries a transverse steel slip let into it. Two insulated springs, S S, are carried upon a rocking arm, H; the rocking arm can be traversed over through half a circumference, and is centred upon the gunmetal end screw which prevents side shake in the shaft. A pointer and graduated scale, G, enables the exact angular position of the springs, S S, to be determined.

One of the springs, S, is carried on a small adjusting screw, so that one spring can be given a little lead over the other, and in this manner the duration of the contact made when the steel transverse piece passes underneath and electrically connects the springs S S is determined. By means of a set screw the springs can be lifted off from the ebonite disc, and their pressure also adjusted. This little synchronising motor with its attached contact-breaker forms the apparatus for determining the form of the current and electromotive force curves. The motor is started in step with the alternating current flowing through the armature coils by passing round the end of the steel shaft which projects at the end opposite to the contact-breaker a tape or thin leather strap sprinkled with rosin. To start the motor the following arrangements are made: the field magnets must be served with about four amperes of current, which may be obtained from a small secondary battery, or from any other constant source of continuous current. The armature circuit requires about two amperes to make it run properly. Let us assume that the curve of electromotive force is to be taken from two 100-volt alternating current mains which come into a building. The armature of the motor is joined across these mains in series with two or three incandescent lamps placed in parallel. The field magnets being excited in the proper direction, the operator passes the strap or tape half round the shaft, and by pulling on one side of the tape the motor can gradually be set in rotation with an increasing speed. If the frequency of the alternating current is, say, 100 ∿, then the motor has to be brought up to run at something approaching to 1,500 revolutions per minute before it will drop into step, but at a certain speed the incandescent lamps in series with the armature begin to blink, and by a little skill in adjusting the speed by suitable pulls on the tape the motor will drop into step and continue to run in synchronism with the circuits. If the springs are then put down gently upon the revolving contact piece, a contact is made from one spring to the other at an assigned position during the phase of electromotive force, depending on the position of the rocking arm. If the maximum pressure to be read does not exceed 160 volts, then by far the most convenient instrument to employ for reading the pressure, and the one which has been constantly employed in these tests, is Lord Kelvin's vertical or horizontal pattern of multicellular voltmeter. As these voltmeters only begin to read at about 60 or 80 volts, it is necessary to add a constant electromotive in series with them, and this is done by employing a set of small lithanode secondary cells. About 50 cells in one tray form a convenient arrangement, provided that they have contacts at every cell, so as to take off any required electromotive force. The battery is joined up in series with the electrostatic voltmeter, and the terminals of the voltmeter are short-circuited by a condenser having a capacity of about half a microfarad. This arrangement of voltmeter and battery is then connected across the two points between which the potential is to be determined through the two springs SS. The motor being started, the needle of the voltmeter takes a certain deflection which is due to the electromotive force of the cells, plus the value of the difference of potential between the mains at an instant depending upon the position of the rocking handle. By blocking up the voltmeter in this way, and using more or less cells as required, so as to add a known amount to the electromotive force to be measured, the electrostatic voltmeter can be employed to measure potential differences over the whole range varying from zero to 160 volts in either direction. These observations are taken at equal short intervals as the rocking arm H is swept over through a quarter of a circle. It is possible to thus measure the instantaneous values of the alternating potential difference between the two points at equidistant instants throughout the phase. It has been found by experiment that this small alternating-current motor, when working on the circuits of any alternator of a size such as would be used in a generating station, does not affect the form of the curve of electromotive force sensibly. The motor is only used as a means of making the contact with a voltmeter at an assigned instant during the phase, the current which passes through its armature is not in any way measured or taken account of; the motor simply acts as a synchronising arrangement, which connects the contact-breaker *electrically* to the distant alternator. A large number of experiments were made with this curve tracer in the electrical laboratories at University College, London, these experiments being carried out with great zeal and assiduity by one of my assistants, Mr. J. T. Morris, and two of our senior students, Messrs. Petavel and Grimsdale. This curve-tracer was first employed to determine the curve of electromotive force of one of the Kapp alternators in the dynamo room of the electrical engineering laboratories at University College. This Kapp alternator is provided on its shaft with a contact-breaker, and the first experiment tried was that of determining the form of the curve of electromotive force of the alternator by means of the contact-breaker fixed on the shaft of the alternator, and then determining the same curve with the above described curve-tracer placed in the electrical laboratory at a distance from the alternator, but connected electrically to it. These two curves were identical curves. After having in this manner satisfied doubts that might exist as to the ability of the curve-tracer to give a curve identical with that obtained by a contact-breaker actually upon the shaft of the alternator, the curve-tracer was employed to delineate the curves of primary electromotive force and primary current of a Ganz 10-H.P. transformer worked off the Kapp alternator, and these curves are shown in Fig. 2. The transformer was constructed to transform down from 2,400 volts to 100 volts. In order to determine the curve of primary electromotive force, a non-inductive resistance of a form to be described later was constructed. This non-inductive resistance was capable of being put across the 2,400-volt circuit, and under these circumstances it absorbed 1,000 watts. This resistance was divided into two sections, nearly in the ratio of 1 to 23. From the ends of the smaller section wires were brought down and connected to the voltmeter, condenser, and battery, as above described, through the two springs, so that the potential difference actually measured was a known fraction of that existing between the terminals of this non-inductive resistance. The primary terminals of the transformer were then connected to the ends of the non-inductive resistance, both being in parallel across the high-tension circuit from the alternator. In addition to this another non-inductive resistance was placed in series with a primary circuit of the transformer of such magnitude that when the transformer was on open secondary circuit the fall in potential down this resistance was about 100 volts. From the measurements made, the varying potential difference at the end of these two resistances was determined, and it was possible to plot out the curves of electromotive force and primary current of the transformer when working off this alternating-current circuit. Three curves are given in Fig. 2. From the curves of current and electromotive force the curve of magnetic induction could be calculated. The dotted curve marked *volt curve* is the curve of primary electromotive force, or difference of potential at the terminals of the transformer. The dotted curve marked *current curve* is the curve of primary current, and the dots show the actual position of the observations. The figures on the horizontal line indicate degrees of phase. The scale on the left-hand side is the scale of volts, and that on the right-hand side the scale of current. The firm line curve is the curve of magnetic induction, and the middle scale is the scale of C.G.S. units representing induction density, or "number of lines of force per square centimetre" in the core. From the curves of induction and current the magnetic hysteresis curve was drawn, and the whole in the diagrams of the transformer thus obtained without access to the alternator at all. These being satisfactorily done the curve-tracer has been employed in the above-mentioned manner very successfully in taking a number of exceedingly interesting curves of current and electromotive force off the circuits of the City of London Electric Lighting Company. We have determined in this manner the curve of electromotive force of a single Mordey alternator working on open circuit, the curve of a Thomson-Houston 350-kilowatt alternator working on open circuit, or with its poles only closed with a non-inductive resistance taking up a 1,000 watts. We have also determined the curve of electromotive force of the same Thomson-Houston 350-kilowatt machine when supplying current to the transformer sub-stations of the City of London Electric Lighting Company between the hours of 11

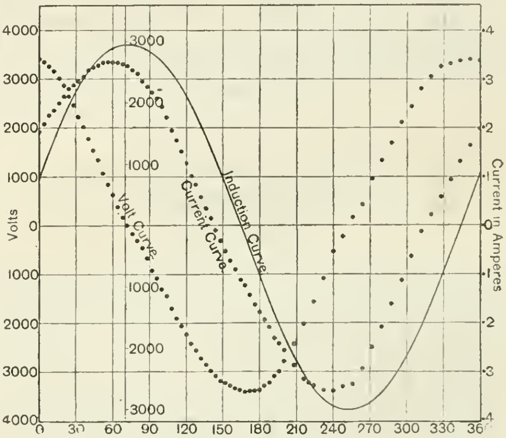

FIG. 2.—Curves of Ganz 10-H.P. Transformer taken off a Kapp Alternator by the Alternating Curve Tracer.

p.m. and 5 a.m., when the current is tolerably constant and the load is an inductive load owing to the fact that it largely consists of transformers lightly loaded. The resultant curves of current and electromotive force for the whole of the Bankside station have thus been determined during the night time. The curves of groups of alternators working single or in parallel or on non-inductive water resistance and also on the ordinary station load have been determined, and these curves form an exceedingly interesting addition to our knowledge of the form of the curves of electromotive force taken from different machines in different states of load. They show how widely different are the forms of the curves from different machines, and how much variations of the load may affect the form of the curve of electromotive force. A selection of these curves will be given in the continuation of this article.

These investigations are not nearly complete, and it is therefore too early to discuss the results obtained; but the very satisfactory performance of this apparatus for so determining the curves of electromotive forces and current shows that it will become a useful addition to our means of investigating alternating phenomena

One question has received solution. The iron core losses have been taken of a transformer when working off two different alternators, and the curves of electromotive force of these alternators also taken, and it has been found that the iron core loss in the transformer is least when taken on that alternator the electromotive force curve of which is farthest removed from being a simple sine curve, a result in contradiction to some statements made not long since.

(To be continued.)

CORE LOSSES IN ALTERNATE-CURRENT TRANSFORMERS.

BY ERNEST WILSON.

The losses in an alternate-current transformer, when in action, are to be accounted for by currents in the copper coils, by magnetic hysteresis, and by induced or "eddy" currents—whether current is taken from the secondary coil or not; in other words, whether the transformer is "loaded" or is working on "open circuit."

When in action on "open circuit," the energy supplied to the transformer by the primary coil is that taken by the current in overcoming the ohmic resistance of the primary coil, and that taken to produce changes of magnetism which account for losses by magnetic hysteresis and induced or eddy currents.

When "loaded," the energy supplied by the primary coil is, in addition to the above, that taken by the current in overcoming the resistance of the secondary coil itself, and also the energy transmitted to the external circuit.

It is the object of this Paper, setting aside all energy dissipated in the copper coils by the primary and secondary currents, to ascertain, if possible, whether the energy dissipated by magnetic hysteresis and induced or eddy currents combined is greater when the transformer is in action on open circuit than when loaded; in other words, to find the effect of current in the secondary coil upon this dissipation of energy.

Prof. Ewing has pointed out that "independent experiments by Prof. Ryan, Mr. Mordey, and Prof. Ayrton on the efficiency of transformers had apparently agreed on showing a marked reduction in the loss of energy due to magnetic reversals when the 'load' was put on."[*] Dr. Fleming also refers to these same experiments and discusses the matter fully.[†] On the other hand, Prof. Ewing's own experiments on small transformers, having rings of iron for their cores, show that "no change could be detected in the rate at which heat was produced by the reversal of magnetism when the 'load' on the secondary coil was varied from nothing to an amount greatly in excess of any 'load' used in practical transformers."

In the present research a 2,000-watt Westinghouse transformer has been experimented upon. The method of test adopted has been that originally introduced by Dr. Hopkinson for testing the efficiency of dynamo electric machines, and subsequently used by him for testing the efficiency of transformers.[*]

In a modern closed magnetic circuit transformer the dissipation of energy by magnetic hysteresis and eddy currents in a given time is a very small quantity as compared with the total energy transmitted from the primary to the secondary coil in the same time when the transformer is fully loaded. If we proceed to find this small quantity by *difference*; that is to say, if we find the work done upon the core by the primary in a given time, and also the work done by the core upon the secondary in the same time, it is the *difference* between these quantities which gives us this dissipation of energy.

Let A be the area of section of the core in square centimetres.
m and n be the number of convolutions of primary and secondary coils respectively.
R, r and ρ be their resistances in ohms, ρ being the resistance of the secondary coil external to the transformer.
x and y be the currents in amperes in the primary and secondary coils respectively.
$\mathbf{H}_1$ and $\mathbf{H}_2$ be the magnetic forces per centimetre linear in C.G.S. units, due respectively to x and y.
$\mathbf{H}$ be at any time the resultant of $\mathbf{H}_1$ and $\mathbf{H}_2$.
E_1 and E_2 be difference of potential in volts at any time between the extremities of the primary and secondary coils respectively.
$\mathbf{I}_1$ and $\mathbf{I}_2$ be the average total induction per turn in C.G.S. units through primary and secondary respectively.
l be the mean length of induction in core in centimetres.
f be the frequency in complete periods per second.

We have, then, the following equations :—

$$\frac{4\pi}{10}(m x - n y) = l\,\mathbf{H}.$$

$$E_1 = R x + m\frac{d\mathbf{I}_1}{dt}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$0 = (r+\rho)\,y + n\frac{d\mathbf{I}_2}{dt} \text{ if } \rho \text{ is non-inductive.}$$

$$E_2 = n\frac{d\mathbf{I}_2}{dt} - r y. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The work done upon the primary, per half period, by the external source is $\int_0^{\frac{1}{2f}} E_1\, x\, dt$. The work done upon the external circuit ρ by the secondary, per half period, is $\int_0^{\frac{1}{2f}} E_2\, y\, dt$.

From equation (1) we have work done, per half period, upon the core by primary $\int_0^{\frac{1}{2f}} m\, x \frac{d\mathbf{I}_1}{dt}\, dt$. From (2) we have work done, per half period, by the core upon the secondary $\int_0^{\frac{1}{2f}} n\, y \frac{d\mathbf{I}_2}{dt}\, dt$, and the energy dissipated, per half period, in the core itself is the difference of these two quantities. On open circuit the work done upon the core, per half period, reduces to $\int_0^{\frac{1}{2f}} m\, x \frac{d\mathbf{I}_1}{dt}\, dt$.

2,000-WATT WESTINGHOUSE TRANSFORMER.

This transformer is of the Westinghouse Company's usual type, and is intended to transform from 1,000 volts ($\sqrt{\text{mean}^2}$) on primary to 50 volts on secondary. Fig. 1 gives an end view of the core. The secondary consists of four wires in parallel, which, for the purpose of these experiments, were placed in series in order to increase the potential difference and to avoid circulating currents in the copper coils. This is not a new transformer, and, therefore, the results here given must not be taken as necessarily representing the Westinghouse Company's present practice.

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[*] *Phil. Trans.* Roy. Soc., Vol. 184 (1893).

[†] "The Alternate-Current Transformer," Vol. II., p. 463.

[*] See *The Electrician*, June 24, 1892.

(1) *Transformer in Action on Open Circuit.*—Fig. 2 gives a diagram of connections in the experiments made upon the transformer when working on open circuit, in which W is a Siemens W 12 alternator, R and r are the primary and secondary coils of the transformer, C is a revolving contact maker* fixed to the shaft of the alternator, k is a two-way switch, Q is a Kelvin quadrant electrometer, $r_1\ r_2$ and $r_4\ r_5$ are high non-inductive resistances ($r_1 = 100{,}400$, $r_2 = 300$, $r_4 = 21{,}200$, $r_5 = 300$ ohms) for the purpose of reducing the potential applied to the electrometer, r_3 is a non-inductive resistance of 10·13 ohms for the purpose of obtaining the current in the primary coil. The alternator was run at 980 revolutions per minute, or a frequency of 98 complete periods per second; the volts ($\sqrt{\text{mean}^2}$) on primary and secondary were 653 and 129 respectively, and the readings for the three curves

1. Primary current x,
2. Primary potential difference E_1,
3. Secondary electromotive force $n\dfrac{dI_2}{dt}$,

observed. These are tabulated for a half-period in Table I., from which the other data in Table I. have been obtained.

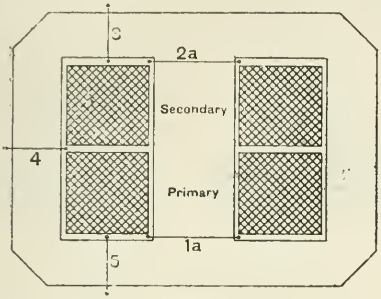

Fig. 1.

A is taken to be 147½ sq. cm.
l is taken to be 34·6cm.
$m = 400$; $n = 80$.

R = 5·82 ohms; this was taken immediately after test, the temperature of transformer being about 37° C.

From Table I. we find that $\sum_0^{\frac{1}{2f}} H_1 \dfrac{\delta I_1}{\delta t} = 45{\cdot}9$, $\delta t = \dfrac{1}{30f}$. It must be noted that this quantity includes any loss due to eddy currents in the copper coils, as well as the losses due to magnetic hysteresis and eddy currents in the core itself.

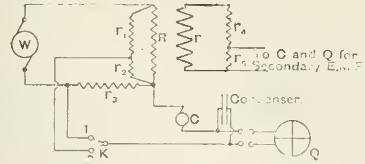

Fig. 2.

Subsequent experiments show that this loss is reduced by about 4 per cent., when the temperature of the transformer is raised from 16 to 50°C., the frequency being, as before, 98, and the secondary $\sqrt{\text{mean}^2}$ volts 130.

A cyclic curve of hysteresis was obtained by means of the ballistic galvanometer, and when compared with the cyclic curve got by plotting B_1† in terms of H_1 from Table I., shows that in this transformer when working as in these experiments the loss per cycle due to eddy currents alone would be about 11 per cent. of the loss due to hysteresis. So that the effect of temperature on the loss by eddy currents might not be expected to be considerable.

Table I.

Angle in 60ths of a period.	Amperes x	H_1	Volts E_1	Volts Rx	Volts $m\dfrac{dI_1}{dt}$	Volts $\dfrac{dI_1}{dt}$	$H_1\dfrac{dI_1}{dt}$	B_1	Volts $\dfrac{dI_2}{dt}$
0	0·209	3·03	809·6	1·17	808·4	2·021	6·12	994	2·003
2	0·226	3·284	702·2	1·27	700·9	1·752	5·74	1,441	1·725
4	0·2451	3·561	620·8	1·37	619·4	1·548	5·52	1,824	1·535
6	0·267	3·88	521·0	1·5	519·5	1·299	5·04	2,156	1·304
8	0·2863	4·16	354·6	1·6	353·0	0·8825	3·67	2,405	0·911
10	0·2988	4·34	130·9	1·67	129·2	0·323	1·40	2,550	0·382
2	0·2898	4·21	*95·48	1·62	*97·1	*0·243	*1·02	2,560	*0·158
4	0·2102	3·055	308·3	1·18	309·5	0·774	2·36	2,435	0·663
6	0·0965	1·402	474·6	0·54	475·1	1·188	1·67	2,209	1·095
8	0	0	578·3	0	578·3	1·445	0	1,902	1·362
20	0·0708	1·028	674·9	0·396	674·5	1·686	1·74	1,536	1·604
2	0·1214	1·765	796·6	0·68	795·9	1·989	3·50	1,111	1·896
4	0·1568	2·279	919·3	0·88	918·4	2·296	5·24	618	2·210
6	0·1798	2·613	980·4	1·01	979·4	2·448	6·39	55	2·386
8	0·1974	2·868	924·8	1·11	923·7	2·309	6·63	*500	2·280
							45·94		

* The asterisk indicates where the curve crosses the axis.
Maximum $I_1 = 379 \times 10^3$. Maximum $I_2 = 368 \times 10^3$ C.G.S.

If the whole of the induction were confined to the iron core there should be no difference between the curves $\dfrac{dI_1}{dt}$ and $\dfrac{dI_2}{dt}$. There is a difference, and this is due to "stray" magnetic field, by which is meant all induction not confined to the iron; this may either thread through a portion of the secondary coils or may miss them altogether.

(To be concluded.)

NALDER BROS. AND CO'S "N.C.S." FOUR-COIL GALVANOMETER.

Now that galvanometers must be classed among engineers' tools, it is necessary that the brass and glass covers and all unnecessary excrescent parts should be avoided. When an instrument maker built each galvanometer separately, each instrument was a work of art, no two were alike, and a high resistance sensitive instrument not only took up a good deal of space but generally had a considerable part of a room devoted to it. The galvanometer which we illustrate herewith is of a remarkably compact and simple design, and is capable of standing rough handling in technical colleges and central stations, while it is at the same time a high-class sensitive instrument.

By means of the four milled heads the ebonite front of the case may be removed, and with it two of the coils which are embedded in it. This gives access to the needle suspension. The base is arranged for screwing to a table, or, as is customary now in many laboratories, to a wall bracket. Levelling screws are provided, and act not as feet for supporting the instrument, but as part of the apparatus, as in surveying instruments. It will be seen that there are two upper magnets, and one lower one, just above the levelling screws. The lower one is for the purpose of bringing the spot to zero, and the upper pair for controlling the strength of the field. The resistance is about 5,000 ohms. There are no loose connections, the contacts between the front and back pairs of coils being through two of the clamping screws.

The needle is generally air damped, and comes to zero very quickly; it is not subject to electrostatic disturbances. The whole system is easily removable through the slot at the top when the front plate and magnets are taken off. The following directions are given by the makers for adjusting these magnets:—

When the needle is moving freely, adjust the spot to the zero to which it is required to work by the bottom magnet, and do not touch this again; then replace the top magnets with their poles opposed and over one another, and bring the spot to zero again by moving the two together. Try

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[*] For description of contact maker see "Original Papers on Dynamo Machinery," by Dr. J. Hopkinson, p. 187.

[†] B_1 is the average induction per sq. cm of the core, the assumption being that the distribution of induction is uniform and confined to the iron core.

whether they are working direct or opposed to the previous resultant field. If direct, a small clockwise movement will move the needle clockwise; if opposed, it will move the needle counter clockwise. By turning the two together through 180deg. from the direct position they will work opposed. If a quicker swing be required than that given by the lower magnet, put the top ones direct, open them a little, and bring the spot to zero; if the swing is still too slow, repeat the operation.

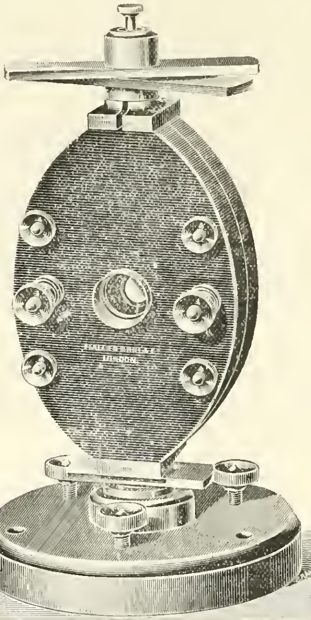

Fig. 1.

The quickest swing is, of course, that when the two north poles are over one another.

To get a slow swing, put the magnets (closed and N over S, as before) opposed, and bring the spot to zero. If not slow enough, open a very little and again bring to zero. The openings should be very little increased at a time, as the effect is much greater than when working direct; it is easy to open a little too much, and then the needle becomes unstable. With a little practice it is easy to get any time of swing from the quickest up to 15sec. in a couple of minutes.

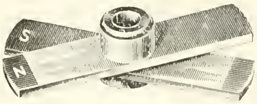

Fig. 2

On no account interfere with the magnetism of the control magnets; they are very carefully magnetised to the right strength.

The Majunga-Mozambique Cable.—The "François Arago" has left Calais with the 260 miles of cable manufactured by the Société des Téléphones and will stop at St. Tropez to take in the 200 miles of cable contracted for by M. Grammont. These cables will be laid between Majunga and Mozambique, where a connection will be made with the cable of the Eastern and South African Company. "It is deplorable," remarks a Paris journal, "to be forced still to use English cables. It proves the vital necessity for our country to extend the system of French cables."

THE CHEMNITZ THREE-PHASE ELECTRIC LIGHTING STATION.*

In 1892 the Town Council of Chemnitz decided to light the town by electricity, and in 1893 the contract for the whole work was placed with Messrs. Siemens and Halske. Building was commenced at the end of August, 1893, and the end of May, 1894, saw the regular supply of current started.

The three-phase system of distribution, with one transformation, was adopted, as it was found necessary to send current to some distance, not only for lighting purposes, but also for working a large number of motors. The place chosen for the central station is in the northern boundary of the town.

Steinmüller boilers, for working at 180lb. pressure, and fitted with Leach's mechanical stokers, are used. These stokers are driven by a small rotatory current motor. In the engine house are erected three triple-expansion condensing engines, from the Sächsischen engine works of Chemnitz. The expansion gear is worked directly from the regulator. This arrangement, used for the first time here and contemporaneously in the central station of the Dresden railway station, makes it possible to regulate the steam supply as desired from the switchboard. For this purpose a small motor is arranged on each machine, which is connected in the main circuit of the exciting dynamos. By means of double switches on the main switchboard, the motors can be made to revolve in either direction, and through a double worm and tooth-wheel arrangement to move the balancing weight up or down in the regulator.

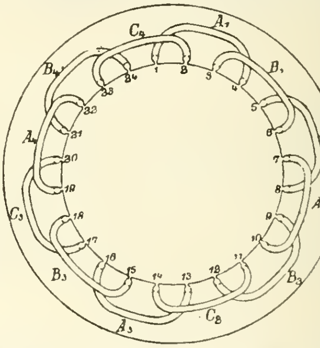

Fig. 1.—Diagram of winding of armature of Siemens and Halske Three-phase Machine

The dynamos are Siemens and Halske's type R, built for an output of 52 ampere and 2,000 volts, or about 180 kilowatts, and are coupled direct. The dynamos consist as a whole of a fixed outer ring armature and a revolving inner star-shaped magnet. In these machines the number of pole-pieces is 40, and at 150 revolutions per minute the periodicity is consequently 50. The armature ring, made up of iron sheets and fastened by bolts to a cast-iron frame, has on its inner circumference a row of slots, usually three slots for each pole. In these slots are wound the armature coils. The slots are of considerable size to allow of a perfect insulation. The insulation throughout is of mica, laid for extra precaution between plates of insulating fibre.

The method of winding is shown in Fig. 1, and is performed as follows:—The wire, brought from the back to the front through slot 1, is carried on the front face to slot 4, through it and back to slot 1 on the other face, so that we have a closed loop. This is done as often as required. In the same way, the wire through No. 2 is carried to 23 on the front face and back to No. 2 on the other face. In a similar manner coils are wound through 3 and 6, through 5 and 8 and 7 and 10, &c. Fig. 1 represents the armature of an 8-pole machine. If the machine is built for a high voltage, as is the case here, the coils A_1, A_2, A_3, and A_4 are joined up in series; the coils B_1, B_2, B_3, and B_4 in series, and the coils C_1, C_2, C_3, and C_4 also in series. One end of each of the three is joined to a common terminal, and the other three ends are joined to three separate terminals on the machine. The opening of the slot is narrower than the slot itself, and after winding is plugged with a wooden key, to keep the coils quite firm.

The R machines show, with an inductionless external resistance and constant normal excitation, only about 7 per cent. difference in voltage, when running light or with full load. When driving motors the phase displacement between current and volts causes the fall in voltage to be much greater, on account of the increased armature reaction. In pure motor driving the fall of potential may be increased four times. The form of the voltage curve does not differ much from the sine curve.

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* From the *Elektrotechnische Zeitschrift.*

In Fig. 2 are shown the connections for one machine. The dynamos, it should be mentioned, are provided with auxiliary coils, which carry the 80th part of the main circuit voltage; this device obviates the necessity of small transformers for measuring the voltage and for connecting in parallel. The paralleling arrangement (P, Fig. 2) has two switches, each of which has two curved metal strips and a number of contact pieces. Diametrically arranged are springs which rub on these contact pieces, and connect each of the two opposite contact pieces with the curved metal strip next to them. Each two opposite contact pieces on each switch are connected with the ends of the auxiliary coils of a dynamo. In the diagram the left-hand voltmeter S_1 is connected with the top right-hand contact piece on the right-hand switch. If now we place the right hand switch on these contact pieces then the left voltmeter shows the voltage in the auxiliary coils of that machine which is connected to the contact pieces, on which the left-hand switch stands. The right-hand voltmeter, as well as the lamp in parallel with it, are during this time without current. In order to be able to connect two dynamos in parallel, each would be first brought to the same voltage. In order to do this, both switches are used in the manner just described, placing the left-hand switch first on that pair of contact pieces belonging to the one dynamo, and then on that pair which belongs to the other dynamo. Next each switch is placed on the contacts in connection with the two dynamos. The left voltmeter is then cut out of the circuit, and the right voltmeter and lamp are put in the circuit of the two opposing auxiliary coils. Parallel connection then takes place, when it is shown that synchronism of phase prevails in the auxiliary coils. This is shown by the voltmeter going back to zero and the lamp going out. Fig. 2 shows at the bottom the small motors for regulating the steam engines, above them the rotatory current dynamos, and above these the excitors.

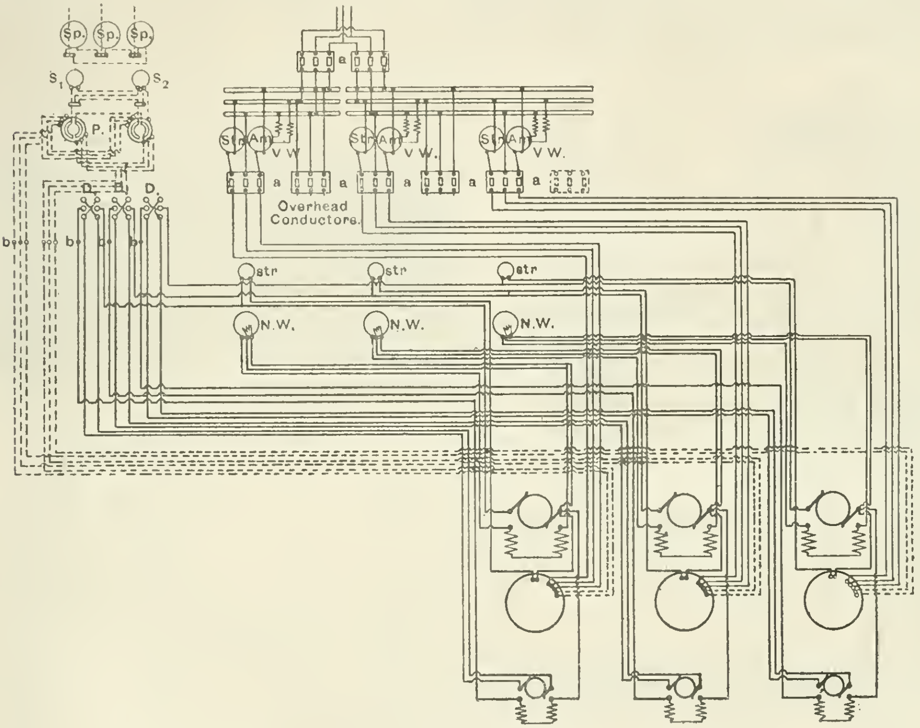

FIG. 2.—Diagram of Connections.

Sp=voltmeters for distributing mains, P=arrangement for connecting in parallel, *Str*=ammeter for rotary current dynamo, *str*=ammeter for exciting dynamo, D=two-way switch, A M=energy meter. V W=relay resistance. *a*=high-pressure switch with fuses, *b*=fuses, N. W.=shunt regulating resistance.

All the connections between the switchboard and dynamos are carried out by means of cables laid in tunnels in the engine house. The current from each machine is led through fuses in the high-pressure switches, through the measuring instruments, to three omnibus bars fitted on the back of the switchboard, from whence branch the high-pressure conductors to the distributing mains. In order to be able to work on one part of the switchboard while the plant is running, the omnibus bars are divided, in such a manner that they can be joined and divided by two high-pressure switches placed on the back of the switchboard (shown in Fig. 2 at the top).

The high-pressure cables are all Siemens and Halske's triple concentric. The current is transformed from 2,000 volts to 120 volts by transformers dotted about the town, and is then carried at this voltage by the distributing mains to the points of consumption. The number of transformers was originally 19; but it has since risen to 24.

The distributing mains are calculated for supplying current to 20,000 8-c.p. lamps, burning at the same time. For this purpose were required about 10 kilometres (6·2 miles) of armoured lead-covered triple concentric cables, with from 3×16 sq. mm. to 3×50 sq. mm. section of copper, intended for the high-pressure currents. About 20 km. (12.4 miles) of similar cable with from 3 by 25 sq. mm. to 3 by 70 sq. mm. section of copper for low pressure. About 7 km. (4·3 miles) of bare and insulated conductors, with from 35 sq. mm. to 40 sq. mm. section of copper. About 1·2 km. (¾ mile) testing cable with three conductors.

The central point of consumption is about 1 mile, the farthest point about 2 miles from the central station.

The first 19 transformers were built for a total output of about 500 kilowatts, and they are placed with the necessary fuses and switches in iron pillar boxes of about 13ft. high and 4ft. diameter. The pillars are all made of the same size, and large enough to take a 50-unit transformer. Fig. 3 shows on the right the outside, and on the left the inside, of such a pillar. These pillars are as follows: On a strong cast-iron pedestal, A, is fastened a metal cylinder, B, 6ft. high, strengthened with T iron, which carries on its top rim a strong cast-iron ring, C. The ring C supports a floor, partly open and strengthened with high ribs. On this ring is placed a second metal cylinder 6ft. high, which is closed in and has rain-proof roof.

The floor divides the inside into two parts, I. and II. In the top part (I.), which has three doors to it, is placed the transformer, while in the bottom part (II.), which has only one door, are placed the switches, fuses and cable terminals. The cores of the transformers, made of thin insulated iron sheets, consist of three vertical pillars set up at the corners of an equilateral triangle, and are magnetically connected at the bottom and top by iron plate end pieces. The coils are wound on separate bobbins, which can be easily interchanged when the cover of the transformer, with the end connecting piece attached to it, is removed. The low-pressure coils lie concentrically inside the high-pressure coils. The bobbins for the high-pressure coils are made of insulating fibre and mica; for the low-pressure they are of fibre only, which is coated to protect it from damp. The air spaces between the outer and inner bobbins, and between the inner bobbin and the iron core, serve for ventilation. According to the size of the transformer, the windings on each column consist of two or three pairs of coils arranged one above the other. The coils on the three separate columns are always joined "star" fashion. The rise of temperature due to continuous full load is about 50°C. Fig. 4 shows diagrammatically the cable connections. These pillar boxes are ventilated by means of an opening in the roof, but a double cast-iron shade prevents snow and rain driving in. All doors are provided with safety locks.

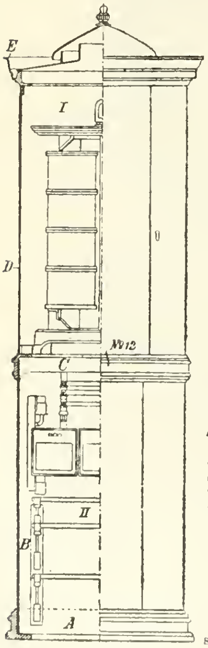

Fig. 3.—Transformer Pillar Sub-station.

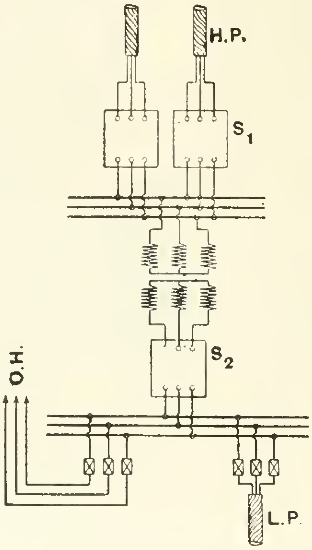

Fig. 4.—Diagram of Connections in Transformer Sub-station.
H.P. = high-pressure leads, S_1 = high-pressure switch and fuse, S_2 = low-pressure ditto, L.P. = low-pressure network, O.H. = overhead wires.

Insulation tests of the distributing cables gave the following results:—

1. Low-pressure Cables tested at 109 volts.

Insulation resistance of inner conductor (middle and outer conductors to earth) = 446 megohms.
Insulation resistance of middle conductor (inner and outer to earth) = 208 megohms.
Insulation resistance of outer conductor (inner and middle to earth) = 172 megohms.
Total length about 18 kilometres (11·2 miles).

2. High-pressure Cables tested at 960 volts.

Insulation resistance of inner conductor (other two conductors to earth) = 301 megohms.
Insulation resistance of middle conductor (other two conductors to earth) = 150 megohms.
Insulation resistance of outer conductor (other two conductors to earth) = 114 megohms.
Total length about 10 kilometres (6·2 miles).

The insulation resistance of the whole of the low-pressure mains, with transformer coils in circuit, tested against earth at 109 volts, was 210,000 ohms; that of the whole high-pressure system, with transformer coils in circuit, tested at 965 volts against earth, was 401,000 ohms. The insulation resistance of both lots of mains, with the transformer coils in circuit, tested also at 965 volts, was 465,000 ohms.

The capacity test of the high pressure mains (the transformer coils not in circuit) could only be an approximate one, on account of the difference in the dielectric used here and in ordinary condensers. Between inner conductor on the one hand, and middle and outer conductors and earth on the other, it was 0·47 microfarads. Between middle conductor and other three it was 1·06 microfarads. Between outer conductor and other three it was 2·12 microfarads.

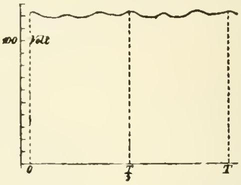

Fig. 5.—Curve of Exciting Current.

The form of the current curve was determined by Messrs. Siemens and Halske by means of a special apparatus. In this apparatus there is a small rotatory current motor, whose field-magnet ring is supplied with current from the dynamo being tested. The armature is not arranged as short circuit, but is excited by a continuous current from the exciter, so that it must run synchronously. The shaft of the motor carries rings and contact pieces, which at a certain point in each revolution make connection, first between a condenser and the current under test, and then between the condenser and a galvanometer. Thus, at each revolution, the condenser is charged to a voltage corresponding to a certain phase, and is then discharged through the galvanometer. With a high speed of the motor one gets a constant deflection on the galvanometer proportional to the voltage of the phase. In testing the current from a dynamo, the whole voltage is not used; but a large inductionless resistance is placed in parallel to the conductor feed from the dynamo, and only from a portion of this resistance is current taken to charge the condenser. The exciting current curve was examined as well as the current curve from the dynamo itself, loaded and unloaded.

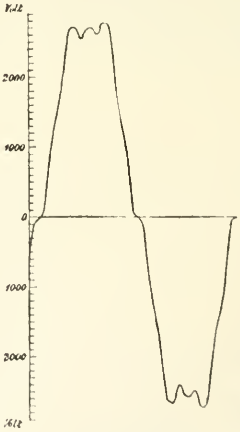

Fig. 6.—Dynamo Current Curve (running light).

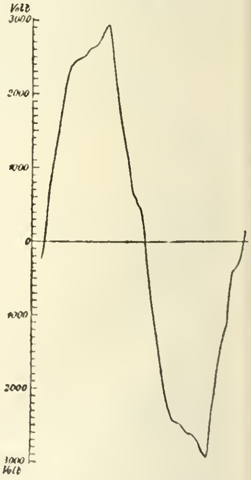

Fig. 7.—Dynamo Current Curve (running loaded).

Fig. 5 shows the curve of the exciting current, and exhibits plainly the results of armature reactions. The period of the fluctuations is six times that of the current supplied from the dynamo. If T is the period of the latter, t the time, then the curve for the exciting current is given by

$$1+\frac{1}{66}\sin\left(\frac{12\pi t}{T}+\frac{\pi}{2}\right).$$

The form of the current curve of the dynamo itself (Fig. 6) when running light is, above and below the abscissæ, as well as on each side of the maximum, almost symmetrical, and may be found by the formula—

$$\sin\frac{2\pi t}{T}+0{\cdot}087\sin\left(\frac{10\pi t}{T}+\pi\right)+0{\cdot}052\sin\left(\frac{22\pi t}{T}+\pi\right).$$

The current curve for the loaded dynamo (Fig. 7) is unsymmetrical on each side of the maximum, but the curve below the abscissæ is a representation of the curve above. A similar curve, but without the finer points, may be obtained from the formula—

$$\sin\frac{2\pi t}{T}+\frac{1}{15}\sin\left(\frac{10\pi t}{T}+\frac{3\pi}{2}\right).$$

At the end of November, 1894, there were connected to the central station: 5,220 16-c.p. glow lamps, 152 arc lamps, and 29 motors with a total output of 62 H.P. The charge for current is 7 pfennigs (about 8½d. per B.T.U.), and 1·8 pfennigs per 100 watt-hours for power (2d. per B.T.U.). Power is also supplied, if specially mentioned in application sheet, by the time, and is charged for at the rate of 14 pfennigs, or about 1½d. per 1 H.P. per hour.

The rotatory current motors made by Siemens and Halske have a fixed outer field-magnet ring, which is built and wound exactly like the outer fixed armature ring of the rotatory current dynamo. A drum armature, built up of iron sheets and having slots on its outer circumference, rotates inside the field-magnet ring. The air space between armature and magnet is as small as possible to keep the current when running light, and the displacement of phase between current and volts, as small as possible. The armature is wound exactly like the outer ring. The ends of the three groups of coils are joined up "Star" fashion. On each ring rub brushes, which are connected to three points in a starting resistance. The contact pieces corresponding to the resistances are arranged in an arc. Three brushes, joined together and placed at 120° from one another, join the resistances in "Star" connections. This allows different resistances to be cut in or out, which are always equal for the three groups. On starting the whole resistance is put in, so that the induced current in the armature coils cannot become too strong. As the speed increases the resistance is gradually cut out. At full load the resistance is all cut out and the armature short circuited. The use of this device allows the motors to be started, even under full load, without influencing materially the voltage in the conductors.

THE THREE-WIRE SYSTEM AT ST. LOUIS.*

For three years the three-wire system has been used by the Union Power Company, of Portland, Oregon, for supplying current to the street railway systems of that city. At Bangor, Me., it has also been used three years. Although these roads have been operating with success on the three-wire plan for so long a time, the matter has attracted little attention until recently. In October, about the time of the Atlanta Street Railway Convention, the General Electric Company began to push this system. Meanwhile, experiments were being begun at St. Louis under very unfavourable conditions, and as these have now terminated successfully, an extended description of the work done there will be of special interest at the present time, when so many street railway men are watching the three-wire system, with a view to its possible adoption.

As no less than two prominent street railway men have asked the writer "where the third wire comes in," it may be well to preface this description with a short explanation of the principles of the system. The term "three-wire" does not mean that more than one trolley wire is used. It refers simply to the manner of connecting the generators to the trolley feeders. Not even an expert could tell whether a road was being operated on the three-wire plan by simply looking at the overhead lines. The connections for the three-wire system are made as shown in Fig. 1. The trolley wire is divided into sections. The positive poles of half the generators running in the station are connected to a part of the sections, and the negative poles of the remaining generators are connected to the remaining sections. The positive poles of half the generators are connected to track and ground, and the negative poles of the other half to track and ground. This practically puts the two generators in series with one another. The trolley wire sections are so arranged that about the same number of cars are on the positive and negative sections. The system is then "in balance." In Fig. 1 two generators are pulling two cars. The current goes out through the positive feeder and trolley, through the car to the ground, along the track to the car on the other section, and through that car back to the power house and to the generators. If the car on one section is stopped, the system is out of balance, and the current from the other returns to the power house through the rails and ground, as in the ordinary two-wire system. However, on a large road, with a large number of cars, the balance between the two sides can be kept, so that very little returns through the ground. Aside from preventing electrolysis, the system has the advantage of a saving in copper, as it is practically a 1,000-volt system, and the amount of copper required varies inversely as the square of the voltage. Hence, theoretically, only one-fourth as much copper is necessary to transmit a given power with a given loss as with the 500-volt system. This, however, is modified by some practical considerations, and the matter of the actual saving accomplished will be discussed later. The three-wire system is not a new thing. It has been used for years by all the large direct current incandescent lighting stations. Its economy is unquestioned. The only difficulties in applying it to railway work are the maintenance of the balance between the positive and negative sides, and the insulation between the sections, which must be strong enough to withstand the 1,000 volts pressure.

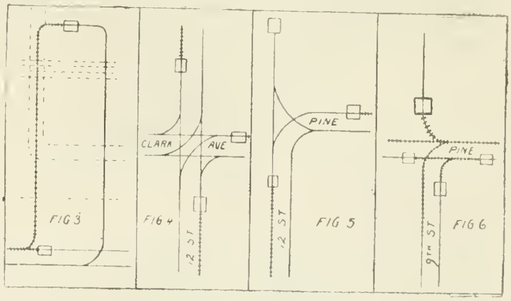

Fig. 1.

The experiment at St. Louis was tried on a portion of the lines of the Union Depot Railroad. The work has been under the charge of W. C. Gotshall, the well-known electric railway expert, formerly of Chicago. To him is due the credit of working out the technical details and pushing to success a plan which met with much opposition on the part of local experts. He has proved the soundness of his judgment in advocating the system. John Scullin, president, and Harry Scullin, general manager of the Union Depot Railroad, also deserve the thanks of the other street railway men of the country for giving the system a trial in spite of the assurances they received from certain electricians that it would burn out the entire station and bankrupt the company.

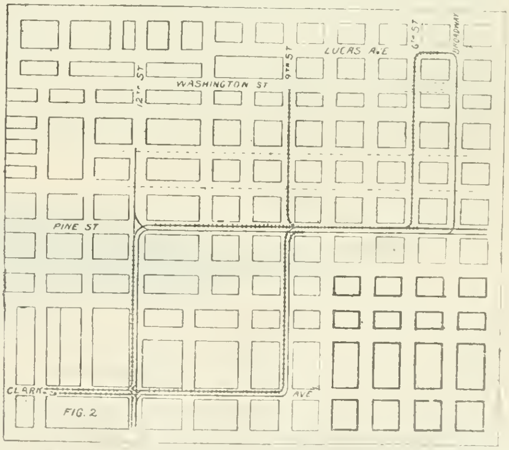

Fig. 2.—Map of Down Town Loop Union Depot R.R., St. Louis. Operated on the Three-wire System.

╫╫╫╫ Positive Trolley, ——— Negative Trolley, ... Other Lines.

The portion of the road selected on which to try the experiment was the down town loop comprising five miles of single track. This is the part on which there is the heaviest traffic and on account of its many curves and crossings is the most difficult to successfully operate on the three-wire plan. It was admitted beforehand that

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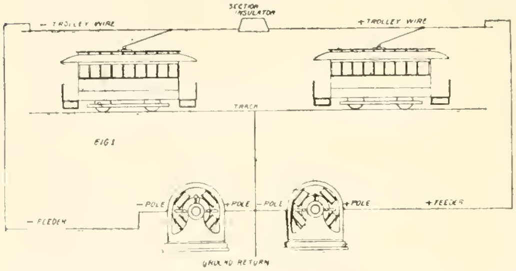
*Abstract from *Street Railway Review*.

if the loop could be operated in this way there would be no difficulty on the rest of the system. Another reason for making the change on this part of the road was that there was a heavy drop in voltage on that portion. Fig. 2 shows the lines now operated on the three-wire plan. The plain lines are the negative trolley wire sections, the crossed lines are the positive trolley wire sections, and the dotted lines are the lines of other roads which are, of course, positive. It will be seen that in general the policy has been pursued of making the wire over one track positive and the other negative. At the branch off curves either the positive or negative wire is insulated by section insulators from the curve, so that the entire special overhead work at a curve is either positive or negative. After the curve is passed another section insulator is put in and the different polarity of wires resumed. This is well illustrated by Fig. 6, which shows in detail the work at Ninth and Pine-streets. Fig. 4 shows another piece of special work at Clark-avenue and Twelfth-street, and Fig. 5 one at Pine and Twelfth-streets. Fig. 3 is most interesting of all, however, as it shows thirteen overhead crossings with other roads. Of these, seven are on the negative wire, so that there is 1,000 volts difference between the wires. On Washington-street the trolley wires of two other companies are run, paralleling each other, and about a foot apart. They cross the negative trolley at Broadway.



FIGS. 3, 4, 5, and 6.

Preparations were begun for the change about September 1, 1894, and the three-wire system was first put in operation about October 1st. Owing to changes that were being made in the station, the three-wire system could not be operated continuously until about seven weeks ago. Since then, according to Mr. Gotshall, the three-wire system has been in continuous operation, and there has been only one emergency call on the three-wire portion. This was caused by the breaking of a crossing by a trolley pole which flew off. The three-wire system has not caused the shutting down of any portion of the road, even during the experimental period, because, in case of a short circuit between positive and negative sections, it is only necessary to throw a switch at the station and resume operation on the two-wire plan until the defect can be fixed. The section is being operated now with eight 62-kilowatt Thomson-Houston generators—four on each side. The only expense for material in the station in making the change was the cost of two single-pole switches and 500ft. of 0000 feeder wire. The practical advantage gained has been a great improvement in the voltage at the down loop, which is two miles from the power station. The speed was formerly slow and the light bad, but there is now evidence of very little drop in potential.

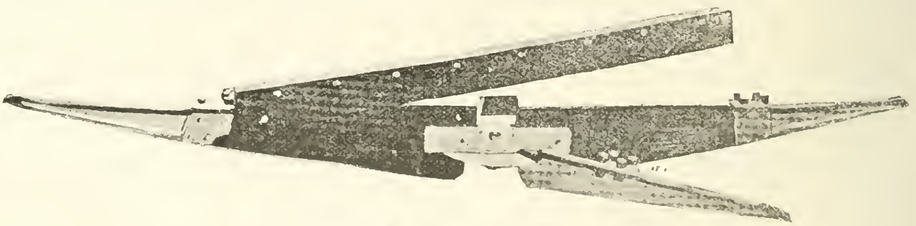


FIG. 7.—Crossings used with Three-wire System. St. Louis.

In the course of experiments it did not take Mr. Gotshall long to find out that the ordinary forms of section insulator and crossing will not withstand 1,000 volts in all kinds of weather, and, accordingly, slight modifications were devised which served the purpose well. The form of section insulator adopted is simply a slab of hard fibre, with 10in. between contacts instead of the usual 5in. For crossings the ordinary swivel crossing, in which the wire on the dead side runs in a groove along the top of the hard fibre, is modified by putting a wedge of hard fibre in the opening over the centre bolt (Fig. 7). A cap is also put over the wire after it is put in the groove, so that it is enclosed in a water-tight case the length of the crossing. Before the wedge was put over the bolt head, dirt or moisture would sometimes strike an arc across the ¾in. air space between wire and bolt head, and a burned out crossing would result. The crossings have ten inches of hard fibre between metal contacts.

Another important point is the method of tapping in from feed wire to trolley wire. It often happens that the positive feed wire will be on the opposite side of the street from the positive trolley wire. It is, therefore, necessary to keep the tapping-in wire thoroughly clear of the trolley wire of opposite potential which it crosses. This was finally successfully accomplished by making the trolley clip with a special piece into which the wire could be soldered and run directly across to the feed wire on the pole. Making the span wire a feed tap, and trying to insulate one of the trolley wires from it, was found to be impracticable, because there must be 1,000 volts between the trolley and the span wire.

Aside from the problem of insulation, which has been successfully solved in the manner described, the maintenance of the balance is the principal question. This is a matter that cannot be decided in a general way to cover all cases. There are two methods of dividing a line to maintain a balance. One is to make one track positive and the other negative. This will keep the balance as long as the cars are not bunched and the traffic is not too much on one side. The other method is to divide the line up into short sections, and make alternate sections positive and negative. This will keep the balance better under all circumstances, but it is not desirable to cut up the line so much. A combination of these two methods, with plenty of common sense and judgment, will give the best results. The arrangement of the switchboard with the three-wire system may be such as to permit any arrangement of feeders or generators. It should be possible to put any generator on either side of the circuit. Otherwise it is necessary to set aside half of the generators to permanently operate one side and half on the other side. In case of an unusual number of breakdowns on one side the service would be seriously impaired, as it would not be possible to bring all the idle generators into service. Therefore it should be possible to put any generator on either side, and to do this it is only necessary to put a double throw three-pole switch in place of the usual single throw three-pole generator switch. Throwing the switch one way would connect the positive pole of the generator to the positive trolley bus bar, and the negative pole to the grounded bus as in usual practice. Throwing it the other way would connect the positive pole of the generator to the grounded bus and the negative to the negative trolley bus. At the feeder board each feeder or group of feeders supplying a section should have a double-throw single-pole switch in place of the single-throw single-pole switch now used, so that a section can be thrown either on the positive or negative side. This is important for two reasons. In the first place, it obviates shutting shutting down a section when the insulation between sections or at crossings breaks down. When this occurs, the section can be thrown in on the other side until the insulation is repaired. In the second place, it is easier to maintain a balance when the sections can be thrown on either side. In case it is found that the balance is not good, it is only a matter of a few seconds to restore it by changing the polarity of some of the sections. Thus the traffic will be heaviest on the ingoing tracks in the morning and outgoing tracks in the evening. This can all be provided for by the double-throw feeder switches. Main ammeters should be put in both the positive and negative bus bars, so that the balance can be determined at a glance.

The principal objection now raised against the three-wire system is that it always requires the operation of at least two generators, and where, as in the most recent modern practice, there are only a few generators in a power station, it is not easy to proportion the generator capacity to the load to be taken care of. There is some weight to this objection, but on very light loads, as for running owl cars during the night, the sections can all be switched on to one side of the circuit, and one small generator can operate the road on the two-wire system. The fall of voltage would not be much with a light traffic. Hence the above objection would not have as much weight as would at first appear.

Now as to the saving in copper. The installation of the three-wire system on a road already installed has the practical effect of eliminating the drop of potential, and consequent loss of energy in the ground return. This is on the supposition that the same amount of copper is used for trolley feeders as was used with the two-wire system. There are several ways of arriving mathematically at this result. Perhaps the most simple conception of it is as follows :—When the two-wire is changed to a three-wire system, it takes only one-half the former current to move a given number of cars, owing to the doubled voltage. At the same time the feed wire is divided between the two sides of the circuit, so that there is only half the cross section of copper to carry the current, hence the loss in the trolley feeders will be exactly the same as before ; but as the overhead lines are carrying all the current, there is no loss in the ground return. Certain engineers now advocate putting as much copper in the return as in the trolley feeders. On this theory only about one-third as much copper is needed to wire a road for a given loss as with the two-wire system. The amount of copper required to transmit a certain amount of energy a given distance at a given loss varies inversely as the square of the voltage, hence one-fourth the copper is necessary on a 1,000-volt system that would be necessary with 500 volts However, the neutral or ground circuit must have a sufficient capacity to carry some current when the system is not in balance, and hence the amount of copper will be brought up to about one-third that necessary on the two-wire plan. This, it must be remembered, is on the assumption that a road is going to put as much copper in its return as in its trolley feeders—a condition of affairs that hardly ever exists. In average practical every day electric railway work the three-wire system simply saves the loss in the ground return, whatever that loss is, and enables a road to operate economically without putting as much money in a ground return as would otherwise be necessary. The ground return, however, can not be entirely neglected with this system, as the track is the neutral wire and must carry considerable current for short distances from the cars on positive sections to the cars on negative sections.

The Telephone Agreement Agitation.—At Tuesday's meeting of the London County Council the Highways Committee reported the result of their recent deputation to the Postmaster-General. The Committee thought that every effort should be made to obtain some modifications of the agreement before it was finally ratified, and recommended that the London members of Parliament should be requested to ask for a Select Committee of the House of Commons to make full inquiry into the question, and the relation of this agreement to the powers and duties of municipal authorities in London and elsewhere. Mr. Beachcroft said he would move as an amendment that the words after "National Telephone Company" be omitted. He was surprised that the Committee should have inserted these words at all after the information that had been given them when they waited on the Postmaster-General. Mr. Doubleday thought the telephone would be quite as useful to the people as the telegraph. It was merely a question of expense. The amendment was lost, and the recommendation agreed to.——On Monday, deputations from Edinburgh, Glasgow, and Aberdeen on the subject of granting telephone licenses to municipalities waited on Mr. Arnold Morley. His reply gave great umbrage, and Sir Charles Cameron immediately issued circulars inviting hon. gentlemen interested in the question (without distinction of party) to assemble in one of the committee rooms on Wednesday to consider what further action should be taken. At this meeting a very strong opinion was generally expressed against the establishment of any telephone monopoly other than a Government monopoly, and the following resolutions were, on the motion of Sir John Leng, adopted :—(1) That this meeting of Scottish members declares itself strongly opposed to either the direct or indirect establishment of any monopoly, other than a Government monopoly, of the Telephone Service. (2) That this meeting resolves to urge upon the Postmaster General the importance of granting to Municipal Corporations or local authorities applying for them, licences to establish telephonic exchanges within their municipalities. A deputation, consisting of Sir Charles Cameron, Sir John Leng, Mr. Paul, Mr. Baird, and Mr. Cochrane, was appointed for the purpose of conveying the views of the meeting to the Postmaster General.

THE BROOKLYN TROLLEY STRIKE.

From last week's letter of our New York correspondent, and from later cablegrams, it would seem as if the strike of the motormen on the principal trolley lines in Brooklyn has come to an end, and, judging by a sketch from the *Street Railway Gazette*, which we reproduce, it was evidently about time that the strike was settled one way or the other. This strike at Brooklyn has brought out a weak feature of the trolley system ; namely, the ease with which the service can be interrupted by a little judicious wire-cutting or short-circuiting. The Brooklyn feeders appear to have been run overhead ; but the present tendency, even in the States, is to place these underground, and this would, of course, render their interruption somewhat more difficult. The trolley wire will, however, still be there. If strikes, accompanied by injury to life and property, are to be accepted as inevitable incidents in the progress of our existing industrial civilisation, the comparative ease with which a trolley line can be "tied up" will have in future to be accepted as oneof its admitted defects.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, February 15th.

Institution of Junior Engineers.

8 p.m. Meeting at the Westminster Palace Hotel. The following Paper will be read : "The Practical Application of Alternating-Current Motors," by W. J. Fryer.

TUESDAY, February 19th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. The following Paper will be read : "Plant for the Extraction of Gold by the Cyanide Process," by C. Butters and E. Smart.

WEDNESDAY, February 20th.

Royal Meteorological Society.

7:30 p.m. Ordinary Meeting at 25, Great George-street.

Society of Arts.

8 p.m. Ordinary Meeting. The following Paper will be read : "Rule of the Road at Sea," by Admiral P. H. Colomb.

Royal Microscopical Society.

8 p.m. Meeting at 20, Hanover-square.

THURSDAY, February 21st.

Institution of Electrical Engineers.

8 p.m. Extra Meeting at the Society of Arts, John-street Adelphi. The following Paper will be read :—"Propagation of Magnetism in Iron," by Dr. John Hopkinson, F.R.S.

FRIDAY, February 22nd.

Institution of Electrical Engineers.

8 p.m. Students' Meeting at 28, Victoria street. The following paper will be read :—"The Efficiencies of Dynamos and Motors and their Measurement," by E. C. Hoadley.

Institution of Civil Engineers.

8 p.m. Students' Meeting. The following Paper will be read :—"Caissons and Gates for Closing Lock and Dock Entrances," by W. G. Wales.

Royal Institution.

9 p.m. Evening Discourse :—"Atmospheric Electricity," by Prof. A. Schuster.

⁂ Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

The Electrician.

The Oldest Electrical Journal, 1861—1878.

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UNDERGROUND ELECTRIC RAILWAYS AND THE INVESTING PUBLIC.

Some three and a-half years ago—that is to say, in the summer of 1891—Parliament sanctioned an electric underground railway scheme known as the Central London Railway. In the following year company promoters, encouraged by the Parliamentary success of the Central London Railway, hatched a big batch of Bills and a Joint Committee of the two Houses of Parliament was appointed to consider the general principles upon which powers should be granted to the promoters of these and any similar undertakings in the future. On the 23rd May this Committee published its report; a report which may without exaggeration be termed the charter of electric underground railways. The Committee could see no reason why the schemes in question should not go forward; indeed, the proposed lines would, in its opinion, tend to relieve the crowded condition of the London streets, and check the congestion of our metropolitan population. The Committee was also satisfied as to "the sufficiency and special adaptability of electricity as a motive power for the proposed underground tubular railways." In the result four fresh lines—namely, the Waterloo and City, Great Northern and City, Waterloo and Baker-street, and the Charing Cross and Hampstead—received Royal Assent, and all that the paternal blessing of a strong Committee, and the ready sanction of a docile Legislature could do to ensure an immediate commencement of a work of admitted public utility was thus done. London, however, still awaits its electric railways. Of the five lines which had received sanction by the summer of 1892 only one, the Waterloo and City, has reached the constructive stage. The Central London Railway, the most important of them all in many respects, and the one which has been the longest in the possession of parliamentary powers, has not as yet been bold enough to even invite public subscription, and we may be assured it is not likely to be encouraged to take this step by the recent failure of the Great Northern and City line to secure a modest million and a-half from the investing public.

The failure of the promoters of the Great Northren and City line to obtain sufficient money to go to allotment upon is probably the worst day's work as regards the development of heavy electric traction which has yet been done. We feel sure that the brief history of electric railway enterprise in this country is not to blame for this rebuff. The record of the Liverpool Overhead Railway is, on the contrary, sufficiently satisfactory for the most timorous investor. Though not yet two years at work it is already paying 2 per cent., and the last half-year's accounts show, when compared with the half-year ended December 31, 1893, a 40 per cent. increase of income, with only a 25 per cent. increase of expenditure. Even the City and South London Railway, a concern nearer home, and more similar to the proposed lines, should not act as a deterrent to the thrifty investor. A dividend at the rate of 1¼ per cent. per annum is certainly not calculated to make one rich beyond the dreams of avarice. But the line is not doing badly for all that. Expenses are stationary, and revenue is growing; slowly it is true, but it may well be, very surely. Locomotive and generating expenses, which started at 9d. per train mile, now stand at 6d. And then it has to be remembered that the company has all along been hampered by the fact that it at present starts from nowhere in particular, and ends—at King William-street; as cramped a terminus as could well be imagined and approached by a nasty curve and an ugly incline, two infallible specifics for waste of power.

No clue to the apparent public distrust of electric railway enterprise as an investment being therefore afforded by the financial history of the only two lines of the kind in existence, to what are we to attribute this reluctance to put money into electric railways? It certainly is not because money is scarce; it never was more plentiful. The only reasons we have been able to unearth is that South African gold mines are the fashion just now, and that the prospectus of the Great Northern and City Company was not drawn up in a clear or attractive manner. It must be admitted that the exact relations of the Great Northern Railway Company to its foster-child and the terms of its guarantee were a trifle complicated; but the net outcome of a careful perusal of the prospectus was to inform the reader that the electric railway was to receive a minimum annual sum of £30,000 from the Great Northern Company—a by no means inappreciable contribution towards a dividend. As to the attractiveness of the prospectus, it was undoubtedly truthful and uncommonly sober as to the future of the undertaking; but it was not obscure. Indeed, the excellent nature of the investment spoke for itself to any investor of average intelligence. However, "what's done is done and there's an end on't." The best reparation which can be made by those responsible for this unfortunate mistake of inviting the Public to subscribe to something safe, when that august abstraction was seeking excitement in the South African market, is to induce the Great Northern Railway Company to follow the good example set by the London and South-Western Railway Company in regard to the Waterloo and City line. Let it ask its own shareholders to subscribe to a concern which is more likely to pecuniarily benefit them than anyone else, and let it simply guarantee a modest minimum dividend, instead of a somewhat complicated sliding-scale payment. We may then hope to see this enterprise go forward, and thus help its congeners to do likewise.

THE ELECTRIC ARC.

BY HERTHA AYRTON.

(Continued from p. 401.)

The sets of curves in Figs. 7, 8 and 9 (page 338, *The Electrician*, January 18th) were drawn by taking a number of *vertical* sections of the curves in Figs. 4, 5 and 6 (pages 336, 337). In a similar way a set of curves can be drawn for each of the three pairs of carbons by taking a number of *horizontal* sections of the curves in Figs. 4, 5 and 6, and the results so obtained show the connection between current and length of arc for various constant potential differences.

Dealing with Fig. 5 in this way, we obtain Fig. 17 for the 13mm. cored positive carbon and the 11mm. solid negative carbon; but it is to be remembered that the points on these curves were *not* obtained by keeping the potential difference constant until the current became constant for each length of arc, but by keeping the current constant until the potential difference became constant for each length of arc. In fact, *current* and length of arc were kept constant, and not *potential difference* and length of arc. From the curves in this figure we can see the current that each particular potential difference will *finally* send through each length of *silent* arc with this pair of carbons, as well as the maximum length of *silent* arc that can be maintained with any given potential difference between the carbons.

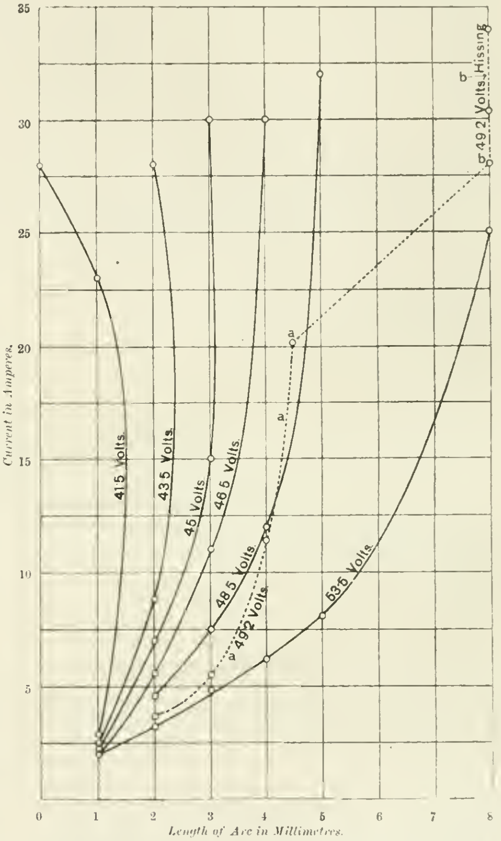


FIG. 17.—Current and Length of Arc for various constant Potential Differences. Carbons: Positive, 13mm. cored; negative, 11mm. solid.

To obtain this maximum length for any constant potential difference we have merely to draw a vertical tangent to the corresponding curve, and observe where it cuts the axis of length of arc. For example, the vertical tangent to the curve corresponding with a constant potential difference of 43·5 volts between the carbons, cuts the axis of length at about 2·4 mm. Hence, while a potential difference of 43·5 volts can produce a *silent* arc of *any* length between 1 and about 2·4 mm., it can produce *no permanent silent* arc longer than 2·4 mm. with these carbons.

If, starting with a small current, the potential difference between the carbons be kept constant, and the arc gradually lengthened, the current will gradually increase until a certain value is arrived at when either the current begins to decrease, or the arc becomes unstable; for example, with the constant potential difference of 48·5 volts this happens with a current of about 32 amperes if the current has been kept at a fixed value for some time for each length of arc.

When the constant potential difference is less than about 46 volts the curves in Fig. 17 bend back before the condition of instability is reached, so that for some lengths of *silent* arc there are two very different currents *permanently* produced with the same potential difference. For example, with the constant potential difference of 45 volts a current of about 15 or of 30 amperes may pass and maintain a *silent* arc of 3mm. With a constant potential difference of 43·5 volts a *silent* arc of 2mm. can be produced with a current of about 8·8 or 28 amperes, and a constant potential difference of 41·5 volts will send a current of about 2·8 or of 23 amperes *silently* through an arc of 1mm.

For a constant potential difference of 48·5 volts, on the contrary, there is only one current that will pass *silently* for each length of arc and remain constant, this current being about 4·5 amperes when the arc is 2mm. long, about 7·5 amperes when it is 3mm., about 12 amperes for a 4mm. arc, and about 32 amperes when the arc is lengthened to 5mm.

The arc now becomes unstable, and the curve shifts *sideways*, and continues as a vertical straight line for a much longer *hissing* arc.

As no results obtained with *hissing* arcs are given on the curves in Fig. 5, from which the curves in Fig. 17 have been derived, a dotted curve *a a a b b b* (Fig. 17), derived in the same way by taking horizontal sections of the curves in Fig. 6, is given to illustrate what happens when hissing takes place.

The carbons used in this case were a 9mm. cored positive and an 8mm. solid negative, and the constant potential difference taken was 49·2 volts; *a a a* represents the curve connecting current with length of arc for this potential difference for the *silent* arc, *b b b* the same thing for the *hissing* arc. There is a gap between the two, showing the lengths of arc for which the given potential difference of 49·2 volts would send no current at all through the arc. A dotted line bridges over this gap, simply for the sake of showing the connection between the two parts of the curve; but it is not meant to represent any relation between current and length of arc, since there is no current which will flow *permanently* through lengths of arc between 4mm. and 8mm. with a potential difference of 49·2 volts.

From the curves in Fig. 17 it follows that when the potential difference is kept constant at, say, 46·5 volts and the arc is *lengthened* from 1mm. to 5mm. the current *increases* in value; whereas when it is kept at about 44 volts a wide range of current can be obtained with the same length of arc, and, lastly, that when the constant value of the potential difference is, say, 41·5 volts *lengthening* the arc *diminishes* the current.

These facts have been already stated in connection with the curves in Fig. 5 (p. 337, *The Electrician* for January 18th), from which the curves in Fig. 17 have been deduced. But it appeared to me so astonishing, as well as novel, that a change in the constant value of the potential difference from, say, 46 to 44 volts should entirely alter the way in which the current varied with length of arc, *increasing* in the former case with the *lengthening* of the arc, and *decreasing* in the latter, that I thought it worth while to test these facts by actually experimenting on arcs with various constant potential differences.

The experiments were tried in two ways—(1) the potential difference was kept constant by using accumulators with no external resistance beyond that of the arc; (2) a dynamo was used, and the potential difference between the ends of the carbons was kept constant by means of a wide range of external resistance.

With the dynamo, a constant potential difference of 55 volts was maintained between the ends of the carbons in the following way:—The arc was struck with a large amount of resistance in circuit, the carbons were then separated to the desired extent, the resistance being altered meantime until a potential difference of 55 volts was obtained; then the arc was kept at the given length for some time, and the potential difference kept at 55 volts by means of the external resistance, until the current appeared to have reached its steady value, when the reading was taken. The carbons used were 13mm. cored positive, and 11mm. solid negative.

It was found that a current of 2·7 amperes could be maintained steadily flowing through an arc of 2mm., with 55 volts potential difference; a current of 3·3 amperes would flow steadily through an arc of 3mm., and that the current that could be maintained *permanently* flowing through the arc *increased* steadily as the length of the arc was *increased*, thus proving that the curves for constant potential differences of 46·5 volts and upwards on Fig. 17 were correct in character.

The next thing to prove was that various steady currents could be produced with one constant potential difference and length of arc; but as there is only one potential difference and length of arc for which this is the case with given carbons, and as the time at my disposal was very short, I did not attempt this.

The third problem, Does the current sometimes *decrease* as the length of arc is *increased* with short arcs and large steady currents? was tried with the dynamos and external resistance in the same way as before, and an answer was obtained in the affirmative. It was found that with a constant potential difference of 42·5 volts a current of 22 amperes could be maintained steadily flowing through an arc of 1·3mm., while a current of 19·5 amperes only would flow permanently through an arc of 1·5mm. Thus, since it has been shown experimentally that with certain constant potential differences the current increases as the arc is lengthened, and that with other constant potential differences the current increases as the arc is shortened, it is evident that there must be an intermediate constant potential difference which will permanently maintain many different currents with the same length of arc; therefore, all the three cases suggested by the curves in Fig. 17 are evidently correct.

These experiments, in which the potential difference and length of arc are kept constant and the current allowed to vary, are very difficult to carry out, because each potential difference will only send a current permanently through certain lengths of arc, and if you happen to hit upon a length of arc to which the potential difference you are trying does not belong, you may have all your pains for nothing. It may take an hour to find out that, although you are sending a current through the given length of arc with the fixed potential difference all the time, yet that current will not remain constant but will change continually. Finally, if the current is increasing, it rushes up rapidly, and the cut-out goes when the potential difference is maintained constant by means of accumulators with no interposed resistance. Or if, to prevent this occurring, you endeavour to maintain the potential difference between the carbons constant by means of a dynamo with interposed resistance, the arc suddenly hisses and the potential difference falls in spite of all attempts to prevent it by rapidly adjusting the interposed resistance. If, on the other hand, the current is decreasing, the arc flickers and goes out.

The further consideration, therefore, of these experiments, and the new facts they have brought to light belong to the subject of the *variable* state of the arc, which is begun later on in this article.

The curves in Fig. 18 connect the apparent resistance of the arc with length of arc for various constant potential differences, just as the curves on Figs. 13, 14, and 15, connect the apparent resistance of the arc with length of arc for various constant currents. The carbons used for these particular curves were 13mm. cored positive and 11mm. solid negative.

It has already been shown (p. 338, *The Electrician*, January 18th) that with a constant potential difference the apparent resistance of the *silent* arc diminishes as the arc lengthens: but the curves in Fig. 18 show something more, namely, that as the arc gets nearer and nearer to the hissing point the apparent resistance approaches a constant, which, for these carbons, is about 1·6 ohms. For the lowest point on each of the curves, except that for a potential difference of 53·5 volts, gives the apparent resistance of the arc when it is near hissing, and these points are all evidently very nearly in a straight line.

We have therefore apparently this very important law—*the apparent resistance of the arc when it is on the point of hissing is a constant for given carbons, and independent of the length of the arc.*

The following table is taken from the curves on Fig. 6, and shows that the apparent resistance of the arc at the hissing point for those carbons—namely, 9mm. cored positive and 8mm. solid negative—is for each length of arc about 2·5 to 2·8 ohms, which is very fairly constant, considering how difficult it is to determine the exact maximum current that will flow silently through an arc of given length.

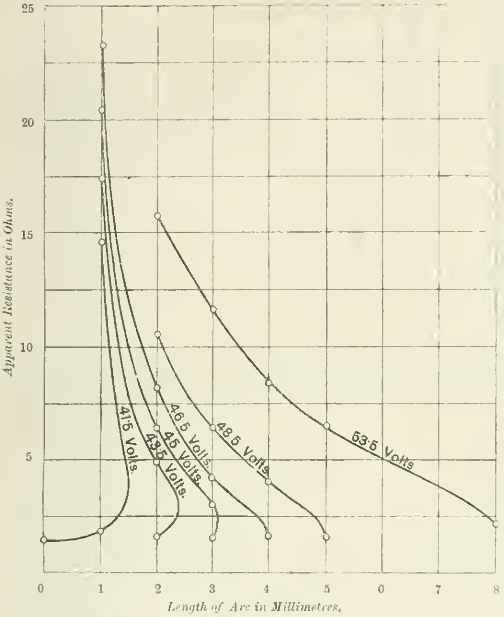


FIG. 18.—Apparent Resistance and Length of Arc for various constant Potential Differences. Carbons: Positive, 13mm. cored; negative, 11mm. solid.

Table VII.—*Carbons: Positive 9mm. cored; Negative 8mm. solid. Arc bordering on hissing.*

Length of arc in millimetres.	Potential difference in volts.	Current in amperes.	Apparent resistance of arc in ohms.
0	38·6	15·5	2·50
0·5	40·5	14·5	2·80
1	43·0	15·6	2·75
2	44·0	15·6	2·82
3	46·0	17·5	2·63
4	48·2	19·0	2·54
5	51·0	19·5	2·61
8	55·5	22·0	2·52

Again, taking the only hissing points that are given on Fig. 4 for an 18mm. cored positive carbon and a 15mm. solid negative, and dividing the difference of potentials of each of these points by the corresponding current, we find that for these carbons the apparent resistance of the arc when it is about to hiss is approximately 1 ohm.

Comparing, then, the apparent resistances of the arc when about to hiss for the three sets of carbons, it is evident that this resistance is greater the smaller the carbons.

In all the curves hitherto discussed each point was obtained by keeping the length of arc and current constant (the latter by means of an external resistance that could be varied at will) for a sufficient length of time for the carbons to have taken their final shape for that particular current and length of arc before each observation was recorded. But when these experiments were first started, at the beginning of 1890, it was not even known that such a period of waiting was required, and consequently it was found that a given current could be sent through an arc of given length by many different potential differences, and that no set of experiments made one day could be repeated the next.

In the earlier experiments a reading was taken soon after the current had been brought to the desired value; hence the curves connecting potential difference with current for a constant length of arc were too steep. For example, with both positive and negative carbons cored, and both 13mm. in diameter, the early curves show that when the arc had a constant length of 5mm. the potential difference fell from 59 volts for a current of 4 amperes to 24 volts for a current of 30 amperes; that is, it was diminished by 35 volts. Whereas, in the later experiments with a 13mm. cored positive carbon and an 11mm. solid negative, the results of which have been used to obtain the curves in Fig. 5 (p. 337, *The Electrician*, January 18th), the potential difference fell from 60·5 to 48·8 volts, so that it was diminished by only 11·7 volts for the same change in current with the same length of arc.

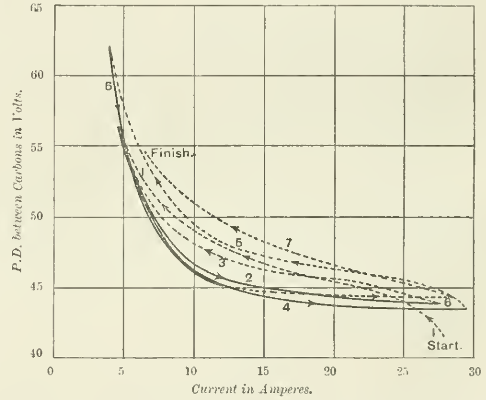


FIG. 19.—18mm. cored carbons. Arc not allowed to go out during the 5 hours' run. Termination of experiment due to wasting of carbons. Arc at a constant length of 4mm. Current increasing, ——→—— Current decreasing, - - - ← - - - Latter half of curve 6 is dotted owing to the length of arc being indeterminate. This was due to inequality in the carbons.

The first step in advance was made by keeping each new current flowing for a certain minimum time before taking the observations. This resulted in making the curves connecting potential difference with current for a given length of arc much flatter, and not quite so widely different with different sets of experiments; but it was still found that the curves for values of current ascending and those for values of current descending were different.

Fig. 19 is one of the curves drawn during this series of experiments made in 1890, when it had been found that allowing a certain time to elapse before the reading was taken after the current had been altered made the readings for ascending and descending current more nearly equal, and also made the curve connecting potential difference with current for a given length of arc less steep. It was also found that, if the whole series of readings could be taken without the arc going out, better results were obtained; therefore, during the five hours occupied by the experiments from which Fig. 19 was taken the arc was never extinguished.

A large number of experiments were now carried out, each of which occupied the greater part of a day, as the current, which was made to slowly vary backwards and forwards between two limits, was never stopped, nor the arc allowed to go out for many hours at a time.

However, even with all these precautions looped curves similar to those in Fig. 19 were obtained, and it is apparent from these curves that the potential difference needed to send a given current through the arc, which was kept at a constant length of 4mm., was never twice the same. For instance, a current of 10 amperes (Fig. 19) was sent through the arc by potential differences of 51, 49·5, 49, 48, 46·5, 46·2, and 46 volts respectively, so that for this one current the potential differences ranged from 46 to 51 volts. Hence, from these curves it would be impossible to find any exact relation between potential difference and current for a given length of arc.

Consequently, when the work was taken up again, it was thought advisable to make a complete investigation of the variation of potential difference with the time that had elapsed after the arc had been started or the current suddenly changed, the current and length of arc subsequently being kept constant during each experiment.

The questions to which answers were sought were the following:—

(1) Does the potential difference *ever* become a constant for a given current and length of arc?

(2) What is the *cause* of the variation?

(3) Is it the same whether a cored or an uncored positive carbon is used?

(4) How is the period of variation affected by (*a*) different lengths of arc, (*b*) different currents?

(5) How is the period of variation affected by the current that was flowing through the arc before the change was made?

In obtaining the curves in all the Figs. 19 to 24 inclusive, the carbons employed were 18mm. cored or uncored for the positive, and 15mm. solid for the negative, the current used was 10 amperes, and the length of the arc was 3mm.

Question (1) is answered in the affirmative by the fact that after a shorter or a longer time the potential difference in all cases finally reached a value of from 44 to 46 volts, when the positive carbon was cored, and from 47 to 50 volts when it was solid (Figs. 19 to 24), the slight variation of potential difference finally arrived at with the same current and length of arc for the same kind of carbons being accounted for by the fact that every pair of carbons differs slightly from every other pair in hardness and structure.

Questions (2) and (3) must be taken together, for the answers to both of them are given by the same set of experiments.

Fig. 20 shows the connection between potential difference and time after starting the arc, when the positive carbon is cored and shaped as it comes from the maker, and the negative has previously been properly shaped with a current of 10 amperes and an arc of 3mm. To save using this expression again and again, I shall call a carbon "normal" when it has been burnt long enough with a given current and an arc of given length for the potential difference to have reached its steady value.

It will be observed in Fig. 20 that *after* the length of the arc had been adjusted at 3mm. the potential difference between the carbons fell to the low value of 16 volts. Hence a genuine arc 3mm. in length can be maintained silently, at any rate for a short time, with a potential difference of only 16 volts. It was thought probable that this very low potential difference might have been caused in some way by the soft core of the positive carbon, and experiments were, therefore, made with cored and uncored positive carbons under precisely similar conditions. The tips of the positive carbons were filed flat, and they were used with negatives that were "normal" for 10 amperes and 3 millimetres.

The results may be seen in Fig. 21, curves A A A and B B B. Curve A A A starts with a potential difference of 44 volts, B B B with one of 25 volts. The low potential difference at starting *is*, then, caused by the positive carbon being cored. But why should there be such a great difference, namely, 19 volts, in the potential differences at starting, when the difference between the steady values of the potential differences is only about four volts?

To settle this question an arc was started with a cored positive carbon shaped as when it came from the makers, and a "normal" negative, and, after burning for less than one second,

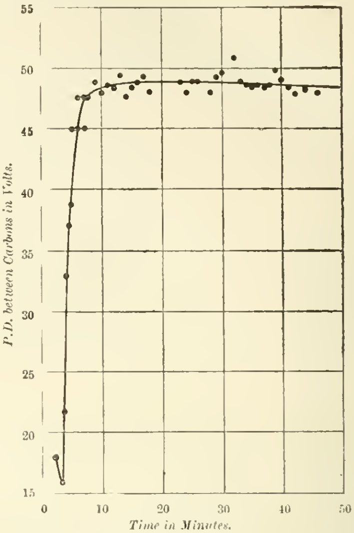
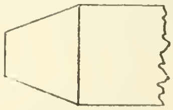


Fig. 20.—Current suddenly started and maintained at 10 amperes. Length of arc maintained at 3mm. Carbons: Positive, 18mm. cored; negative, 15mm. solid. Positive carbon was shaped as it came from the makers, thus,



shown full size. The negative was shaped by being previously used in a 3mm. arc with a current of 10 amperes.

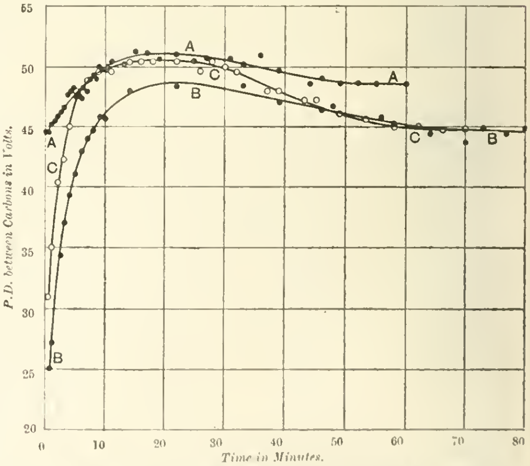


Fig. 21.—Current suddenly started and kept at 10 amperes. Length of arc kept at 3mm. Carbons: Positive, 18mm. solid or cored; nerative, 15mm. solid Negative carbon in each case shaped by being previously used for a long time to form an arc 3mm. long, with a current of 10 amperes. A A A: Positive carbon, solid, end filed flat. B B B: Positive carbon, cored, end filed flat. C C C: Positive carbon, cored, with a crater mechanically made at the end which was filed flat.

the current was suddenly turned off. On examining the carbons it was found that the core had been torn out of the positive carbon to the depth of one eighth of an inch, while the negative carbon was covered with the finely-powdered material. All this extra loose and easily volatilised carbon would, of course, much enlarge the cross-section of the arc, and thus lower its apparent resistance, and also the current probably flows with a much smaller potential difference when it is conveyed by means of small particles of carbon actually travelling across the arc than when it flows simply through volatilised carbon. Indeed, it is probable that the fact that particles of carbon unvolatilised fall in showers from the positive carbon when there is *hissing*, and thus lower the resistance of the arc, may fully account for the fall of potential difference in the arc in that case, for I have found from experiments of my own, to be described later, that this fall of potential difference with a hissing arc is very largely due to an actual lowering of the resistance of the heated space between the carbons.

In curve C C C (Fig. 21) the crater of the positive carbon had already been formed mechanically, and therefore the potential difference started higher than in curve B B B, and remained higher for about 45 minutes; in fact, for half an hour it more nearly coincided with A A A, the curve for solid carbons, which is not to be wondered at, seeing that the part of the carbon from which the core had been mechanically extracted, was practically solid; and while it burnt away, there was very little loose carbon extracted from the crater to be easily volatilised, and so lower the potential difference.

It is probable that the extra low potential difference at starting in Fig. 20 may have been caused by the pointed tip of the positive carbon being easier to volatilise than the flat one; and the reason that the potential difference took such a short time to reach its steady value—only five minutes—when the tip of the positive carbon was pointed, was that when the carbon from the crater had been volatilised it only came in contact with the hot tip, and was not cooled down by the mass of comparatively cold carbon surrounding the crater, as happened when the tip was flat. This mass of cold carbon is evidently the cause of what I may call the "hump" in the curves in Fig. 21. For, from the time of starting the arc, this mass of carbon had to be heated sufficiently for it to gradually burn away, most of it, probably, without becoming volatilised; therefore part of the heat of the crater was used in warming up this surrounding carbon until it was all burnt away, and the positive carbon had become "normal." This took place between 50 minutes and an hour after the arc was started. The extra amount of heat needed during this time meant, of course, that a higher potential difference was required to send the same current through the arc; for since the rate of production of heat depends upon the current multiplied by the potential difference, and the current was kept constant, the potential difference was bound to be higher. Hence the "hump," which will be found in every curve for which a *flat* positive carbon has been used.

The curve A A A (Fig. 23) would appear to contradict this rule, but on referring to the laboratory note books, I find that certain somewhat high potential differences obtained between 10 and 35 minutes after the arc had been started have been omitted in drawing this curve, presumably because it was supposed that these observations were wrong. Had points corresponding with these somewhat higher potential differences been plotted, however, and the curve A A A (Fig. 23) drawn through the average position of all the points, it would have shown a hump such as exists in all the other curves obtained from experiments with a flat positive carbon.

(To be continued.)

FIRE AT KENSINGTON COURT.

After nine years of perfectly regular supply, the electric lighting of Kensington was somewhat disturbed on Tuesday evening last. Between half-past nine and ten there were a few blinks, but more irregular than the well-known "five-o'clock-Bankside-effect" in the city. The lamps went down to dull red, and one or two streets on the negative conductor were left in darkness for a few minutes, but soon all was right again, and the fog on Wednesday morning was met with the usual steady light which is so greatly appreciated in this district. Little did the consumers think that the disturbance was caused, not by a hot bearing, a faulty connection, or a misturned switch, but by a serious fire which broke out in the station, and which burned furiously until nearly 1 a.m. on Wednesday morning. Mr. Crompton was at work in his laboratory at about half-past nine putting the finishing touches to a potentiometer which is to break all records, and Mr. Miller was also fortunately in the station when an alarm of fire was raised in the office of the works. This part of the building was at once filled with dense smoke. The wife and three children of the foreman engineer were sleeping on the floor above; two were rescued at once; but it was afterwards discovered that there was yet another, and about half an hour had elapsed before Mr. Morgan Williams succeeded in breaking through the windows and in reaching a baby, who had been unfortunately suffocated. Meanwhile the fire had rapidly spread towards the back of the premises, and took strong hold of the upper floors, gutting the stores. A small quantity of liquid fuel took fire, and added greatly to the serious appearance of the conflagration, though not doing much harm. The main body of liquid fuel is stored in an iron tank, and though exposed to the fiercest part of the fire did not get alight, owing to its being efficiently protected by its tank; showing that liquid fuel of the Astatki class can be protected from fire more easily than ordinary coal in bunkers. Mr. Crompton, whose house adjoins and overlooks the station, and who is, of course, intimately acquainted with the premises, directed the work of the brigade, and was able to take the firemen to the best point for attacking the flames; and from his back windows, as well as from the side passage, hoses were kept playing on the fire. When we arrived on the scene, Mr. Crompton was climbing up the inside of the lift shaft of his house, and by this means got a hose-pipe on the roof, where no fireman would follow him. Three steamers were at work in High-street. The hydrants on the premises were frozen, but after a delay of a quarter of an hour or so there was a good supply of water for the engines.

Meanwhile the dynamos had been shut down, and the supply was taken up entirely by the battery; but the performance of this invaluable adjunct was disconcerted by the torrent of water which was thrown into it from the fire engines. Fearing that although the load in the district was quickly falling through natural causes, the battery might not hold out, a man was sent off at about half-past ten to close the switch near the Albert Hall, and thus to connect the Kensington with the Knightsbridge system. A messenger was despatched to the Knightsbridge station, Mr. Barley arrived at about 11 p.m., and Mr. Crompton and Mr. Miller, who were drenched with acid and water, promptly made plans with him for continuing the supply. Arrangements were made for running the Knightsbridge engines all night, and for charging the Queen's Gate battery from that station. Mr. Miller soon afterwards went into the engine room, and crawling through a shower of acid and water under the switchboard, managed, though in the dark, to cut off the battery, and put the remainder of the night's load on to the Knightsbridge plant. Disconnections had to be made also in the Kensington Court subway, which threatened to receive the water with which the basement was flooded. A view of the fire from the roof of Mr. Crompton's house showed that it was confined by the fire-proof floor to the upper part of the building, and by the efforts of a considerable number of firemen, it was prevented from spreading. Subsequent examination shows that everything above the fire-proof floor, including the whole battery, will have to be rebuilt, and its contents replaced. At about a quarter to one the flames were got under, and Mr. Crompton, Mr. Miller, and the sergeant of the fire brigade, armed with a lantern, made an inspection of the engine room. We should, perhaps, have had a little hesitation in accompanying them had we known at the time that the shower from the floor above was not water but acid and water. The engine-room floor was a flood of water, and it was pouring in a sheet over the switchboard and meters. One dynamo, the last which had been shut down, was steaming, and the rest were tolerably protected by tarpaulins. Mr. Miller found the feed pump was safe, and 120lb. of steam in the three boilers, and hoped to be running again in the course of a few hours.

Traffic in High-street was stopped, and the crowd was not a little increased by people who were anxious to know whether there was any risk of an explosion, and whether they ought to switch their lamps off; the impression seemed to be that the storage battery was quite as dangerous as a gasholder.

The electrical accidents were not serious. The highest voltage being 220, there was at no time any danger from shocks, and a few short circuits in the wiring of the station did not seem to produce any harm. The firemen were, however, of another opinion, and had no difficulty in explaining the rapid spread of the fire by its "running along your wires, it always does." A very convenient explanation, but not a very clear one.

Offers of assistance came on Wednesday morning from the Westminster Company, who were ready to connect at the boundary of the districts, but the Kensington Company have been able, to their great credit—thanks to Mr. Crompton's bravery, Mr. Miller's coolness, the inter-communication of their system, the ample storage at Queen's Gate, the excellent equipment of the station, the fireproof structure of the engine-room, and to the smartness of the staff—to carry on the supply from their own plant. A meeting of the Directors, some of whom had been apprised of the fire by Mr. Crompton while it was still burning, was held on Wednesday morning. The damage is put approximately at £6,000.

TRANSFORMER CHAMBERS.

What with the Board of Trade inquiry just before Christmas, and the still simmering discontent of certain London Local Authorities, transformer chambers have of late been much in evidence. That being so, some illustrations and particulars of two types now in use in the metropolis may be of more than usual interest.

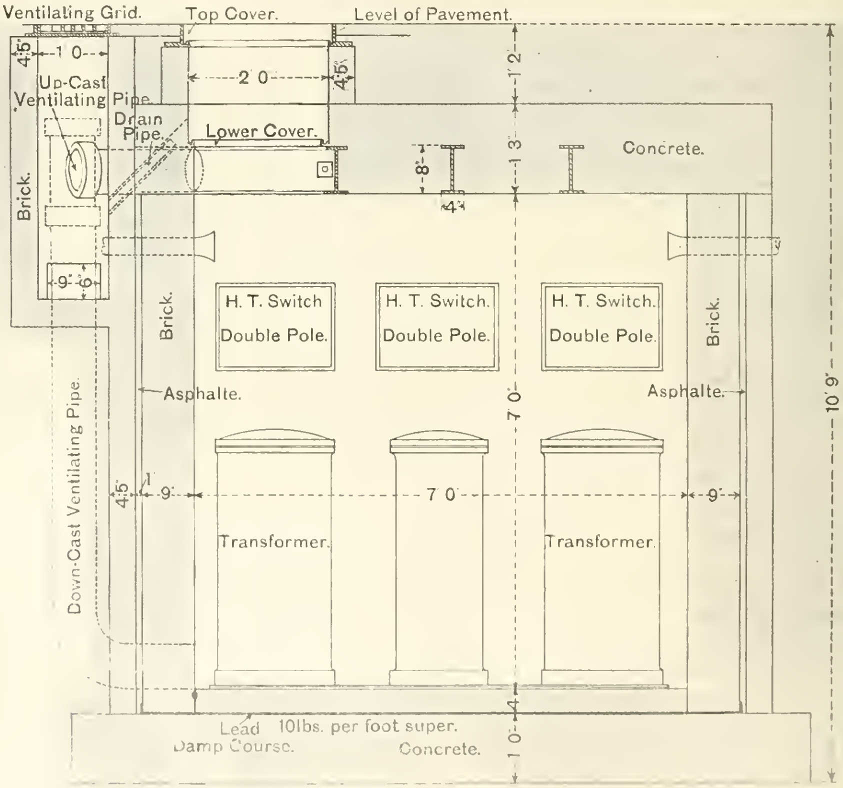


FIG. 1.– Front Elevation of a County of London and Brush Provincial Company's Transformer Chamber

In Figs. 1 and 2 we have views of the type of transformer chamber adopted by the County of London and Brush Provincial Electric Lighting Company both in Clerkenwell and Wandsworth and at Dover. The block (Fig. 1) which we have had prepared from the drawings kindly sent us by Mr. A. J. Lawson, does not show the drainage pipe from the ventilating shaft, the top of which, we may add, is plugged up, the ventilation taking place through a tee (not shown), thus preventing the dripping from the grid above falling into the ventilating shaft. The metallic connection between the pipes through which the cables go is provided for by galvanised iron wires connecting the pipes. The earthing of the transformers is provided for by a similar connection to earth by rails shown under transformers in Fig. 2; the beams of the ceiling and lower cover are also connected to the pipes passing through the chamber. The pipes shown in Fig. 2, under words "level of pavement," are for electric mains passing on to the other pits, and these do not make connection with the transformer pit over which they pass.

The left-hand and middle transformers will be in use at time of maximum load; the left hand transformer alone will be in use at time of average load, and the small middle transformer at time of light load. Transformer No. 3 is a spare of the same size as transformer No. 1. Thus in the case of a pit with 75 kilowatts capacity, transformers Nos. I and 3 would be of 50 kilowatts, and No. 3 of 25 kilowatts capacity. The object of making transformer No. 3 the same size as No. 1 is, of course, to provide against the breakdown of either of the other transformers, but especially of No. I transformer at time of maximum load, since it is always at times when a transformer is most wanted that it is likely to cause trouble.

An important point in connection with these pits is that the top and lower covers will be opened up at the time of switching off, to avoid the possibility at the time of switching on or off of an explosive mixture, even should the ventilation grates by any chance be choked up and gas find its way into the chamber. This latter contingency appears hardly likely, since the leading-in pipes will be efficiently stoppered up round the cables, and the construction of the chamber itself is such as will prevent leakage through the walls.

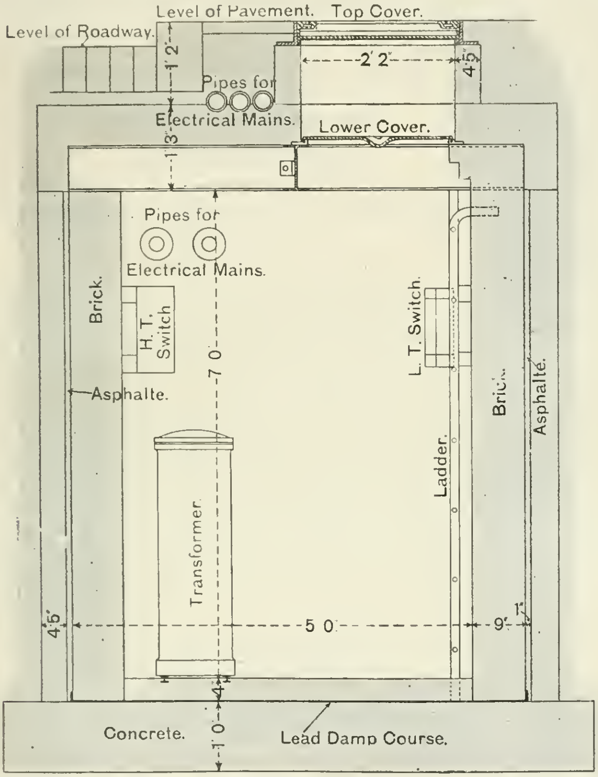


FIG. 2.
End Elevation of a County of London and Brush Provincial Company's Transformer Chamber.

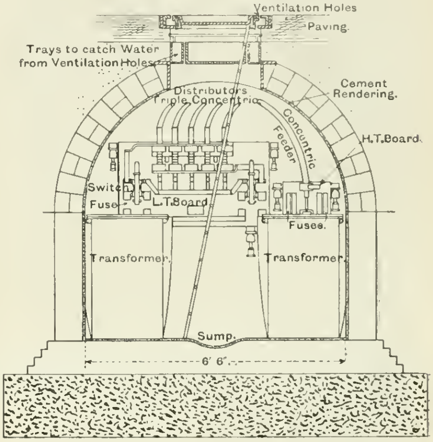


FIG. 3
End Elevation of a Hampstead Vestry Transformer Chamber

In Fig. 3 is given a view of the transformer chamber adopted by the Hampstead Vestry. It is built of brick 14in. thickness, arched at the top, and rendered inside with 1in. of neat cement. The dimensions are roughly, 5ft. × 6ft.6in. × 7ft.6in. high. In the top is a manhole 2ft. × 2ft. 6in. square let into a cast-iron frame. This latter forms the keystone of the centre of the arch, and has ventilation holes round the edges to render accumulation of gas impossible. Beneath these ventilation holes trays are arranged to catch any water that may find its way in. These are emptied by hand, and Mr. Chattock finds that once a week is sufficient for this purpose, except in times of heavy rain. Access is gained by means of a removable iron ladder. Two 25-kilowatt transformers are placed on the ground at one end, the cases being earthed. A high-tension fuse board and a low-tension fuse and switchboard are fixed on insulators at the other end. The concentric feeders and triple-concentric distributors are all armoured and cemented into the walls where they enter the chamber; they are then connected to their respective boards. When the transformers are set to work, the chambers dry out in about three hours, and remain quite dry and warm. No gas whatever has been found in any of the chambers, though in many cases gas pipes pass close to them. The cement rendering has been found quite efficacious in keeping back water, in spite of considerable accumulations on the outside, evidence of these having been given when piercing the walls for any purpose by a stream of water entering at once. The construction of the chambers was carried out by Messrs. John Aird and Sons as sub-contractors to Messrs. Siemens Brothers and Company, who have carried out the complete equipment of the Hampstead Vestry Electric Lighting Station.

PHYSICAL SOCIETY.

Ordinary meeting, January 25, 1895. Mr. MEDLEY concluded the reading of a Paper by Prof. Ayrton and himself on

"Tests of Glow Lamps,"

which was commenced at a former meeting. The object of the investigation was to find at what electromotive force glow lamps could be most economically run. Too low an electromotive force gives a low efficiency, and too high an electromotive force renders the lamps short lived; so that there must be (for a given lamp) a certain electromotive force which is more economical to work at than any other. It was also pointed out that, as glow lamps deteriorate and become less efficient with use, it may be an economy to discard a lamp before the filament actually breaks. The lamp is then said to have reached the "smashing point." Accumulators were used to drive the lamps, automatic apparatus being used to keep the electromotive force constant, and when a lamp filament broke the fact was automatically recorded on a tell-tale.

With the newer lamps employed in these tests, it was found that candle-power, current, and candles per watt all rose as the lives of the lamps increased. The authors, being surprised at this result, took care to satisfy themselves that the effect observed was due neither to change in the resistance of their manganin potentiometer strip, nor to uncertainty of contact at the sockets of the lamps. Starting again with new lamps, they found that in all cases the light given out was greater after the lamps had been glowing for some time than it was when they were new. In the earlier tests a considerable falling off in candle-power had always taken place after the lamps had been running for some time. Further, while the globes of the earlier lamps were always much blackened, even after a run of a few hundred hours, and so became comparatively useless long before the filament broke, the Edison-Swan lamps now examined showed hardly any blackening, even when the filaments lasted over 1,300 hours. The rise in candle-power was always accompanied by a rise in current, which was, however, proportionally much smaller, so that the consumption of power per candle was actually less after the lamp had been running 50 hours than it was at the beginning. Among the conclusions drawn by the authors were the following: (*a*) When a group of Edison-Swan lamps marked 100-8 are run at 100 volts, and each lamp as its filament breaks is replaced by a new one, it may be expected that the light given out will never subsequently be as small as when all the lamps were new; (*b*) an Edison-Swan lamp marked 100-8 when run at 100 volts will give an average illumination of about 10 candles, and will absorb on an average power of about 4·3 watts per candle, so that such a lamp must be regarded as a 43-watt lamp, and not a 30-watt lamp, as is frequently stated; (*c*) the maximum rise of light recorded during the life of any lamp was 45 per cent.; (*d*) with lamps of the type examined there is no point at which it becomes economical to discard a lamp before its filament actually breaks; (*e*) no marked economy can be gained by over-running such lamps (*i.e.*, by using pressures exceeding 100 volts).

Prof. AYRTON mentioned that the improvement in glow lamps after running for some time had been attributed to an improvement in the vacuum. Experiments made on new and used lamps by means of an induction coil showed that the more a lamp was used the better the vacuum became; but he (Prof. Ayrton), though at first inclined to adopt this explanation, had since found that, though in all the lamps examined the progressive improvement of the vacuum was equally marked, the increase in candle-power varied between very wide limits, being very considerable in some lamps, and hardly perceptible in others.

Prof. RÜCKER asked if it made any difference to the life of a lamp whether it were kept running continuously until the fibre broke, or were run for periods of a few hours, alternating with intervals of rest. The latter case would more nearly correspond with the conditions obtaining in practice.

Prof. AYRTON replied that the lamps were kept running during the night, and were disconnected during the day.

The annual general meeting of the Physical Society of London was held on Friday, February 8th. After the business was transacted, the following list of officers and Council for the year 1895-6 was read:—President, Capt. Abney; Vice-Presidents who have filled the office of President, Dr. Gladstone, Profs. Carey Foster, and Adams, Lord Kelvin, Profs. Clifton, Reinold, Ayrton, Fitzgerald, Rücker; Vice-Presidents, Mr. W. Baily, Major-Gen. Festing, Prof. Perry, Dr. Stoney; Secretaries, Messrs. Blakesley and Elder; Treasurer, Dr. Atkinson; Demonstrator, Prof. Boys; other members of Council, Mr. Shelford Bidwell, Prof. Crookes, Messrs. Fletcher, Glazebrook, G. Griffith, Profs. Henrici, Minchin, Mr. Swinburne, Profs. S. P. Thompson and S. Young.

Prof. Rücker then vacated the Chair in favour of Capt. Abney, and, the meeting being resolved into an ordinary meeting,

Mr. W. B. CROFT gave

"An Exhibition of Simple Apparatus."

The apparatus was chiefly of an optical character.

Mr. S. SKINNER read a Paper

"On the Tin Chromic Chloride Cell."

He said that his attention had been attracted to the cell by an account published by Mr. Case, of New York. The cell had been stated to give no E.M.F. at ordinary room temperatures, while it gave a considerable E.M.F. at 100 C. The author had found that when the cell was directly connected up to a galvanometer, there was no current at ordinary temperatures, and some current at 100 C.; but when he had measured the E.M.F. by Poggendorff's method, he had found 0·44 volt at 15 C. and 0·40 volt at 97 C. The cell, as originally described, consists of a tin plate and a platinum plate immersed side by side in a solution of chromic chloride; when the temperature of the cell is near to 100 C. and the poles are connected, the following reaction occurs:—

$$Cr_2Cl_6 + Sn = 2CrCl_2 + SnlC_2;$$

and when the poles are disconnected and the cell cooled the reverse change takes place. The author prefers to use as electropositive metal an amalgam of tin and mercury, instead of a tin plate; so that when the tin precipitated during cooling falls to the bottom of the solution, it is redissolved in the mercury, and the cell has regained its original state. When silver nitrate solution is added to chromic chloride, only two-thirds of the chlorine comes down as silver chloride, and this has led the author to suppose that the proper formula for chromic chloride is $2CrCl.Cl_2$. Hence he works out the electrolytic action by means of a Grotthus chain.

Prof. RÜCKER asked whether a change of polarisation would explain the behaviour of the cell at different temperatures.

Prof. CAREY FOSTER asked whether the reversed chemical action on cooling from a high temperature was accompanied by a reversed E.M.F.

Mr. SKINNER said, No; the tin was precipitated throughout the solution, and not at the surface of the tin plate, so that no E.M.F. of the kind was to be expected.

Mr. APPLEYARD thought that Prof. Minchin had used tin chloride cells with two tin plates for electrodes, the cells only working when one plate was illuminated.

Mr. TROTTER wished to know whether heating the cell supplied energy to it, or simply removed an obstacle in the form of polarisation.

Mr. SKINNER thought that heating acted by removing an obstacle.

Capt. ABNEY: And so doing work.

CORRESPONDENCE.

"LABOUR-SAVING" APPARATUS AS AN INSTRUMENT OF EDUCATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: You have been good enough to do me the honour of asking me to take part in the discussion on technical instruction which is now going on in the columns of *The Electrician.* I cannot bring myself to pass judgment on the methods adopted by my English *confrères*, since these have in view young men who have had a scientific preparation totally different to that of my own pupils. From the little that I have seen of English colleges, I have gathered that instruction in the mathematical and physical sciences is made comprehensible to the students by examples which have carefully been made suitable to their degree of intelligence. Your professors do not disdain examples taken from the daily life of their pupils in order that they may be understood. It is a matter of considerable astonishment to Continentals, especially to those belonging to Latin countries, to find in the middle of the works of your men of science comparisons which would seem trivial in our own text books, in which efforts are made to preserve an academic turn at the risk of not always being understood by those to whom these books are addressed. Your "natural philosophers" are also true physicists, whilst they are, unfortunately, often with us disguised mathematicians, who see in physics only an opportunity for fine formulæ. The result of your system of scientific education is to develop the initiative of the students, who feel sure of their knowledge and only desire an opportunity of applying it. In our own colleges sometimes the result is quite different. The student, lost in the midst of theories which he has not always mastered, has his first ardour damped little by little, and reaches the conclusion of his course with the belief that but little of the instruction given to him will be useful, and that a yawning gulf separates theory from practice.

I was called eleven years ago to the direction of the Montefiore Electro-Technical Institute, and had to draw up the programme of study for this college, where students and engineers who had received a preparatory training in Continental colleges were to come to complete their studies. I arranged a practical course, so as to bring the young men straightway into contact with constructive materials, with a view of showing them that they could devise in a few weeks instruments capable of precise measurement. One of the instruments constructed by the students is a Deprez-d'Arsonval galvanometer, which, although very roughly made (the apparatus is constructed in two months by young men who have never previously touched a file), is as sensitive and as accurate as a good instrument made by an instrument maker of to-day. This apparatus once made, the student studies it exhaustively. He determines its constant, verifies its proportionality, determines its period of oscillation and logarithmic decrement, its critical resistances, &c. The student is thus placed in possession of an instrument of which he is the master, and in which he has confidence, and to which he applies the amount of theory he has learned, and he convinces himself that this theory is not a mere pretext for integrals, but, on the contrary, that these latter place at his disposal a sure means of making good use of his apparatus, and of determining the limits of error in using it.

From this moment the student knows how to use not only the apparatus which he has constructed, but the other instruments which he has entrusted to his care, and which it will be easy for him to regulate and manage. I think I see a proof that the object I aim at is attained by the care with which my old students preserve the instruments they have constructed, and the way in which they place them in a prominent position in the laboratories they direct; this is a testimony, so to speak, of their first victory over matter.

After a few weeks passed in the workshop, the students enter the laboratory, where they make direct application of the methods taught them in the lecture room, and that by means of their own instruments and those belonging to the laboratory itself. The students have to arrange their experiments from the very beginning; the preparation of an experiment constituting the great and often the only difficulty. They have to calculate the best conditions, and to vary the arrangements so as to obtain the most accurate results. They are not asked to make many experiments, but to make good experiments. A few experiments carefully carried out yield better results than many experiments done in haste; the latter can only end in erroneous results and the discouragement of the student. In the same way that the construction of a single instrument is a sure guide to the comprehension and the management of other instruments, so a few experiments well carried out afford a means to the student of making many others. The same difficulties are almost always present, and can be overcome by analogous arrangements. In the dynamo tests my students make use of direct-reading apparatus which they previously calibrate themselves. The practical laboratory work finds its indispensable complement in dynamo, transformer and electric installation design, to which great importance is attached.

My idea is that I have done what I can to give my young engineers the necessary initiative to solve the practical problems with which they are confronted the moment they enter the industry.

I must ask you to excuse me for having said so much about what is done at Liége. I can speak on this point with knowledge, whilst I should run some risk of losing my way were I to talk about what is being done in London. The value of the method of instruction adopted by my learned English *confrères* cannot be better judged than by its brilliant results, which prove that it is the best for the students to whom it is applied.—Yours, &c., ERIC GÉRARD.

Liége, February 1, 1895.

THE FIRST POLYPHASE MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If Prof. S. P. Thompson regards "the driving by *induced* current" as "the essential feature of the polyphase motor," I will not attempt even to discuss his opinion. Allow me, however, to point out that an illustration inserted in Prof. S. P. Thompson's own book on "Dynamo Electric Machinery" (fourth edition, p. 705) represents as a typical four-phase motor an apparatus where the above "essential feature" is absent. The arrangement of this apparatus, which does not differ from Pacinotti's motor, shows how the latter might be supplied with alternating currents by the use of only four (and even three) line wires.—Yours, &c., G. GIORGI.

Rome, February 5, 1895.

[As we understand Prof. Thompson's book the figure on p. 705 is typical, not of the motor but of a method of transmitting currents. The typical motor on p. 707 for use in such a transmission is certainly an induction motor.—ED. *E.*]

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NOW READY.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Although about 100 pages are added to the book, no addition is made to the price, which is 7s. 6d., post free 8s. 3d., abroad 9s.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices:—*

THE LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, presented with our issue of January 4th, can be obtained mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s.—each post free. The Map showing positions of Supply Stations is mounted on the back of the Table. The Coloured Map issued with the Jan. 18th number and the Electricity Supply Statistics issued with the Feb. 1st number are also mounted on some copies, and the price of these, complete, post free, is 5s.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is just out, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

LABORATORY NOTES AND FORMS.—With the above title, we have in the press a set of Elementary (now ready) and Advanced Exercises (ready shortly) for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. net., is now ready.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d (abroad 8s.). Prospectus on application.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

TENDERS INVITED.—The Weybridge Urban District Council invite tenders for the public lighting of the district on and after September 29th next. Tenders, stating the number of public lights proposed, the illuminating power and price per light, must reach Mr. George Wheeler, the clerk *pro tem.* to the Council, before February 20th.

——— The Roumanian Posts and Telegraph Department, Bucharest, invite tenders until the 27th inst. for the supply of 20,000 large and 23,000 small porcelain insulators.

——— The Erfurt Direction of the Prussian State Railways invite tenders until the 20th inst. for the supply of 71,000 arc-lamp carbons and 1,590 incandescent lamps.

TENDERS ACCEPTED.—At a meeting of the South Shields Town Council on February 6th the following tenders in connection with the electric lighting scheme were accepted:—

Boilers and pipes (Black, Hawthorn and Co., Limited, Gateshead)	£1,809	0	0
Pumps (Henry Watson and Sons, Newcastle)	905	14	3
Engines and Alternators (S. Z. de Ferranti, Limited, London)	8,003	0	0
Cables and trenching (India Rubber, Gutta Percha, and Telegraph Works Company, Ltd., London)	4,846	0	0
Arc Lighting (S. Z. de Ferranti, Limited, London)	793	11	0

It was ordered that the tender for meters, &c., should stand over for the present.

——— The Walsall Corporation has accepted the tender of Mr. H. Gough, Dudley-road, Wolverhampton, for alterations to the Wolverhampton street gasworks, including the erection of the necessary buildings for an electricity generating station, for the sum of £1,750.

Tenders Received.—The Wigan County Council have received the following tenders for plant and apparatus for their electric lighting scheme:

John Fowler and Co.: High tension, inside plant £5,502, distributing plant £2,429, total £7,931.

Brush Company: High tension, inside plant £5,189, distributing plant £1,796, total £6.985; low tension, inside plant £6,079. 10s., distributing plant £2,164, total £8,243. 10s.

Corlett Electrical Engineering Company: Low tension (copper strip), inside plant £5,743, distributing plant £2,978, total £8,721; low tension (insulated cable), inside plant £5,743, distributing plant £2,804, total £8.547.

Siemens Bros. and Co.: Low tension, inside plant £4,290, distributing plant £2,843, total £7.133.

Mather and Platt: Low tension, inside plant £4,810, distributing plant £4,010, total £8,820.

Vacant Appointment.—The Town Council of the City of Aberdeen require applications for the appointment of electrical engineer in connection with their electric lighting department. The salary will be £200 per annum. Some further particulars are given in our advertisement columns. Applications must be sent in to Mr. W. Gordon, town clerk, not later than Monday, the 25th inst.

Scottish House-to-House Electricity Company (Limited).—Mr. Angus McLeod has resigned his position as Managing Director of this Company, and Mr. A. J. Lawson has been appointed engineer and manager, while Mr. Francis Teague remains resident engineer at Coatbridge. The registered offices of the Company have been removed to 49, Queen Victoria-street, London, E.C.

Dissolution of Partnership.—Messrs. Paine and Thompson, electrical engineers, 115, Queen's-road, Brighton, have dissolved partnership. Debts will be paid by Mr. G. Thompson, who continues the business.

Personal.—Mr. George Offor has opened an office at 78, Mansion House-chambers, Queen Victoria-street, E.C., where he will continue to act as contractor for the supply of electricity.

Electric Locomotives.—The Acme and Immisch Company have received a letter from the Greenside Mining Company (Limited), of Westmoreland, in which the performance of an electric locomotive erected by the Acme Company is referred to as follows:—"Our electric locomotive has just completed her 6,000 miles of running with her average working load of 20 tons at a cost of only £12, and this for renewing the training wheels, which have just been replaced. The wearing of these can be to a great extent accounted for, seeing that some of the gradients are equal to 1 in 20, necessitating a heavy brake being applied occasionally. The electrical part of the locomotive has required no repairs whatever, the armature and commutator apparently are as good as at the first, the latter has never been turned up since it left your works. Taking into consideration the exceedingly sharp curves and their frequency in the line of rails, to say the least, the wear and tear is really surprisingly low, and does great credit to the workmanship on the machine." The whole of the electrical plant at the mine, which has been working for three years, has proved thoroughly efficient at an infinitesimal working and repairing cost.

High-Speed Gas Engines.—Messrs. Scott Bros., of Halifax, have recently brought out a high-speed duplex gas engine, upon which they have just conducted a series of efficiency trials. They find that their 10-H.P. engine, which will give off 18 B.H.P., consumes about 230 cubic feet of gas per hour. Another test, on a 5-H.P. engine, giving 8 B.H P., showed a consumption of 120 cubic feet per hour, while a third trial shows a consumption of only 12 cubic feet per brake horse-power on a 4-H.P. engine. As anything below 20 cubic feet per brake horse-power per hour is considered really excellent practice, even in the largest engines, it will be seen that these tests, which appear to have been carried by the makers themselves, are truly remarkable.

The Simplex Ventilator.—Messrs. Pierson and Co. send us particulars of improvements in the ventilator which we described in a recent issue. Separate air inlets and gas outlets are provided, both in the pattern which is intended to discharge at the kerb, and in an uptake flush with the side wall.

The Right Thing in the Right Place.—Messrs. David Moseley and Sons send us a sample hydraulic cup packing made of "celluvert," a kind of red vulcanised fibre. Testimonials show that for such purposes this material is distinctly superior to leather.

Messrs. Clarke, Chapman, and Co. (Limited).—This firm send us a long list of light and plant installations successfully carried out during 1894. The work includes the lighting of the Crown Preserved Coal Company's Colliery at Cardiff, and one of the Earl of Durham's Collieries; the shipyard of Messrs. Short Brothers at Sunderland, and the works of the Seaton-Carew Company at West Hartlepool, and the Tilghmans Sand Blast Company at Sheffield. No less than 36 steamers are included in the list of lighting plants supplied. Messrs. Swan and Hunter, of Wallsend, entrusted the firm with the contract for the supply of large electric cranes, and special electric galvanizing plants were supplied to Sir W. G. Armstrong, Mitchell and Co. (Limited), Elswick; the Naval Construction and Armaments Company, Barrow-in-Furness; Messrs. Hanna, Donald and Wilson, Paisley; Palmer's Shipbuilding and Iron Company, Jarrow; and H. J. Waterston and Co., Sunderland. In addition to the above, some large generating plants and switchboards were constructed for Messrs. Swan and Hunter, of Wallsend. The orders received and carried out during the year included a number of combined engines and dynamos and belt-driven dynamos for installations not carried out by the firm. For search-light projectors of various types, which the firm have made a speciality for years past, a number of orders were received. Amongst the important orders now in hand are included lighting plants for H.M. ships "Powerful," "Juno," and "Doris."

"The Engineering Magazine."—The February number of this magazine is up to the usual high standard, both as regards matter and illustrations. Its contents include—"Reasons why Prices are Low"; "The Railroad of the Future"; "Selecting Motive Power for a New Plant"; "Municipal Cleansing and Public Health"; "Relation of Railways to Municipalities"; "Ancient and Modern Irrigation in Egypt"; "The Professional Mechanical Inventor"; "The Great Steamships of the River Hudson"; "Electric Power for Isolated Factories"; "The Construction of a Great Building"; and the increasingly useful Review of the Industrial Press. The new number, and nearly all back issues, may be obtained at the office of the European edition, 1, 2 and 3, Salisbury-court, Fleet-street, London, E.C.

Turbines.—We have received a copy of a catalogue just issued by Messrs. J. P. Hall and Co., of Oldham. These manufacturers are supplying turbines and various kinds of water motors for driving dynamos for electric lighting and transmission of power, as well as for other classes of work. The turbines are of the Girard and Jonval type, suitable for different conditions of fall, and are designed for falls up to 200ft., and for vertical and horizontal driving.

Messrs. Elliott Bros.' Catalogue.—A substantial catalogue of electrical and other apparatus has been issued by this firm. It is well arranged in sections, and has a complete index and telegraphic code words. An attempt is made to suggest to purchasers the characteristic points and chief advantages of the leading types of instruments; thus, ten lines are given to d'Arsonval galvanometers, which have not yet found their way into all laboratories. It would be worth while, perhaps, to largely amplify such advice and suggestions. Besides the more important instruments, the catalogue includes minor accessories such as galvanometer mirrors. A selection of optical, engineering, and mathematical apparatus is given. The catalogue is marked E 4.

New Catalogue.—We have received from Messrs. Mason, Wathes and Brown, of Leicester, a copy of their catalogue and price list of electric bells, indicators, telephones, and general electrical apparatus, which is just issued, and includes particulars of the firm's dynamo machine with a third bearing. All kinds of indicators, portable bell sets, batteries, pushes and pulls, telephones, &c., are set out in the list.

Second-Hand Plant.—The Tube Company, of 100c, Queen Victoria-street, London, E.C., have for disposal a large quantity of dynamos, accumulators, and gas engines by the best makers.

Electro-Harmonic Society.—A "Ladies' Night" will be held at St. James's Hall Restaurant, Regent-street, W., on Friday evening, the 22nd instant, at eight o'clock. An excellent programme is provided. The musical arrangements will be under the able direction of Messrs. T. E. Gatehouse and A. E. Izard.

Aberdeen.—Accounts in connection with the electric lighting scheme for the ten months ended December 31st last have been presented to the Corporation, and the net revenue shows a debit balance of £217. The price of current for the present quarter has been fixed at 6d. per unit.

Ambleside.—The District Council have appointed a Committee to consider the advisability of opposing the application of the Windermere and District Electric Lighting Company for a Provisional Order.

Arlecdon and Frizington.—A resolution was carried at the last meeting of the Arlecdon and Frizington District Council that steps be taken to secure the services of an electrical engineer to examine the district and various water courses which they might be able to get access to, and ascertain whether sufficient motive power could be produced to light the district by electricity; also to prepare an estimate of the probable outlay for lighting the district by water or steam power. It was stated that the cost of the present gas lighting was £200 a year; but on stormy and dark nights, when the lights were most needed, they were usually blown out. It was estimated that the district would be much better lighted by electricity for a nominal sum, even if it were necessary to have substations. A committee was appointed to make the necessary arrangements.

Battersea (London, S.W.).—The Special Committee appointed to consider the question as to the cost and practicability of the Vestry adopting the electric light recommends the Vestry to sanction the expenditure of £200 to employ an expert to assist them in their inquiries. They believe the Vestry will be in a position to apply for a Provisional Order themselves within twelve months, and they urge the Vestry to continue its opposition to the application of the County of London Company to supply the electric light to Battersea.

Birmingham.—With reference to the question of the lighting of the new technical school referred to in our last issue, the Technical School Committee took the subject again into consideration on Tuesday and consulted with the Gas Committee, and will submit a further report at the next meeting of the City Council.

Bowness.—At the meeting of the Urban District Council on Monday the Chairman announced that the local electric lighting company had agreed that the charge to the Council for current would for the future be 25 per cent. less than that made to ordinary consumers. He, however, mentioned that some of the 16-c.p. lamps were to be replaced by 22-c.p. lamps, which, it was hoped, would be more satisfactory.

Bradford.—The Gas and Electricity Supply Committee of the Corporation, having discussed the advisability of increasing the present generating plant at the electricity works, Bolton-road, have decided to invite tenders for the supply and laying down of two new engines of 300 H.P. each.

Burglary.—Fynn, the man who was sent to the Sessions for breaking into the warehouse of the London Electric Wire Company, has been sentenced to five years' penal servitude, to be followed by three years' police supervision, he being an old offender. The commissionaire, Robison, who so pluckily defended his employers' property, was ordered by the learned Chairman to receive a reward of 40s.

Cardiff.—There does not appear to be full agreement on the electric lighting question into this town. Even in the necessary duty of appointing an engineer to take charge of the electricity works bitter feeling is imported. After discussing the subject at the last meeting of the Town Council, the matter of the appointment of Mr. Franklyn was referred back, and instructions were given to Mr. Harpur and Mr. Massey to present reports on the general position of affairs in regard to the electric lighting works.

Cheltenham.—The report of the Public Library Committee has been presented to the Town Council, and strongly urges the necessity for the introduction of the electric light on the grounds of safety to the building and to the books, as well as on the ground of economy in the cost of rebinding. The Committee make a strong representation to the Electric Lighting Committee to supply the light to the library free of cost, in which case the Library Committee will borrow a sum to meet the expenses of the first installation of the light. This suggestion has met with partial success, as an offer has been made which is to be discussed at the next meeting of the Library Committee. The librarian estimated the damage done to the books by gas as 30 per cent. upon the original cost.

Chichester.—An inquiry has been held here on the subject of the extension scheme, and it is stated that the extensive range of barracks, which are shortly to be added, are to be lighted throughout by electricity.

Damaging Electric Lamps.—Two lads named Trew and Flint were charged at Westminster with damaging the electric reading lamps in carriages on the District Railway. A number of the money receptacles in these lamps have been tampered with for some time past, and the accused lads were detected in the act of tampering with the lamps and locks. The magistrate ordered a sound flogging.

Dublin.—The electric lighting installation at the new Parcels Post Depot in Amiens-street is now nearly complete. The work has been carried out by Messrs. W. Curtis and Sons, of Middle Abbey-street, assisted by their engineer, Mr. H. L. P. Boot. The lamps are at present being run with temporary plant, but it is expected that the permanent plant will be ready for working in the course of a few weeks. The installation is equivalent to about 900 8-c.p. lamps.

Dundee.—The Clerk to the Town Council has reported that in connection with the electrical department the expenses and disbursements to March, 1893, had amounted to £28,030. 5s. 10d., while to January, 1895, additional expense had been incurred amounting to £4,147. The Council had contracted to spend £1,942, making in all £6,089, which, being added to the first sum mentioned, brought out a total expenditure of £34,120. Their borrowing powers at present were limited to £30,000. There was a contemplated expenditure of £6,000, which would make a total of £40,120. It was decided to apply for further borrowing powers to the extent of £10,000.

Edison-Bell Phonograph Corporation v. Hough.—In an action—heard in the Court of Appeal on Monday—to restrain the infringement of patents by the defendant, who let out phonographs for the amusement of the public, a motion was made *ex parte* on the part of plaintiffs for leave to appeal from an order made by Mr. Justice Stirling for the examination of Mr. T. A. Edison in America. Mr. Gresham stated that the patent was not Mr. Edison's, and he was therefore nothing more than an expert witness. The plaintiffs did not object to Mr. Edison giving evidence, but to the expense of a commission to America. The appeal was refused, and the commission will proceed.

Electric Organs.—An "echo" organ is being added to the instrument at Westminster Abbey. It will be erected in the triforium, and it will be blown from a fifth manual, which will be connected to the "echo" organ by electricity.

Grange.—The consent of the Urban District Council has been given to the application of the Windermere Company for a Provisional Electric Lighting Order. Under the agreement with the Company the Council has power to purchase at the end of 10 years.

Grasmere.—The Urban District Council have decided not only not to oppose the proposed application for a Provisional Order by the Windermere Company, but to support the Company's application.

Hammersmith (London, W.).—At the last meeting of the Vestry a proposal to refer to a Committee the question of lighting Uxbridge-road by electricity by means of lamps in the centre of the road was rejected.

Hastings.—At a meeting of the Corporation on Friday last exception was taken to a recommendation of the Finance Committee that the electric light company be paid £323. 11s. for the lighting of the front for the quarter, and after some discussion the item was referred back.

Keswick.—At the last meeting of the Urban District Council a request by the Keswick Electric Light Company (Limited) for the Board's consent to an application by the Company for a Provisional Order for lighting the district was agreed to, after some discussion, on condition that the Company supply and light three are lamps for public lighting free of charge.

Lectures.—Mr. F. H. Taylor, A.I.E.E., is announced to lecture on behalf of the East London Church Fund at St. Andrew's Parish Room, Fairholt-road, Stoke Newington, London, N., on Monday, in March 4th, the subject of the lecture being "Recent Developments Electrical Science."——Prof. A. B. W. Kennedy was to have lectured to the members of the Edinburgh Literary Institute last week, but was, we regret to learn, prevented by indisposition from attending. In his place Mr. Monkhouse, resident engineer to the Edinburgh Corporation, read the lecture, which was fully appreciated by a large audience.——Prof. Horsley lectured at the London Institution on Monday on "Truth and Falsehood as to the Effect of Electric Currents on the Body." The purpose of the lecture was the exposure of "electric" quackery, and public journals like *The Times*, whose proprietors accept the flaming announcements of so-called electric belts, should give their readers an opportunity of studying the remarks made by Prof. Horsley on this subject. So far as these "electric" contrivances are concerned the exposure was complete. The lecturer was particularly severe on the lassitude displayed by the Public Prosecutor in protecting the public against quacks and quackery of all kinds, but especially where the word "electric" is concerned.——Mr. Sam Mavor lectured on Tuesday at Glasgow before the Insurance and Actuarial Society on "Electric Lighting in Relation to Fire Insurance."

Leeds.—The Yorkshire House-to-House Electricity Company announce a further reduction in the charge for electric current, commencing on the 1st July next. When the consumption for the quarter does not exceed 1,500 units, 6d. per unit; exceeding 1,500, and not exceeding 3,000 units, 5¾d.; exceeding 3,000 units, 5½d., subject to discount of from 5 to 15 per cent. For heating, cooking, and power purposes, current will be supplied at 3d. per unit.——A special meeting of the Leeds Corporation Parliamentary Committee was held on Wednesday, to receive the report of the Tramways Committee on the proposed sites for electrical generating stations for the working of the tramways. The following were recommended as possible sites by the Tramways Committee, viz., all the four sites on which the destructors stand, the highway depot in Whitehall-road, and the sanitary depots at Crown Point and Call-lane. One of the latter the Parliamentary Committee decided not to have named in the bill. A deputation, consisting of Alderman Ward, Alderman Firth, and Councillor Battle, and the Town Clerk, was appointed to proceed to London as early as possible. A meeting of the Highways Committee was also held on Wednesday, when reference was made to the recommendations of the Tramways Committee in favour of the electrical conduit and overhead systems of propulsion for the tramcars of tho city. No vote, however, was taken on the matter, the members deciding to wait until they had tho full report of the Tramways Committee before taking action in the matter.

Llanelly.—The Town Council have decided to invite tenders for lighting the Town Hall, Athenæum, Market Hall, and other public buildings, and a portion of the town, by electricity.

Marriage.—Mr. J. D. F. Andrews was married at Fulham parish church on Wednesday last.

Mevagissey (Cornwall).—At a recent meeting of the Parish Council committees were appointed to ascertain the cost of lighting the parish by electricity, by gas, or by oil.

Newhaven.—At the last meeting of the District Council the clerk stated that the Board of Trade had called attention to Section 4 of the Electric Lighting Act of 1888, which compels local authorities to give timely intimation to the Department of the laying down of electric light wires in their districts, in order that steps may be taken to protect the telegraph lines in the neighbourhood of the electric lighting mains.

Newtown.—The Directors of Pryce-Jones (Limited) have decided to erect a new factory in close proximity to that block of buildings known as the Royal Welsh Warehouse. The new factory is to take the place of three large buildings now used, and the electric light is to be adopted throughout.

Northwich.—It is stated that a local electric lighting company will shortly be established in this town, with favourable chances in the competition with gas. Already the gas company has reduced its charge for gas from 4s. 2d. to 4s. per thousand.

Nottingham.—The National Telephone Company are placing their wires in this town underground. Three cables are being put down of 600, 1,100, and 1,200 yards in length.

Portsmouth.—At the last meeting of the Town Council the Electric Lighting Committee recommended that they be empowered to sell incandescent lamps. Complaints had been made by private consumers, and the Committee asked to be allowed to sell a lamp guaranteed as to quality. They proposed to sell these lamps at 1s. 6d. each.

Queenstown.—A special meeting of the Town Commissioners has been held to receive a report from Mr. R. Hammond on the practicability of lighting Queenstown by electricity. It was subsequently decided that Mr. Hammond should send a written report on the subject to the Commissioners.

Redcar.—A special meeting of the Urban District Council was held on Monday to consider the question of adopting the electric light in the town. A deputation attended from the Tradesmen's Association, and presented a requisition in favour of the adoption of the electric light, signed by the principal tradesmen. On the motion of Councillor Phipson it was unanimously agreed to grant a concession to Messrs. Stacey and Bennett, of Sheffield, to lay down plant, mains, &c., and to supply electric light for a period of ten years. Much satisfaction is felt at the decision of the Council.

Rochdale.—In reply to an inquiry as to the question of employing the surplus steam at the sanitary works, with the view to utilising it for generating electricity, the Mayor stated that the subject had not yet come before the Electric Lighting Sub-Committee for consideration, but so far as the question of steam was concerned, it had proved more successful than even the Health Committee had anticipated when the work was undertaken. Mr. Cunliffe stated that there was sufficient steam at the sanitary works to at least provide electric current for the lighting of the Town Hall and Free Library, and the splendid decorations at the former building, and the books at the latter, were sadly in need of protection. The Electric Lighting Sub-Committee is to be called together to finally discuss the matter and report.

Southport.—At the meeting of the Town Council on Tuesday a lengthy discussion took place on the minutes of the Electricity Committee with reference to the tender of Mr. Thomas Bridge to erect the extensions to the engine and boiler house of the electricity works for £1,897, which tender had been accepted by the committee, although a tender lower by £138 had been received. Evenually it was decided to discuss the matter in General Purposes Committee.

South Shields.—Under "Tenders Accepted" will be found particulars of the tenders recently accepted by the Town Council in connection with the electric lighting scheme. The specification for the plant was issued in September last, and we understand that from the first it was decided that, whatever tenders were received, the question of accepting the lowest tender should be waived in favour of what was considered by the Borough Electrical Engineer to give the best value for the sum quoted. It was a condition of the specification that all firms tendering were to submit, along with their tenders, drawings as per a list appended to the specification. This is given as the reason why the acceptance of the tenders has been so long delayed. A sub-committee of the Council, in conjunction with Mr. J. A. Jeckell, considered the tenders sent in, and the report of the Committee was unanimously adopted. The plant now decided upon is in excess of the original estimate. Application is to be made to the Local Government Board for power to borrow £28,000.

St. Olave's (London, S.E.).—The Board of Works have now decided to give their consent to the Provisional Order sought to be obtained by the County of London Company, subject to clauses being inserted to the satisfaction of the Board.

Stockton-on-Tees.—The Electric Lighting Committee have reported to the Town Council that the consideration of the electric lighting scheme has been deferred for a period of six months. In connection with some proposed gas extensions, Mr. Councillor Smith pointed out that the time was singularly inopportune for such extensions when the electric light was fast coming to the front. Mr. Alderman Hind pointed out that the gas extensions were necessary, because if the electric lighting scheme were adopted it would be some time before current could be supplied to the extreme points of the district. It was fortunate that somebody wanted more gas, for the demand in the town for that commodity had been seriously decreasing within the past few months.

Wakefield.—At the monthly meeting of the City Council, on Tuesday, Councillor Lee mentioned that it had been decided to engage Mr. R. Hammond as electrical engineer to the Corporation, and to apply for powers to expend £20,000 in carrying out the first instalment of the proposed electric lighting works for the city.

West Cowes.—At the last meeting of the District Council the Lighting Committee's recommendation that the Council's sanction be not given to Mr. Reader's application for a Provisional Order for lighting the district by electricity was discussed. At the meeting Mr. Reader pointed out that a serious error had been made in the estimated cost which had been sent in, and he was now prepared to supply current for the public lamps at half the figure previously quoted. Ultimately the Committee's recommendation was adopted.

Wigan.—The County Council have received a letter from the Corlett Electrical Engineering Company (Limited) in connection with the recommendation of the Gas Committee to accept the tender of Messrs. Fowler and Company (Limited), of Leeds, for the supply of electric lighting plant. The letter states that the Company, which is a local one, was not placed in a position to tender for a high-tension plant, and suggests that the matter be referred back to the Gas Committee for reconsideration in order to enable the local firm to tender for the high-tension plant. After considerable discussion it was finally decided that "the minutes of the Gas Committee be approved, with the exception of so much thereof as related to the contract for electric lighting."——The names of the firms to whom invitations were made for tenders are: Messrs. John Fowler and Co. (Leeds), the Corlett Electrical Engineering Company (Wigan), Messrs. Mather and Platt (Salford), the Brush Company, and Messrs. Siemens Brothers and Co. (London).——The Sub-Committee of the Council appointed to consider the subject of electric lighting in Wigan have presented their report, in which it is stated that the Committee have decided to recommend the scheme prepared by Messrs. John Fowler and Co. as being suitable for the present, and more particularly for the prospective requirements of the whole borough, and asked for instructions to proceed with the initial works in connection with the scheme, including powers to borrow £16,000, made up as follows: generating and distributing plant, £8,724; buildings, £5,000; service mains and meters, £2,276. The list of tenders sent in will be found in another column.

Worcester.—At the meeting of the City Council on Tuesday the Chairman of the Electricity Committee mentioned that during the first quarter that the electricity supply station had been at work (from October 11th to January 11th) the entire loss amounted to less than £100, after the payment of all proper revenue expenses, and including interest on invested capital. The Committee had no doubt that during the ensuing quarter—or at any rate the first quarter of next winter—the accounts would show a balance on the right side.

BOOKS RECEIVED.

"Lockwood's Builders, Architects, Contractors, and Engineers Price Book for 1895." Price 4s. (London: Crosby, Lockwood and Son.) 1895.

"Journal of the Institution of Electrical Engineers. January, 1895." Price 5s. (London: E. and F. N. Spon.)

"Elementary Lessons in Electricity and Magnetism." By Prof. Silvanus P. Thompson. Price 4s. 6d. New Edition. (London: Macmillan and Co. 1895.)

"Proceedings of the American Association for the Advancment of Science." Vol. XLII. 1894.

"Electrical Boats and Navigation." By S. C. Martin and J. Sachs. (New York: C. C. Shelley.) 1894.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

January 8, 1895.

524. D. Halpin and J. B. Alliott. London. Improvements in steam generators.

527. H. F. W. Burstall and J. J. Hicks. London. An improved galvanometer lamp, stamp, and scale.

January 9, 1895.

530. R. H. Tonking. London. An improved electrical current reverser and testing key.

531. A. G. Adams. Loughborough. Dynamo machines for producing alternating currents of low tension.

541. A. Eckstein and R. P. Eidsforth. Manchester. An improved combined electric bell and indicator.

545. C. M. Dorman and R. A. Smith. Manchester. Improvements in electrical switches.*

546. A. Neimczik. Berlin. Ignition and gas-generating body for explosive engines rendered incandescent by an electric current.*

563. J. Klein. London. Process for compressing and moulding electrolytically obtained metallic precipitates.

January 10, 1895.

619. T. Ireland. Nottinghamshire. A mode of giving warning by means of electric bells of the approach of trains at level crossings on railways.

620. W. Jeffery and F. Taylor. London. Improvements in electrical apparatus for protection against fire.

632. E. Ageron and A. Fournier. London. Improvements in galvanic or primary electric generators.

656. J. E. Preston. Loldon. An automatic clutch-sustaining device for brackets, pedestals or other fixed or moveable supports for electric light lamp and other purposes.

671. S. Andrews. London. Improvements in magnetic cut-outs.

January 11, 1895.

684. G. C. Cannon. Bellshill. An improvement in and relating to lamp-holders for incandescent electric lamps.

687. G. Cheffey-James and H. P. Ward. Sheffield. An improvement in machines for transforming continuous or direct currents of electricity and for other purposes.

712. L. Münzing. London. Process for the electrolytic extraction of nickel and cobalt from ferruginous raw materials.

736. R. W. Hill. London. Electric alarm detector and valve for chlorine gas.

737. R. W. Hill. London. Production of aluminium and generator of electricity.

January 12, 1895.

807. W. Siepermann and H. Riegermann. London. A process for the electrolytic decomposition of alkaline chlorides.

816. R. W. Hill. London. Production of gaseous ammonia by electricity.

817. R. W. Hill. London. Production of nitric acid by electricity.

818. V. Lahola and A. Sachs. London. Improvements in phonographs.

825. J. J. Mann and L. Hermand. London. Improvements in arc electric lamps.

831. R. C. Quin and B. Symmons. London. Improvements in automatic spring bolts for folding doors.*

January 14, 1895.

856. J. H. Salter. London. Improvements in telephonic transmitters

867. F. J. Beaumont and F. Hallows. London. An improved electricity meter for registering the amount of current consumed on direct or alternating polyphase, triphase, or quadruplephase circuits.

883. R. W. Hill. London. Production of liquid ammonia by electricity.

884. R. W. Hill. London. An electric alarm and detector of oxygen gas.

890. A. Cannot. London. An electrical ballet.

January 15, 1895.

962. C. F. P. Stendebach. London. Improvements in and relating to electric railways and apparatus therefor.

1,000. W. T. Delany, jun., and O. F. Shaw. London. Improvements in and relating to conduit electric railways.*

1,012. W. P. Thompson. London. An improved electrical device for lighting and extinguishing incandescent gas lamps.

January 16, 1895.

1,028. A. Lomax. Liverpool. Improvements in kinetoscopes.

1,088. Siemens Bros. and Co. (Limited) and F. Hird. London. An improvement in safety fuses for high tension electric currents.

January 17, 1895.

1,115. J. Anderton and A. Lomax. Blackpool. Improvements in kinetoscopes.

1,116. R. McL. MacDonald and A. MacDonald. Glasgow. Improvements connected with boats and vessels propelled by electricity.

1,117. R. MacDonald and A. MacDonald. Glasgow. Improvements in electric batteries.

1,120. A. Eckstein and R. P. Eidsforth. Manchester. Improvements in telephone circuits and apparatus appertaining thereto.

1,164. A. Damaskinos. London. Improvements in typographic telegraph apparatus.

January 18, 1895.

1,180. H. Levetus, E. M. Levetus, W. Rowbotham and C. Levetus. Birmingham. Improvements in solutions for use in primary batteries.

1,181. H. Levetus, E. M. Levetus, W. Rowbotham and C. Levetus. Birmingham. Improvements in solutions for use in primary batteries.

1,202. W. E. Langdon. Derby. Improvements in telephonic apparatus.

1,206. J. Friends and T. J. Murday. South Shields. Apparatus for measuring and recording electrical currents.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

191. Keith. Dynamos.

192. Keith. Electric drills, &c.

4,113. Barnett. Electric batteries.

4,190. Berry and Harrison. Electrically illuminated signs, &c.

5,340. Fleming. Electrical resistance coils.

5,592. Grubb and Sturge. Counter-weights for electric light pendants, &c.

21,098. Borchers. Obtaining electrical energy from fuel gases.

22,821. Tatham. Conduits for electric conductors.

COMPANIES' MEETINGS AND REPORTS.

National Telephone Company (Limited).

The fifteenth ordinary general meeting of this Company was held yesterday at the Cannon Street Hotel, London, E.C., Mr. James Staats Forbes in the chair.

The SECRETARY (Mr. Albert Anns) read the notice calling the meeting, and the report of the Directors was taken as read.

The PRESIDENT said: The report is very concise, and perhaps it will be convenient to begin at the end of it, as it may save a good deal of preliminary explanation. If you will look at the abstract of accounts at the foot of the report, and will deal with the financial aspect of the thing apart from more general questions, you will see that we have had to recast the form of it. As those who have attended our more recent meetings will remember, we altered the constitution of the Company in the sense that instead of having an annual meeting and the great disadvantage of bearing the responsibility of this undertaking for a whole year without the possibility of exchange of thought with our shareholders, we have now divided the period into two half-yearly meetings, and this is the first of those meetings. Therefore, whereas the figures in the upper part of the abstract of accounts begin in 1890 and terminate with the fourteen months to June 30, 1894, we start afresh now with the six months between June and December, and it is with the result of that period that this report and these figures deal. For this purpose we have had to go through the accounts for the six months ended December, 1893, which, having been wrapped up in the twelve months ended April and the fourteen months ended June last, required to be dissected; but fortunately we have, by dint of experience and perseverance, got these very voluminous accounts of ours—extending over 500 or 600 centres—down, so that we can tabulate the results month by month. By that means we are able to tell you what the receipts were for the six months to December, 1893, and all the other incidents down to the profit, reserve fund, and so forth. That is done in these accounts as between the two periods ended December 31, 1893 and 1894, and you will be able to see what progress we have made. The income accrued in respect of the business of the half-year to December 31st last was £378,789, being an increase over the corresponding period of 1893 of £40,861. Then comes the burden under which we groan sometimes—the enormous deduction made under the licence for the benefit of the public revenue in the shape of the royalties we pay to the Post Office. That has increased from £31,493 for the half-year to December, 1893, to £34,953 for the December half of 1894. Therefore, this half-year the Post Office have benefited to the extent altogether of very nearly £35,000, without incurring any risk or making any effort. That is so much clean money taken over the counter by us, and worked for by us for them. Then comes our net income—the amount which remains in our purse after paying out of the gross receipts this large amount of royalty. The net income for the half-year to December, 1894, was £343,835, being an advance of £37,401; and, so far, that is all pleasant enough, because if you multiply these figures by two and compare them with the annual increases in previous years, you will see that we are going on very satisfactorily as regards the increase of our gross and our net revenue. Coming to our working expenses, if we had commenced with the paragraph in the report dealing with that matter you would have been shocked to find that they have rather more than consumed the whole of the increase in our revenue; but there is a consolatory asterisk at the bottom of the abstract of accounts explaining this. The working expenses of the half-year under review amounted to £206.192 against £163.853 in the December half of 1893, but there is this asterisk against the larger amount: "Including £15,000 special provision referred to in paragraph 3 of the report." The fact is, that before the conclusion of the half-year we had already suffered somewhat considerably from storms, and we foresaw, as the half-year ended, and in dealing with these accounts, that the damage, which was considerable up to the end of the half-year, would not be lessened by the frost, snow, and storms of the month of January. We therefore thought it prudent to debit the working account with £15,000 as a special provision for the purpose of putting ourselves back into the position we were in before the storms played havoc with a great many of our wires, poles, &c. Perhaps you will agree with me that that was a prudent thing to do. One cannot tell at the present moment exactly whether this amount will be too much or too little. but it is a very substantial fund to have in hand to meet this extraordinary visitation. I expect it will come upon us from time to time, and some of you will remember that a few years ago we had a similar visitation, which cost us a great deal of money. It is, of course, a working expense, for if our machinery is destroyed by storms we must put it in order again. I hope that, as prudent men, you will encourage us to be prudent, looking to the future, and to the necessity of our being able to meet such a contingency. This provision brings the net result for the half-year down to £138,642, against £142,580 in the December half of 1893. in which period, however, we did not have to include this £15,000, which we have this time had to deal with. Adding that amount to the net result would, of course, put another complexion on the matter as regards the working expenses. The percentage of working expenses to net income was 53·47 per cent. at December, 1893, compared with 59·68 per cent. in the past half-year; but, if you take away this £15,000, there will be a sensible diminution of this percentage rate. I may as well say, also, that, in connection with this sum of £205,192 for working expenses, that we were face to face with a large stock of materials in hand, which has been overhauled. In the course of years in a concern like this a large amount of stock will become depreciated—effete—and we thought it was advisable to write down this stock by a considerable sum, which is also included in the amount of working expenses. When you come to the balance-sheet and see what a very large asset we have in our materials, the figure at which it now stands is a much safer one than it would be if we had not written down this amount for depreciation which will occur in a few years in materials. As regards the column dealing with the amount from the previous half-year, the figure there we had to rectify. When we closed the accounts for the fourteen months to June 30th last we had had an audit for the month of May, but the month of June had to be estimated for, or you would have been kept a month waiting for the meeting, and the dividend would have been withheld. We, therefore, made an estimate for this month, but we took care that it should be a safe one; and when the accounts came to be audited we found that we were very nearly £9,000 to the good for the month of June, compared with our estimate. The balance-sheet has, therefore, been altered by adding this note:—"Rectified figures brought forward on audited accounts for month of June, 1895." If you look at the upper set of figures in the abstract of accounts you will find that the amount carried to reserve fund at the end of the 14 months to June 30, 1893, was £63,429, the amount then carried forward being £1,765. Rectifying this last-mentioned sum by the amount to the good for the month of June last year beyond what we had estimated for, the £1,765 becomes £10,653. Debenture and other interest has increased since December, 1893, from £24,321 to £26,437, arising from the fact that during the interval we had to spend more of the debenture money on capital account in connection with our new subscribers a matter which I shall explain presently. The amount for Preference and Ordinary dividend shows no change, the capital remaining the same. We are enabled to pay upon both the Preference and Ordinary shares, after having cleared off the prior charges, the same dividend for the past half-year as we have paid for the last two or three years—5 per cent. per annum. This will enable us to carry to the reserve fund this half-year £35,000, and to carry forward to the benefit of the current half-year £3,379. You know the story about the reserve fund. I do not know whether we shall have it discussed again; but I see that Mr. Galbraith is here. One, however, must look sufficiently forward to apprehend both the importance and the justice to this Company of having a large reserve every year, because 17 or 18 years' tenure upon one hypothesis means that you must have a fund set aside, probably invested —and certainly later on invested—to meet possible depreciation when the time comes for considering what is to be done as the end of the concession. I know that there are some people who are saying what a scandalous thing it is for this Company to be paying enormous dividends and carrying enormous sums to the reserve fund. Such remarks, however, are made by the uninformed and unreflecting people who talk about things they do not know and things which they do not take the trouble to learn, although it would be very easy to do so. They merely denounce the Company in ignorance. But when new licensees or other people have to find the money and come in, if they ever do, as competitors with us, upon a 17 years' tenure, they would have two things to think about: first, whether they can get capital subscribed at 5 per cent. on such a risky business as this, and, next, whether the 5 per cent. is a very encouraging thing if, at the end of 17 years, the capital value is seriously diminished. That is the *rationale* of that matter. You see that our reserve now amounts to a considerable sum in the balance-sheet, and it is essential to the existence of this Company, or of any Company or Corporation who undertake this business to bear in mind that not only must they earn in those years such a reasonable dividend as justifies the venture, but, *plus* that, a very considerable addition to cover what may arise when their lease ends. Of course, one may have one's own opinion as to what may arise, but this business is in such a position that no one knows or can predict what is going to happen. As prudent people, however, we must provide for what may happen, although, personally, I do not believe it will happen. When I come to deal with the report itself you will see that I have said everything that is there stated on this subject, because it repeats in much the same order and in pretty nearly the same language, barring the figures, what I have said. We refer in paragraph 3 to the sum of £15,000 "specially set aside to meet the heavy exceptional cost involved in replacing and repairing plant destroyed or damaged by the recent storms." It would have been more absolutely correct to say "to be." It is reserved to pay for damage done before you had the opportunity of repairing it, but it is no less a charge on the half-year. and it is necessarily reserved for that purpose; in fact, a good deal of it has been spent in putting things into ship-shape. The net result I have already told you about. Then there is the paragraph which begins "the rentals carried forward for unexpired terms of running contracts." That is an indication of the position of the Company. I have had occasion to explain this matter a good many times, but one sees strange faces at these meetings, and even proprietors who have attended former meetings sometimes forget the explanations given to them. This, however, is a very important matter, as an indication of the progress we are making. It means the amount of money in hand by payments made in advance for periods extending beyond the termination of the half-year. A man pays £10 on the 1st of January in advance for twelve months' service. At the end of the twelve months it is accounted for and becomes part of the revenue; but if on the 1st of February he pays £10, eleven-twelfths of this sum belongs to the year ending the following December, and the remaining one-twelfth to the following January. We therefore always have an amount in hand in respect of service paid for but not performed. Well, the amount so carried forward at the end of December, 1893, on this account was £282,948, whereas the amount is now £313,979, showing that advance. He then went through the accounts, and in calling attention to the amount expended on capital account during the six months to December, 1894, remarked: This is an item which is always important to bear in mind in talking about telephone matters—that this business involves in its very nature the finding of ready money in anticipation of new subscribers, because until you have installed a man he cannot communicate, and, roughly, every new subscriber costs about £40. Therefore you have, to start with, to find £40 to instal a new customer, and the bulk of the amount of £134,959 expended during the six months under review on the construction of exchange, trunk, and private lines is made up in that way. As regards trunk lines, according to the contract entered into with the State a couple of years ago or more, we were bound not to extend the trunk system, the nature of the bargain being that the State should become the "trunkers," we being limited to the humble capacity of collectors and deliverers of goods. But the question between us and the Post Office is treated in rather a different way. We are obliged to anticipate expenditure; we know it will be required, and we must make provision for it a little in advance of the absolute time. The Post Office act upon another principle. When someone has established a business they then think that the time has come to spend money to provide for it. That is the difference between the way the telephone and the telegraph business has been conducted. Some of our claims were so urgent, particularly in the manufacturing districts, and the hindrance to business was so great, that we were enabled to persuade the Post Office to let us go on spending their money a little in advance in the establishment of trunk wires. A portion of this £134,959 has gone in that way, but it comes back when we have ascertained what lines the Post Office will take over under the agreement—a very complicated matter, although one very easy to talk about. It is all mixed up, and it takes a very long time first to determine the principle, and next to do what is convenient, and to see if it is better to consider whether a line is trunk, or local, or a common thing. That has been a very laborious job, and if there had not been in the Post Office and on our side the most perfect rectitude of intention, it would have been a very difficult thing to unravel. We have now settled the principle on which the thing is to be done, and the matter is now remitted to the agent of the Post Office—an engineer, and our own engineer. The principal valuation is going on, and I suppose that in a short time the amount will be decided on that has to be paid, and it will be a good lump sum. As to the item of £121,295 "redemption of Four and a-Half per Cent. Debenture Stock," we redeemed that stock at 110. No one however, knew what would arise, and it was underwriten, on account of which we incurred a moderate expense. We have a balance to the credit of capital account of £305,709, being money we have received on our different stocks; but we have a large amount set aside in reserve, which might have been paid in dividends; and we have also in hand the large amount of money I have mentioned, which has been paid to us in respect of unperformed duties. By means of those funds, we are able to go on without raising capital. There is no particular object in raising capital with which to carry on daily expenditure, or to keep money lying idle when we can distribute it, and, therefore, we have put this money into our business as against a good asset. Then we come to the revenue account and you will see how that stands. There is an increase in the item of "rents of premises, taxes, and insurances," for rents grow, the taxes are always growing, and, as regards insurance, ours is an extremely complicated business, and we must insure in order to meet risks which we might incur by fire, &c., just the same as prudent merchants insure their warehouses. In the net revenue account you will see the modest sum of only £425 paid in the half year by us for parliamentary expenses and legal charges. The balance carried to the balance-sheet is £[illegible]22,85[illegible] and you see how that amount is proposed to be dealt with. He then went through the principal items of the balance-sheet, and, with reference to the stock of materials, stated that they had nearly 600 exchanges scattered all over Great Britain and Ireland, with poles, wires and instruments. In each place the amount was only reasonable; but in the aggregate it came to an enormous amount of lock-up, producing nothing, although such things must be kept in stock. Continuing, he said: I now come to the agreement with the Post Office. This matter is dealt with very concisely in the report. We have entered into an agreement with the Post Office, the heads of which were signed on August 11, 1892. The heads of agreement were very concise, although requiring enlargement as regards details—not affecting the principle of the heads, but enlarging them so as to provide for various contingencies and modifications of detail. We are instructed that this is a valid and binding agreement, which was accompanied by certain things not dealt with in it—pledges of ours, in the interest of the two parties, that when the agreement took effect we would not do this or that thing. Obviously, when the Government had made up their minds that they were going to resume possession of all the trunk lines we had constructed, and that they would provide all future trunk lines, it would have been inconvenient for us to go on spending money instead of the Post Office doing so. Therefore, not in the agreement itself, but in a memorandum, as a matter of honourable dealing, we agreed that, without the sanction of the Post Office, we ourselves would not, as part of our business, construct any further trunk lines. To that we have most loyally adhered, notwithstanding the serious injury that has resulted to the convenience of the telephoning public, particularly in the great centres, from a paucity of necessary trunk lines. We have overcome this matter, however. As we have said in the report, the authorities did what they felt they could do under the state of things which existed, but, of course, the longer this agreement remains inoperative the more serious this thing is felt. We know something about this matter, because we have to deal with it. A great many people, however, who know nothing about it, say what we ought to do, but we learn this by having to do it. We know that we have been greatly prejudiced, both in income and reputation, by the delay which has been forced on us by what I have described; and every six months that that delay goes on, the public and we suffer. I hope the time is very near now when that agreement will be honourably carried out by the Goverment. I do not think that I need say anything more. I have said all that I have to say about the disadvantages of the position, and how they have been met by the forbearance, assistance, and courteous dealing of the Post Office with us. I am not blind to the fact, however, that, with the best intentions, our business has been seriously damaged, and we have been great losers both in money and character. As regards the paragraph dealing with a further issue of debenture stock, you cannot go on getting subscribers without spending money, which we are obliged to find. It is necessary not to be too dependent on bankers, and we thought it was proper to offer some proportion to the ordinary shareholders of the Three and a-Half per Cent. Debenture Stock which is unissued. It is offered to the shareholders at £103 per £100 of stock to such an amount as will represent 15 per cent. on their holdings. I do not know if everyone is going to subscribe for it, but a Three and a-Half per Cent. stock at 103 is not a thing to be despised in these days. It is now saleable at 105 or 106, so that those who take the amount to which they were entitled under this offer will already secure a premium if they like. He concluded by moving the adoption of the report and accounts and the payment of the dividends recommended.

The VICE-PRESIDENT (the Right Hon. Lord Balfour of Burleigh), in seconding the motion, said there were only two points which it was at all necessary for him to advert to. He desired very strongly to impress upon the shareholders that the increase in the percentage of working expenses to net income was apparent, and not real, for the reasons which had been mentioned by the President. As had been stated, £15,000 had been set aside to meet damage to the plant of the Company, owing to the exceptionally severe storms at the end of December and the beginning of January. They hoped and believed that the provision made to meet this out of the half-year's income would be sufficient. In addition to this the stock on hand had been written down by £12,000 If these two sums had not been taken out of the revenue the percentage of working expenses to income for the half year would bear favourable comparison with the percentage of the corresponding period of the previous year, for it would be a point or two less. Constant comparisons were made, always to the disadvantage of the Company, as to the amount they charged for telephonic communication. It was said that one could have telephones somewhere for £2, £4, £6, and so on. Places such as Stockholm and Copenhagen were compared with London; but this was not fair, because the problems connected with giving telephonic accommodation increased according to the aggregation of population, and became more and more difficult where there was an enormous population, such as they had in the large towns of this country. If they were going into a discussion of the matter, they could quite well point out that in some cities of Europe and many in America the charges were very much higher than those made by the National Telephone Company. There was another fallacy underlying these comparisons. He did not for a moment say that they were deliberately made for the purpose of doing the Company a wrong, but when these comparisions were made, the same accommodation which this Company gave was not included in the charges demanded at some of the places with which this Company was compared. In some cases instruments had to be paid for in addition, and in none of these cases, he believed, was there a royalty of 10 per cent. on gross takings to be paid to a sleeping partner, as had to be done in the case of this Company. He did not complain of this, but he did say that when these comparisons were made the shareholders ought to be on their guard and not be misled into the idea that a real comparison—a comparison of like with like—had been made. In almost every case, a great deal had to be taken off the comparison on one side, and added to the comparison on the other, to make it fair with the conditions of things applying to the National Telephone Company. He thought the accounts showed that their concern, speaking generally, was in a prosperous and satisfactory condition.

In reply to Major-General Truell and Mr. Galbraith, who urged the importance of the reserve fund being in liquid securities—Mr. Galbraith alluding to the solid character of the investments of the Eastern Telegraph Company—

The PRESIDENT stated that they had always been in accord with Mr. Galbraith as to the propriety of a liquid reserve. The only point on which they had not been able to agree with him was as to the proper time. If they sanctioned the addition now proposed of £35,000 to the reserve fund it would amount to £260,000, which was in the business. What they were waiting to see was how much they were to receive from the Post Office under the agreement referred to. The amount, as far as they could get at it, would certainly not be less than £400.000, and it might be £500,000. When they received this amount in solid coin an admirable opportunity would be presented of considering the point which had been suggested. As to a deputation to the Government to ask them to give up the 10 per cent. royalty which they had on the Company's gross income, he thought it would be like trying to get butter out of a dog's mouth; but if the shareholders would like to go with some of the Directors as a deputation to the Post Office on the matter, the Board would be glad to fall in with the suggestion. He then put the motion which was carried unanimously.

A vote of thanks to the President, Directors, and Staff was then proposed, seconded, and carried unanimously.

The PRESIDENT, in returning thanks, warmly recognised the invaluable services rendered to the Company by Mr. Gaine (the general manager), Mr. Sinclair (the engineer-in-chief), Mr. Anns (the secretary), and the staff generally. Theirs was a very large establishment. He found that they had 10,000 accounts, 582 exchanges throughout the country, and about 72,000 subscribers, the latter representing financial, political, and social interests of the greatest importance. This was not a combination which could be pooh-poohed, as was sometimes attempted to be done. He quite agreed with the view that telephone shareholders and subscribers should make themselves heard.

The proceedings then terminated.

Cuba Submarine Telegraph Company (Limited).

The forty-seventh ordinary general meeting of the Cuba Submarine Telegraph Company (Limited) was held at the Company's offices, 58, Old Broad-street, on Wednesday last, under the presidency of Mr. Thomas Greenwood.

The SECRETARY (Mr. James Scott) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, considering the state of the weather, I think were are very fortunate in getting a quorum to-day. On the last occasion of our meeting we had some difficulty to make up that number; but our report and accounts are generally so favourable that the shareholders do not think it necessary to trouble us with their presence. This is no exception to the rule, and last half-year's report was quite as good as that which preceded it. It is rather a singular fact that there is not a difference of £1, but of only a few shillings between the traffic receipts of the past half-year and those of the corresponding period of the previous year, and that the like circumstance arose six months ago, when I had the pleasure of seeing a few gentlemen here. The receipts from interest on investments are rather less—not less than they ought to be, but in the corresponding period of the previous year we had an excess of interest. Some moneys were received for interest on deposits with banks, and these sums had been delayed in the former half-year and came together in the half-year with which we are now comparing. With that exception the receipts may be taken to be pretty much what they were twelve months ago. There has been a slight increase in the expenses, and the expenses at stations on the whole are £300 more than they were at the corresponding period of a year ago. The fact is, however, notwithstanding that, that the expenses proper have been less; but we have made an outlay this half-year for putting up aerial cable in place of some of our wires, which has cost us £600, but the state of the line is improved to that extent. We have also some increase in income-tax. We have had some difference with the Commissioners of Inland Revenue. They would not allow us to make a deduction from revenue, as we have hitherto done, in respect of the hire-purchase cable of 1881. These difficulties are now settled, however, and we have had to pay them a larger sum than we expected, and the result is that we had about £300 more income-tax to pay this half-year than in the corresponding period of the previous year. With that exception I think I have brought to your notice nearly, if not all, the points of difference. Our reserve fund stands now at £100.000. It was £105,000 twelve months ago, but in the meantime we have paid some £17,000, and charged the reserve fund on account of the purchase of the new cable. I am pleased to tell you that we have just received intelligence from the other side that that cable has been successfully laid. We shall not make any further payment on that account, of course, until the usual 30 days' tests are given; but we have every reason to expect that the cable will be in as perfect condition at the end of the 30 days as it was when it was laid. A further sum will then be paid, and charged against the reserve fund; but still, I hope that we may have twelve months hence a reserve fund equal to that which we have at the present time; that is to say, that the amount we set aside from our revenue will be equal to the charge against the reserve fund. We have reduced our investments a little by receiving some money from some of the Australian banks, who have been paying a part of the money due to us; and we have also made a further reserve of £1,000 on account of the difficulties which the New English Bank of the River Plate are in. We hold £8.000 there, and it appears that the estimate made by the authorities of the probable receipt by the realisation of the securities was much higher than it should have been, and I am afraid that we shall lose a sum by the New English Bank of the River Plate. Still, the reserve of £6,500 made against loss on deposits may be considered ample to meet every charge on it, and to cover any deficiency that might arise in connection with some of the Australian banks. I shall be very glad to give you any further information, but I will now move the usual resolution—

"That the report and accounts for the half-year ended December 31st last. now submitted, be received and adopted."

Mr. ALEXANDER F. LOW: I have much pleasure in seconding that.

The CHAIRMAN: Have you any inquiries to make, gentlemen?

Mr. F. H. KEENLYSIDE: Can you tell me whether there is any chance of the Spanish Government and ourselves fixing on any agreement as to this item of "Agents near the Spanish Government?" I really cannot tell how many half-years I have seen this item, but it is a great number.

The CHAIRMAN: Yes.

Mr. KEENLYSIDE: I do not know whether the Spanish Government are likely to be drawn into a little more rapid progress or not. Would you also tell me what the balance will be that is taken out of the reserve fund to pay for the cable which we hope to be able to take over in 30 days?

The CHAIRMAN: Is there any other question, as I will answer them altogether? After a pause, and no one rising to address the meeting, he continued. Then I will answer these questions. The item to which you refer of £237. 10s. in every half-year charged for agents near the Spanish Government does not at all touch upon the question of dispute between us and them. This is a charge for salaries which we pay to our representatives in Madrid and elsewhere whom we are obliged to have. We to them are a foreign Company, and we must have a representative there—some one who is authorised to act for us under any emergency, and this amount of £237 has been in our accounts for many years past, and is likely to continue, I should think, to the end of time, as far as we know. As regards the expenditure ou the suit, nothing is charged in the accounts this half-year. The thing is dragging on, and when it will be finished I am sure I cannot tell you, but we are not suffering by the delay. As regards the further payment to be made on account of the new cable, I think it may probably be estimated at about £6,000.

The resolution was then carried unanimously. The dividends announced in the Directors' report which appeared in our last issue were then declared, and a vote of thanks to the Chairman, the Board of Directors, and to the Secretary and officials of the Company, was proposed, and responded to by the Chairman, and the proceedings terminated.

St. James' and Pall Mall Electric Light Company (Limited).

The ordinary general meeting of the shareholders of this Company was held at the offices, Carnaby-street Central Station, Golden-square, London, W., on Tuesday, under the presidency of Mr. Eustace J. A. Balfour.

The GENERAL MANAGER and SECRETARY (Mr. Frederic J. Walker) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN: I have now to propose that the report and accounts be adopted. I will presently read out the formal resolution; but before doing so I just want to say a few words in explanation and give you an account of the year's work. I think the Company may congratulate themselves generally on the result of the year's working. As you know, we pay a dividend of 6½ per cent. on the Ordinary shares, instead of 4½ per cent. as last year, the Preference shareholders, of course, remaining at 7 per cent. I confess that I should have liked to have a little margin with which to pay something to the Founders' shares; but that was not to be. Possibly, if things go well with us another year, as they seem inclined to do, we may be able to arrive at that result. One of the things we shall have to face during the coming year is the question of the increase of our plant. We are at present not at all far from the limit at which we can work with safety. This is partly due to the fact that Mason's-yard station cannot be at this moment trusted to do its full share of the load. We have, as you may probably have seen in the papers, an action pending, brought against us by the vestry for a nuisance, and, of course, while that action is pending my tongue on that point is tied. But in any case we have come to the conclusion, on the advice of our engineer and our expert advisers, that the 1,600 H.P. which Mason's-yard is calculated to give cannot be fully relied on, and what we propose to do during the coming year is to increase the capacity of this station by a re-arrangement of the machinery, and, finally, to deal with Mason's-yard as our experts may advise. The exact method of dealing with it we cannot, as yet, determine. For this purpose we shall have to raise some more debentures under the powers which we already possess; but these figures have not been completely gone into, and I am not in a position to make any definite statement on the subject. Of course the debentures we raise will be offered to the shareholders. During the past year the cost of working has been still further reduced to the extent of ¼d. per unit. I need not say that this result does infinite credit to the engineer's staff. You will find in the accounts a very great increase under the item of rates. We have done our best to get this assessment reduced, but we, unfortunately, had no right of appeal, and the matter will have to stand over until the quinquennial valuation of the vestry takes place. I need not say that we shall use every endeavour to secure the interests of the shareholders in this matter. There is one possible difficulty we have ahead which we are doing our very best to guard against beforehand, and that is the rivalry of the London Electric Supply Corporation. They have the power, and possibly they may exercise it, of reducing the rates to such an extent that this business would cease to be remunerative. I need not say it seems to me that such a course is quite as much against their interests as ours, and we are using every endeavour by the exercise of a friendly spirit to come to some kind of agreement with them by which neither Company will cut its throat. You will remember that I mentioned this subject last year, when I stated that the then Chairman of the London Company was incorrect when he remarked that this war of rates had been commenced by us. We have always been anxious to work in a friendly manner with our rival in the interests of our shareholders, and I have real cause for hope that this friendly spirit may continue between us. We have unfortunately lost one of our Directors, Mr. Kirby, who resigned a short time ago. I must take this opportunity of saying that during all the years—almost from the commencement of the Company—in which Mr. Kirby was a colleague of ours he served the Company admirably, and spared no time or trouble to assist the work of the Directors, and his financial ability has been of enormous advantage to all of us. I cannot say how much I personally—and I am sure the other Directors regret the fact that he felt compelled to resign. I also want to take this opportunity of again thanking our staff—both the General Manager's staff and the engineer's. I think that this Company may be regarded as a sort of model company for all others in its economy of working, in the smoothness with which everything goes on, and on its immunity from accidents and other *contretemps*; and both Mr. Walker and Mr. Dobson deserve credit for the way in which they carry out their duties. You will be glad to hear also, although it scarcely belongs to last year's accounts, that this year has begun in a most satisfactory way. If it only goes on as it has begun we shall be able to do very well. During the first five weeks of the present quarter there has been an increase of no less than £1,500 in gross revenue, which is a very considerable amount, and not only have we increased our customers since December 31st by 26, but the number of lamps between the end of December, 1894, and the end of January, 1895, has increased from 75,217 to 76,610. This is a very satisfactory increase in wiring. I do not think I have anything more to say. I have not made a long speech this time, because I do not think there were any special incidents to dwell on, and I will now formally move

"That the report and accounts for the year ended December 31, 1894, as submitted by the Directors, be received and adopted, and that the dividends recommended therein be declared and paid on February 22nd."

I need not say that I shall be very glad to answer, to the best of my ability, any question which any shareholder may wish to put to me.

The VICE-CHAIRMAN (Mr. Latimer Clark) briefly expressed his pleasure in seconding the motion.

Mr. SAMS inquired why £90 was carried forward to the Ordinary shareholders' account, whereas the Founders' shares were left out in the cold altogether.

Mr. TOOTH inquired when it was proposed to issue the additional debenture stock.

Mr. PEARCE remarked that attention had recently been called to the danger of electric current in the streets, and he inquired what amount of risk in connection with this matter this Company ran, and whether it was receiving the attention of the Directors.

Mr. ACKROYD called attention to the law expenses, and remarked that only two years ago a lawsuit with the Wyndham Club cost the Company about £1,000. There was still complaint on the part of the club as to vibration, and he did not know whether anything was being done to ameliorate this or not, but in talking to some of the committee of the club he knew that they were fully determined to have the nuisance abated.

Mr. FRY stated that he had also heard the opinion of a member of the Wyndham Club expressed, and that gentleman had informed him that, as compared with what it used to be, the nuisance was now comparatively nothing.

Mr. ACKROYD said he believed that it was not so bad as it used to be.

Mr. TOOTH regretted that the Company were going to law again, because this would have a tendency to reduce their profits.

Mr. FRANK MUIRHEAD called attention to the difference in the management expenses between the Westminster Company and their own Company, and stated that the amount paid for Directors' fees in this Company was £1.496, compared with £800 in the Westminster Company. (A voice: "That is going to be altered by the Westminster Company.") He also stated that the law expenses of this Company amounted to £373 in the past year compared with £42 in the case of the Westminster Company.

The CHAIRMAN: I will now answer these questions, and the first one is a very simple matter. Mr. Sams, I think, referred to page 6 of the report and asked why £90. 14s. 5d. was not put to the credit of the profits of the Founders' shares. The sum is too small to divide among the Ordinary shareholders, to whom it belongs, and under no circumstances, had it been divided up, would a single penny have gone to the Founders' shares, because it is not until 7 per cent. has been paid to the Ordinary shareholders that the holders of the Founders' shares receive anything. With respect to the time of issuing the debenture stock which I mentioned, the Board has had no opportunity of considering the matter as yet: but it is quite clear that it would be in many ways bad finance to issue such stock, bearing interest at 4 per cent., earlier than the money is absolutely required. I fear that I cannot give you a more definite answer than that. Mr. Pearce asked about the danger of electric current in the streets. Of course, all questions of danger to the public receive the attention—the very careful attention of the Board, and every incident that occurs which has even a suspicion of danger about it is at once reported to them and considered. We had in the past year only one very small accident, which was caused by a small explosion of gas at the bottom of St. James-street. Both our engineer and the advisers of the Board of Trade are engaged in providing a remedy which will prevent the recurrence of such an accident, by which, however, no one was hurt. I may add to this matter two points. The Southwark Bridge explosion, which has nothing whatever to do with us, was not caused by electricity ; and as our system is low tension, it cannot, except under very exceptional circumstances, and by an extraordinary combination of accidents, produce an explosion. In addition to this, it cannot by itself cause danger to life through shock. I regret that a shareholder of this Company should have brought up this question about the Wyndham Club. It is still undergoing inquiry by the Board of Trade, and we expect to be able to get over all the difficulties in connection with it : but I think it is unfortunate that in this room, at any rate, the matter should have been referred to.

Mr. ACKROYD said he only wished to be a mediator between the shareholders and the Club.

The CHAIRMAN : The Club are meeting us in every possible way, and we are making experiments in their rooms, which, I have no doubt, will lead to valuable results. As to management expenses, Mr. Frank Muirhead spoke about the Directors' fees. I do not know that the comparison in this matter with the Westminster Company is much to the point, as I believe they are going to alter their scale ; but at all events the existing scale in our case was come to two years ago between the shareholders and the Directors, and it has not been altered. I should be very glad if those who object to litigation would induce clubs and others not to litigate with us, but if someone attacks us we must defend ourselves. The vestry are bringing this action against us, and if we did not defend ourselves, they would shut up Mason's Yard. We are doing the best we can.

Mr. TOOTH remarked that the law expenses last year cost them about £4,000, which was a tremendous "pull."

The CHAIRMAN then put the motion in the usual way, and declared it carried unanimously. Continuing, he proposed the re-election of the retiring Directors—Sir John Morris, K.C.S.I., and Mr. Gerald W. Balfour, M.P.

Mr. BENNETT FITCH seconded the motion, which was carried unanimously.

A SHAREHOLDER inquired whether Sir John Morris had not been elected a Director in the place of Mr. Kirby.

The CHAIRMAN : No, Sir John Morris has been a Director for a long time. I may state, as Mr. Kirby's name has been mentioned, that it is the intention of the Directors shortly to elect another gentleman in his place—Mr. Walter Leaf, who is well known in the City. We cannot elect him to-day, as Mr. Kirby's notice of resignation was only sent in a few days ago.

Sir JOHN MORRIS, having thanked the shareholders on behalf of Mr. Gerald Balfour and himself for their re-election,

Mr. HODGSON proposed and Mr. PEARCE seconded the re-election of Messrs. Deloitte, Dever, Griffiths and Co. as auditors for the ensuing year.

The motion was carried unanimously.

A SHAREHOLDER proposed a hearty vote of thanks to the Chairman, Directors, and staff.

The motion was carried unanimously.

The CHAIRMAN : I thank you heartily for the way in which you have proposed, seconded, and received this vote of thanks. I will merely say I am perfectly certain that every one of us is heartily desirous of doing his very best to forward the interests of the Company in every possible way.

The proceedings then terminated.

House-to-House Electric Light Supply Company (Limited).

The seventh ordinary general meeting of this Company was held on Friday at the Company's central station, Richmond-road, Kensington, Mr. Henry Ramié Beeton (Chairman) presiding.

The SECRETARY (Mr. W. Coupland Weir) read the notice calling the meeting.

The CHAIRMAN said : In accordance with the usual practice at our meetings, I presume we may take the report as read. The shareholders who have read it will have noticed that our business continues to show a steady growth. During the past year the number of lamps connected shows a larger increase than in the three previous years, and the gross revenue, which exhibits an increase of £1,452, has been earned at a reduced expenditure of upwards of £400. The reduction in expenses is very general throughout most of the items in the revenue account, and testifies to the more economic organisation of the station and the excellence of the supervision. The capital account of the Company shows an expenditure of £6,670 as compared with £7,409 during the preceding year. About £3,000 of this amount is accounted for by the cost of laying additional mains which, whilst covering the Company's area, is, for the time being, more or less unproductive outlay. In view of the results which we now present to the shareholders, the Directors have had under consideration the question as to the desirability, in the general interests of the undertaking, of making an early substantial reduction in the price of the current to consumers. The Board is not in a position at this moment to make any definite statement with regard to the matter, but they hope that when the reduction is made it will not prejudicially affect the net revenue, although it will undoubtedly affect its rate of progress. There is only one item, I think, in the accounts which calls for some notice, and that is in respect of the Company's expenditure on the construction business, which is represented in the balance-sheet by an asset of £16,618. Since the issue of the report to the shareholders, the Directors have not received the accounts of the Leeds and London Company, which they hope to be in possession of in a few days ; but they are very much disappointed that the admittedly large business which has been transacted under the agreement has not been productive of profit to the Company, and they will make it their business to investigate the circumstances under which such an unsatisfactory result has been obtained, with the view of protecting the interests of the Company as far as they may be able. I ought to add that the Board feel that the satisfactory results which they are enabled to present to the shareholders are in a large measure due to the admirable services which have been rendered by Mr. Page, as Managing Director, and Mr. Bowden, as manager of the works. With these observations, I move—

"That the report of the Directors and the statement of accounts for the year ended December 31, 1894, be received and adopted."

Mr. W. F. LEESE seconded the motion.

Mr. W. PAGE (Managing Director) said he believed it would be in the interest of the Ordinary shareholders that a reduction should be made in the price of current as soon as possible. But before that could be done they must make further provision in the way of plant, because he expected the reduced price would bring them a largely-increased demand, which they must be in a position to meet. As soon as they had the plant something of the kind would be done ; but plant of the best type—or what was considered the best type—could not always be had at once, because everyone was wanting it at the same time. They had new plant on order, and he was hoping to get it erected during the next six months, and they would then be in a position to meet the increased demand expected to be made upon them. The results to which the Chairman had referred in the way of increased expenditure had been brought about by great economy, for which Mr. Bowden was very largely responsible, and they owed that gentleman a great deal for the indefatigable way in which he had discharged his duties. As regards the Leeds and London Company, he would like to point out that the celebrated firm of J. Fowler and Co. had the management of it, and he did not think that firm, with their reputation for good work, business ability, and prosperity would, after the Company got into working order, allow it to prove unsuccessful in their hands.

The motion was then put to the vote, and declared to be carried *nem. con.*

The CHAIRMAN then moved the payment of the Preference dividend for the year, which was carried.

Mr. H. R. Beeton (Chairman) and Mr. W. Page (Managing Director) having been re-elected as Directors, and the auditors (Messrs. Theobald Brothers, Miall and Co) re-appointed,

The CHAIRMAN said the Board hoped in future to pay the Preference dividend half-yearly.

A vote of thanks to the Chairman terminated the proceedings.

Newcastle and District Electric Lighting Company (Limited).

The annual meeting of this Company was held on Monday at the offices of Messrs. Leadbitter and Harvey, Westgate-road, Newcastle, Mr. J. D. Millburn presiding.

The CHAIRMAN, in moving the adoption of the report (which appeared in our last issue), said the output of the Company in 1891 was 206,000 units, at a cost of 3·39d. per unit ; in 1892 it was 290,000 at a cost of 3·11d. per unit ; in 1893, 388,000 at a cost of 2·63d. ; and in 1894, 431,239, at a cost of 2·45d. per unit ; so that while the production had been steadily increasing, the cost had greatly decreased, till it had reached 2·45d. per unit, which was the cheapest price at which electricity had ever been produced. As they went on increasing in production the cost would still further decrease, and they would have the satisfaction in time of making a reduction in the price charged to the customers. This continuous reduction in cost of production had not been achieved by any undue capital expenditure, as, taking the capital expenditure of the Company in conjunction with the amount of electrical energy produced, it would compare most favourably with any Company or Corporation in the United Kingdom. The whole of the machinery, boilers, &c., were in a thoroughly satisfactory condition, and it was pleasant to mention that the mains of the Company were in the best possible condition and quite as good to all appearance as the day when they were laid underground. Of course, there must have been some depreciation, but it was not apparent. A great deal of their capital of course, was sunk below the streets in those mains. There were miles and miles of cables, and they were most successful in the manner in which they laid down their tubes and the special joint boxes. They had a special engine for blowing the air through those mains in order to keep everything perfectly dry and tight. They had great reason to thank the foresight of their Managing Director (Mr. Parsons) for that, for some of their neighbours had not been so successful in that respect. The condensing plant was doing all that was expected, and as the operations of the Company increased it was satisfactory to know that all the new machinery could be of the condensing type, the precaution having been taken when making the drift to the river to make it large enough to meet future extensions for some time to come. In the course of the year they had had their shares quoted on the local Stock Exchange, and the present price of the shares was placed at a fairly satisfactory figure. The price of the light was cheaper in Newcastle than in any other place in England, and in a year or two they hoped to make it still cheaper. They hoped presently to derive a large income from electricity for cooking purposes. They had not yet got hold of the right motor for driving machinery, hoists, &c., but they believed the time was soon coming when they would get it, and then the finances of the Company would be in a considerably better state in consequence. With regard to the tramways, if the Corporation would allow them to run overhead tramways with overhead wires, as at Milan, Genoa, and many Continental cities, they could do it very well, and cheaply, but they could not see their way to do it properly underground. That was the reason, perhaps, why they had not taken the matter up. The prospects for the year were good, and they hoped to extend their business considerably. He moved the adoption of the report, and that a dividend at the rate of 3½ per cent. for the half-year, making 6 per cent. for the year, be declared.

Sir BENJAMIN BROWNE seconded, and the report was adopted, the dividend declared, and Col. W. M. Angus and Mr. J. B. Simpson re-elected Directors.

An extraordinary meeting was afterwards held, at which it was decided to increase the capital from £50,000 to £100,000.

Replying to a vote of thanks, the CHAIRMAN paid a high compliment to the officials, Messrs. Parsons, Patterson and Hunter.

India Rubber, Gutta Percha and Telegraph Works Company (Limited).

The thirty-first ordinary general meeting of this Company was held at the Cannon-street Hotel yesterday under the presidency of Mr. S. W. SILVER.

The SECRETARY (Mr. William J. Tyler) read the notice convening the meeting, and the report of the directors was taken as read.

The CHAIRMAN: The motion I have to propose is

"That the report and accounts now presented be received and adopted, and that a dividend of 5 per cent., or 10s. per share, at the rate of 10 per cent. per annum free of income tax, payable on the 15th inst., be now declared."

In moving this resolution I cannot help saying that we are disappointed after the hard struggle we have gone through; but, like other industrial concerns, we have suffered from the depression that has universally prevailed. Added to this, competition has increased, and "over-production" (about which we hear so much) has seriously affected our profits. The unprecedented state of the Money Market will account for much, as, in consequence of the low standard in the rate of interest, employment for capital is sought for in every channel. In the absence of submarine cable work our steamers have been idle. Our reserve has proved a valuable "auxiliary fund." It has enabled us to purchase the raw material under very favourable circumstances by laying in heavy stocks for future requirements at low prices. There are indications of a revival in commercial operations, but we must exercise great caution in effecting sales, as a new system of transacting business is gaining ground, of a character more likely to result in loss than in profit. I must not omit to refer to the large increase of late years in rates and taxes, which forms a serious item when cost of production is under consideration. It will be interesting information if I tell you that we availed of the invitation to send estimates to the Canadian Government for the laying of 8,000 miles of submarine cable from British Columbia to Australia, which we have reason to believe have received every attention. I must, in referring to this subject, remark that we feel greatly indebted to a member of our Board, Hon. H. Marsham, for the ready way he came forward and offered to accompany our chief submarine engineer, Mr. M. Hamilton Grey, who has already passed over those waters and is familiar with most of the spots involved. I have to report the highly efficient and satisfactory state of the works at Silvertown, as well as our works in France, and that they are fairly well employed at the present time. If we are fortunate in obtaining submarine contracts and find work for our steamers (I may mention that our steamship "Dacia" has just completed a contract entered into for the Spanish Government to repair a cable referred to in this day's papers) we may look forward to the pleasure of meeting you in July next with a favourable account of our labours. With these remarks I beg to move the adoption of the report and accounts, and the payment of a dividend of 5 per cent., or 10s. per share, free of income-tax, payable on 15th inst.

Mr. ROBERT HENDERSON briefly seconded the motion.

The CHAIRMAN: We shall be glad to hear any remarks that any shareholder may desire to make.

Mr. SHELDON said he desired to know how the reserve fund was invested. It was put down on one side of the balance-sheet at £450,000. Was that represented by investments in any way? He saw that the debentures and shares held by them in other companies amounted to £209,540, on the other side, so that he presumed about £240,000 of the reserve fund was invested in stock and plant.

Mr. CONGREVE inquired whether the Board had fixed any limit to which the reserve fund was to be raised. It seemed to him that the interests of some future generation were being considered—partially, at all events—in connection with this fund.

Mr. GILLINGS said he had seen a rumour that the stock which the Company had purchased on favourable terms had been written down to a low price.

Mr. HENDERSON asked whether, if the contract for the cable referred to was accepted, the shareholders would be informed of the fact.

The CHAIRMAN: You refer to the Pacific cable?

Mr. HENDERSON assented.

The CHAIRMAN: If there are no other questions I will answer those which have been put. One question was how the reserve fund had been invested, and that has been answered on previous occasions. I believe that the gentleman who put this question is a recent shareholder. It is invested in the business. As regards the stock which we have bought below value, it is used at the market price of the day, and it has increased in value. As to the Pacific cable, the result will be publicly announced. I do not think we need undertake to inform our shareholders, although we should, of course, be very glad to do so. I will now, if you please, put the resolution.

Mr. CONGREVE observed that his question had not been answered as to whether any limit had been fixed to which the reserve fund was to be increased.

The CHAIRMAN: I do not think we have occasion to consider the subject. I will now put the resolution. Having submitted the motion in the usual manner, and declared it carried unanimously, he said: It affords me great pleasure now to propose the re-election of my friends, the Hon. Henry Marsham and Mr. Weston Jarvis, as members of the Board.

Mr. ROBERT HENDERSON briefly expressed his pleasure at seconding the motion.

The resolution was carried unanimously.

On the motion of Mr. SHELDON, the retiring auditor, Mr. J. F. Clarke, was re-elected for the ensuing year at a fee of 30 guineas.

The CHAIRMAN: I will now ask Mr. Gray to give an account of his recent visit to our French works.

Mr. MATTHEW GRAY (Managing Director): Gentlemen, I went over to our French works about four or five weeks ago, and I had a very gratifying visit. All the work people were busy, and I also found all the machinery and everything else in first-rate order. Everyone seemed to be highly pleased with the way the business was going on. There was no bother about strikes or anything of that sort, but the workmen were doing their duty very satisfactorily. As regards the works, they are in better condition than they were ever in before, and they are able to turn out a large quantity of very satisfactory work, and, I think, at quite as cheap a rate as any other works in France. I do not know that I can say more than this—that everything is very satisfactory over there.

Mr. JOHN TREBLE proposed a vote of thanks to the Chairman and Directors for their admirable management of the Company's affairs in the past year.

The motion was seconded and carried by acclamation.

The CHAIRMAN: In the name of my colleagues and myself, I beg to thank you for these encouraging remarks, which will have their effect on the Board.

The proceedings then terminated.

Liverpool Overhead Railway Company.

The half-yearly meeting of the shareholders of this Company was held in the Law Association-rooms, Cook-street, on Tuesday, Sir W. B. Forwood presiding.

The CHAIRMAN moved the adoption of the report (which appeared in our issue of the 1st inst.), and said he believed it would be satisfactory to the shareholders, for the Directors were enabled to recommend the payment of a dividend at the rate of 2 per cent. per annum, double that which they paid last year. They were also able to carry an increased sum to the fund for the maintenance of their permanent way. From the report they would see that the gross revenue of the railway for the half-year ending the 31st of December was £25,700, and the profit, after deducting working expenses, amounted to £6,538. Out of this they had paid interest on their debentures £2,521, which left them £6,017, to which they had added the balance brought forward from the last half-year, £1,248, which made the sum available to be dealt with by them £7,256. They recommended the payment of a Preference dividend of 5 per cent.—£2,428; also a dividend at the rate of 2 per cent. per annum on their Ordinary shares, amounting to £3,750. This would leave a balance to carry forward to the next half-year of £1,087. In order that they might appreciate the position of the Company, and also form an opinion as to their prospects in future, he thought it as well to give them a few figures to compare their earnings and expenses during the past half-year with those of the corresponding half of the preceding year. And in making this comparison it would be well to bear in mind that they had in the meantime opened the north extension to Seaforth, and opened three new stations—at Seaforth, at the Langton Dock, and at the Nelson Dock. Whilst they had derived increased earnings from that extension, there had necessarily been an increased expenditure. The train mileage run during the half-year was 314,472 miles, as compared with the same half of the previous year 243,539 miles, being an increase of 71,933 miles. They carried 3,641,397 passengers, as against 2,475,629, showing an increase of 1,166,000 passengers. When they originally issued the prospectus of that Company the Directors were bold enough to say that they expected the traffic upon the line would be six million passengers per annum, and a great many people in Liverpool, quite competent to form an opinion, thought that in forming that estimate they were very sanguine people. They were now glad to be able to report that the traffic had reached quite seven million passengers per annum. Nor did he think they had by any means reached the maximum of their traffic, because the more facilities they gave for travel the greater the traffic would be. He did not think that the Liverpool people had all fully as yet realised the facilities and advantages which the railway undoubtedly conferred upon them. Coming to their gross revenue, it was £25,675, as against £18,343 in the corresponding half of the previous year, showing an increase of £7,333. Their average receipts per passenger amounted to 1·61d., but he was glad to tell them that the last two months, since they made some readjustment in reference to return fares, their average receipts per passenger amounted to 1·91d. On the other side, their expenditure had been £17,162—that was to say, their working expenses—as against £13,732, an increase of £3,430. They had put an additional sum of £400 to the account of the cost of maintenance of ways and works. They thought this provision for the maintenance of the permanent way was very wise. The cost of maintenance of their stations had also increased. The Directors, he thought, were justified in taking the working of the line upon their own shoulders, and terminating the contract with the Electric Construction Company. Comparing the expenses of their line with the expenses of the only other electric line in the country, the City and South London Line, he got the following figures: The working expenses of the Overhead Railway per train mile was 13·10d., whereas on the City and South London Line it was 15·36d. However, he thought it ought, in fairness, to be stated that with regard to the City and South London Company their stations were approached by lifts, and no doubt the working of the lifts added to the cost of working the line. Their locomotive expense amounted to 3½d. per train mile, as against 6·3d. on the City and South London line. The Liverpool Company had the advantage of a more economical system of motors than the City and South London Company had, but he believed the latter company were about to adopt theirs. Taking the whole of their working expenses, they came to 66·84 per cent., but they hoped to see their way to make a considerable reduction and bring it down to 60 per cent. He was glad to think their service during the past half-year had given very great satisfaction, and had established for itself a reputation for punctuality and regularity. Although they had been running throughout the entire time trains every five minutes, 96 per cent. of their trains had been on time. He believed there was no record in the United Kingdom of equal regularity. The result was their line had become very popular. With regard to the southern extension, the Directors thought that the time had arrived for it. One reason was that their Parliamentary powers would expire in June next, while in the interest of the development of the property they thought that the extension should be made. The new line would be five-eighths of a mile in length. They also proposed to change the position of the Herculaneum station, placing it at the foot of the cliff, and by means of a staircase enabling the population living on the tableland above having easy access to it. At present the difficulty of approach precluded the station being used by the residents. The engineers estimated that the cost of construction would be £87,000, and the cost of land, easements, and engineering expenses £10,000, showing a total of nearly £100,000. Their experience of the Seaforth extension encouraged them to go on with this. The estimated cost of working the new line was £110 a week, including working expenses, Debenture and Preference Stock charges, and anything beyond that would go towards a dividend on the Ordinary Stock. They had no intention of asking any further extension. With this addition the line would be complete, and it would not only facilitate the dock traffic, but would put them in communication with good feeders at both ends. As to how they would provide the necessary capital, it had occurred to the Directors that by offering Ordinary and Preference shares in certain proportions they would make the issue attractive, and they believed that the shareholders would have sufficient faith in the undertaking to provide the capital without their having to go outside.

Mr. RICHARD HOBSON seconded the motion, which was carried after a short discussion.

Messrs. Edward Lawrence and G. H. Robertson were re-elected Directors.

At a special meeting, which was afterwards held, the following resolutions were unanimously approved: (1) "That this meeting approves of the construction of the Southern Extension Railway, authorised by the Liverpool Overhead Railway Act, 1892": (2) "That the Directors be and they are hereby authorised to issue 7,500 Ordinary shares of £10 each (being the unissued portion of the Company's original capital of 45,000 Ordinary shares of £10 each, created by the Liverpool Overhead Railway Company Act. 1888), in such amounts and manner, at such times and on such terms as they may think fit."

Liverpool Electric Supply Company (Limited).

The twelfth ordinary general meeting of the shareholders of this Company was held on Friday in the Sale Room, Exchange Station Buildings, Tithebarn-street.

Mr. ARTHUR HILL HOLME (Chairman) presided, and in moving the adoption of the report (which appeared in our last issue) said that they had had a very good year, and they might congratulate themselves upon increased business. There had been a steady increase in the number of lamps used—an increase equal to 25 per cent. each year for the past three years. The total number of lights supplied by the Company now was 31,792, and that indicated that the Company was supplying a public want. Whilst recognising the interests of the shareholders, they had not forgotten the customers. When the Company started it charged 1s. per unit, which was afterwards reduced to 8d., and subsequently to 7½d. If they progressed in the future as in the past they might yet be able to make a further reduction. If they had about double the number of lights they now had, the price could be brought down to something like 5d. They would notice that the expenditure on capital account during the year had amounted to over £40,000. This was accounted for, amongst other matters, owing to the Company having put down more boilers and engines in Highfield-street, and some machinery in Oldham-place. The Company had also bought land at both those places, and would therefore have proper room for any extension that might be necessary within the next three years. They had a station at Lark-lane which would be more useful as their system extended, and which at the present time was not a source of loss, although they did not derive profit from it. There was another matter in which they all took a deep interest; namely, the negotiations that they had had with the Corporation. They all knew that the City Council had passed a resolution desiring to acquire the undertaking of the Company, and whilst some of the shareholders would probably think that it should be sold, others might think that it should not. However, he must ask the shareholders to leave the matter in the hands of the Directors, who were giving the matter careful attention, and they and their lawyer, Mr. Radcliffe, had been in communication with the Corporation, and were quite willing to meet them in every way. He asked the shareholders to trust the Directors not to sacrifice the property, and yet not to ask too high a price which would make negotiations impossible. So far as the Corporation was concerned, the Company had nothing to fear from them and very little to hope for. The Corporation had never helped them, and everything that they had done had been done in spite of the Corporation. For any work the Corporation had done for them—and they were compelled to let them do certain work—they had always charged a most enormous price. In conclusion, he said that the Company was commenced under difficult circumstances, it had been developed with determination, and even if that should prove to be the final general meeting of shareholders, owing to the Company being about to die, he thought it would deserve well of their fellow-townsmen.

Sir DAVID RADCLIFFE seconded the motion, which was carried unanimously.

The CHAIRMAN moved the payment of a dividend at the rate of 6 per cent. per annum, free of income tax, for the half-year ending December 31, 1894, which was seconded by Mr. Von SOBBE, and carried.

The retiring Directors—Messrs. Th. von Sobbe and D. de Ybarrondo—were unanimously reappointed; the remuneration for the Directors for their services during the past year was fixed at 750 guineas; and Mr. W. L. Jackson having been reappointed auditor, the proceedings were brought to a close with votes of thanks to the Chairman and Directors.

Westminster Electric Supply Company (Limited).

The following report of the Directors is issued to the shareholders in this Company, and will be presented at the meeting to be held at the offices, Eccleston-place, S.W., on Wednesday, the 20th inst., at 11 o'clock:—

The Directors state that the business of the Corporation continues to make satisfactory progress. The supply of current, which on December 31, 1893, was equivalent to 131,565 8-c.p. lamps, had increased by December 31, 1894, to the equivalent of 167,703, and at the present time (February 6th) there are on circuit the equivalent of 175,695 8-c.p. lamps. Applications are in hand for a further 3,817. The length of roadway in which mains have been laid now exceeds 37 miles, making about 148 miles of ways, into which upwards of 115 miles of copper (strip and cable) have been drawn.

The plant and machinery have been working satisfactorily throughout the year, and have been fully maintained from revenue. Your Board are also glad to be able to report that a still further reduction has been effected during the past year in the cost per unit in generating, distributing, and general expenses.

Owing to the continued increase in the business of the Corporation, it has been found necessary to provide further capital. In accordance with resolutions passed at extraordinary general meetings, held in October and November last, the share capital was increased from £300,000 to £400,000 by the creation of 20,000 new shares of £5 each, and of this amount £40,000 in 8,000 shares of £5 each has been issued to shareholders in accordance with the resolutions passed at subsequent extraordinary general meetings.

In dealing with the revenue of the past year your Directors have, after writing off bad debts, proportion of preliminary expenses, the whole of the patent and law charges account, and placing £2,500 to credit of depreciation, added a sum of £2,500 to the sinking fund. The net revenue of the year amounts to £16,168. 18s., out of which an interim dividend, at the rate of 4 per cent. per annum for the half-year ended June 30, 1894, has been distributed. The Board now recommend the payment of a dividend at the rate of 6 per cent. per annum (less income-tax) for the past half-year, making 5 per cent. for the year ended December 31st last, carrying forward a balance of £1,781.

Mr. E. Boulnois, M.P., and Sir Douglas Galton retire, and offer themselves for re-election as Directors, and the auditors, Messrs. Cooper Bros. and Co., similarly offer themselves for re-election.

Kensington and Knightsbridge Electric Lighting Company (Limited).

The following is the report to be presented by the Directors at the eighth ordinary general meeting, to be held at 1, Great George-street, Westminster, on Thursday next, the 21st inst., at 5 p.m.:—

The Company's mains, which extended to a length of 16¼ miles on the 31st December, 1893, have been increased during the year 1894 to 18¾ miles. The price of electricity to consumers has been reduced 25 per cent., viz., from 8d. to 6d. per Board of Trade unit throughout the district, such reduction having taken effect from the 1st July last. During the year the number of houses and shops connected with the system has increased from 734 on the 31st December, 1893, to 908 on the 31st December, 1894; while the number of lamps, calculated on the usual basis of 8-c.p., has increased from 64,529 to 80,678.

The Directors have thought it advisable, in view of the increased profits of the Company, to use a large portion of that increase in writing off the balances of the preliminary expenses, and cost of Debenture issue account (£500), and of the suspense account (law—£1,199). They also have thought it advisable to strengthen the renewal account, by transferring to that account £3,457. 5s. 9d. After providing for the above amounts, and paying the dividends on the 6 per cent. First Preference Shares to the 30th June, 1894, on the 5 per cent. Second Preference Shares to the 30th September, 1894, and an interim dividend at the rate of 5 per cent. per annum on the Ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1894 is £4,235. 14s. 10d. Of this sum £1,450 has been appropriated to the payment of the First Preference dividend to the end of the year, and £150 has to be set aside to meet the portion of the dividend on the Second Preference Shares accrued to the same date, leaving £2,635. 14s. 10d., out of which it is proposed to pay a further dividend on the Ordinary Shares, at the rate of 5 per cent. per annum for the past half year. This will leave a balance of £823. 4s. 10d. No provision has been made in the accounts for Directors' remuneration.

Sir Frederick J. Bramwell, Bart., F.R.S., and Mr. G. H. Hopkinson are the retiring Directors, and being eligible, offer themselves for re-election; as do the Auditors, Messrs. Lovelock, H. W. S. Whiffin and Dickinson.

Charing Cross and Strand Electricity Supply Corporation (Limited).

The following in the report of the Directors to be submitted to the annual ordinary general meeting of shareholders, to be held at 2, Craig's-court, Charing-cross, S.W., on Thursday next, the 21st inst., at noon.

The Directors have taken steps with a view to obtaining a Provisional Order for enabling the Company to supply electricity in the district of the Strand Board of Works in accordance with the resolutions arrived at in November last, but no portion of the capital authorised by these resolutions has yet been dealt with.

The Corporation was on December 31, 1894, supplying energy to 41,216 8-c.p. lamps, an increase of 19·7 per cent. on the number supplied at the end of the year 1893. There are now upwards of 22 miles of mains laid, and the station has been maintained in all respects in a very high state of efficiency.

The Directors have written £485. 0s. 3d. off preliminary expenses, and carried £1,600 to depreciation account; provision for bad debts has been made by a deduction of £150 from the amount of sales of current in the manner required by the Board of Trade. The net earnings, as shown in the revenue account, have amounted to £10,395. 12s. 9d.; £3,117. 9s. 2d. has been paid in respect of interest on debentures up to December 31, 1894, and £2,906. 3s. 7d. was distributed in payment of an interim dividend for the half-year ended June 30, 1894. A sum of £3,929. 19s. 10d. now remains, which the Directors propose to deal with as follows: To payment of a dividend of 4½ per cent. for the year 1894 (less tax), £6,531. 3s. 7d.; interim dividend paid August, 1894, £2,906, 3s. 7d.; and to carry forward £304. 19s. 10d.

Mr. G. H. Brougham Glasier and Mr. I. Percy Mendoza are the Directors who retire by rotation, and being eligible, offer themselves for re-election; as also do the auditors, Messrs. O. R. Johnson and Son.

Isle of Man Tramways and Electric Power Company (Limited).

The following is the report of the Directors, to be presented to the ordinary general meeting of shareholders, to be held at the offices, 1, Strathallan-crescent, Douglas, on Wednesday next, the 20th inst., at noon:—

The available profit from May 1 to December 31, 1894, including a sum of £526. 12s., premiums on shares sold, amounted to £11,034. 0s. 10d. Out of this profit an interim dividend of 6 per cent. per annum on the Preference shares, and 7½ per cent. per annum on the Ordinary shares, amounting to £4,213. 15s. 3d., was paid for the half-year ended October 31st; £1,666. 13s. 4d., interest on debentures up to December 31st last; and £43. 9s. 10d., interest on mortgages (balance): making a total of £5,923. 18s. 5d. The Directors recommend that a further dividend at the rate of 6 per cent. per annum on the Preference shares, and 7½ per cent. per annum on the Ordinary shares, for the remaining portion of the financial year ended December 31st, amounting to £1,437. 10s., be declared, that £2,000 be carried to a reserve and renewal fund, and that the balance of £1,672. 12s. 5d. be carried to profit and loss new account for the present year.

Owing to unavoidable delays the passenger traffic between Grondle and Laxey was not commenced until July 28th last, and this part of the line being the most important section the profits are much less than what may be anticipated in future years. Last season, owing to the limited number of motor cars, the management was unable to cope with the passenger traffic. The Board, therefore, has ordered four new open motor cars, of an improved type and larger carrying capacity, from Messrs. G. F. Milnes and Co., Birkenhead, and the electrical equipment from Messrs. Mather and Platt (Limited), Salford. The passenger traffic on the electric line during the winter months has exceeded the expectations of the Directors, who have also to report that they are confident that the revenue to be derived from goods and merchandise traffic will be substantial. Arrangements are being made to meet the wants of the districts through which the tramway passes, together with the surrounding neighbourhoods. Negotiations are pending for the erection of a convenient station, and all necessary accommodation at the Laxey terminus; and arrangements are now in progress for an approach road to the terminus. This road will lead into the heart of Laxey, and will meet the fullest demands for vehicular and pedestrian traffic. Convenient waiting-rooms at important points along the line will also be shortly erected. An arrangement has been made between the Company and the Derby Castle Company for the erection of a large waiting-room and other accommodation at the Douglas terminus.

After providing for the dividends on Preference and Ordinary shares, and interest on debentures up to December 31st, and carrying £2,000 to reserve and renewal fund, an available sum of £4,080. 11s. 10d. (over and above the balance being carried forward, of £1,672. 12s. 5d.) remains in hand to meet any necessary outlay on rolling stock, &c.

The retiring Directors, Messrs. Alexander Bruce and F. G. Callow, are eligible, and offer themselves for re-election, as do the auditors, Messrs. Aldred, Turner and Co.

A report by Dr. Edward Hopkinson, the electrical engineer, dated February 1st, is appended. He states that he has inspected the plant at the generating stations at Douglas and Laxey, and also the line and the rolling stock, and has found the whole in good condition, and maintained in a manner reflecting much credit upon the general manager and his engineering staff. At the accumulator station at Grondle the battery is in excellent condition, and has been of great service, not only as a reserve and regulator of the load upon the engines, but also for working the winter traffic through a large portion of each day, thus reducing the time during which the generating plant at Douglas need be worked, and, consequently, effecting a great economy in working expenses.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "The Electrician" Electrical Trades' Directory and Handbook, 1895, pages *304-332, &c. &c.*]

EVERSHED AND VIGNOLES (LIMITED).—This Company was registered on February 5th, with a capital of £10,000, in £10 shares, to carry on the businesses of engineers and manufacturers in all or any of their branches. The subscribers, with one share each, are: Ernest B. Vignoles, Rev. C. J. Vignoles, Adolph Schneider, Frank Evershed, and John Evershed. The first Directors are: Sydney Evershed, Ernest B. Vignoles (Managing Directors for at least five years), Horace M. Gregory, and William E. Ayrton.

PARISH LIGHTING COMPANY (LIMITED).—This Company was registered on February 7th, with a capital of £15,000, in £5 shares, to light, with gas, electricity, oil, or other illuminant, the township of Chester-le-Street, and its immediate neighbourhood. The first subscribers (with one share each) are J. W. Lucock, W. Mitchell, J. C. Hetherington, R. Wilson, J. Mitchell, W. Clarke, and G. W. Barker, all of Chester-le-Street.

VAUGHAN AND BROWN (LIMITED).—This company was registered on February 9th, with a capital of £40,000, divided into 4,000 £7 per cent. Preference and 4,000 Ordinary shares of £5 each, to acquire the business of electric light, gas, hot water, sanitary and ventilating engineers and art metal workers, carried on at Kirby-street, Farringdon-road, London, E.C., by Messrs. Vaughan and Brown, and to carry on the business of electric light, gas, hot water, sanitary and ventilating engineers, manufacturers of and dealers in motors, batteries, arc and incandescent lamps, electroliers, art metal work, chandeliers, gas, oil and electric light fittings, &c., electricians, workers of and dealers in electrical motive power and light, etc. The subscribers (with one share each) are Thomas W. Vaughan, George C. Vaughan, Arthur R. Pilkington, Samuel J. Pemberton, Peter W. Hastings, Alexander Young and William Cook. The first Directors are Thomas W Vaughan, George C. Vaughan and Arthur R. Pilkington.

CHARLES CHURCHILL AND CO. (LIMITED).—The annual return of this Company, made up to December 10th, has recently been filed. The nominal capital of £6,000 is divided into 140 Preference shares of £25, and 50 Ordinary shares of £50 each; 129 of the former and 40 of the latter have been taken up, and 50 Preference and all the Ordinary have been issued as fully paid. The full amount of £25 per share has been called and paid on the remaining 79 Preference shares.

CHELMSFORD ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return of this Company, made up to January 1st, has been filed. Out of a nominal capital of £10,000, divided into 7,500 Preference and 2,500 Ordinary shares, all of £1 each, 5,507 Preference and 2,378 Ordinary have been taken up, and the full amount called. The calls paid amount to £7,878, leaving £7 in arrears.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY (LIMITED). The annual return of this Company, made up to December 3rd, has just been filed. Out of a nominal capital of £800,000, divided into 40,000 Ordinary and 40,000 Preference shares of £10 each, 20,000 Ordinary shares have been subscribed for and allotted. On each of these a call of £6 has been made, resulting in the payment of £121,436, which includes an amount of £1,436 paid in advance of calls.

COVENTRY ELECTRICAL ENGINEERING COMPANY (LIMITED).—The statutory return of this Company, made up to January 23rd, has been filed. 1,765 shares have been taken up out of the capital of £5,000 in £1 shares, and £801 of these have been issued with the sum of £679 considered as paid on them. Consequent upon a call of the full amount per share on 220 shares, and 15s. per share on 745 shares, the sum of £776. 10s. has been received, while £2. 5s. has yet to come in.

COVENTRY ELECTRIC TRAMWAYS (LIMITED).—The annual return of this Company, made up to January 12th, has been filed. The capital of £25,000 is divided into shares of £5 each, and seven of these have been subscribed for. The full amount has been called, and £35 received.

CRYSTAL PALACE DISTRICT ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to October 1st, has recently been filed; 28,586 shares out of a capital of £100,000 in £1 shares have been taken up, of which 14,166 have been issued as fully paid. The full amount has been called and paid on the remaining 14,420 shares. 3,253 fully paid shares have been forfeited, the number issued amounting in 1892 to 17,430.

EDMONDSON ELECTRICITY METER SYNDICATE (LIMITED).—The statutory return of this Company, made up to December 21st, has just been filed; 175 shares have been taken up out of a nominal capital of £2,000 in £1 shares, of which 168 have been issued as fully paid. The full amount has been called and paid on the remaining seven shares.

ELECTRICAL COAL CUTTING CONTRACT CORPORATION (LIMITED).—The annual return of this Company, made up to December 4th, was filed recently. The nominal capital is £402,000 divided into 60,000 Ordinary shares of £5 each, 20,000 Deferred shares of similar value, and 2,000 Founders' shares of £1 each; 9,531 Ordinary, all the Deferred, and all the Founders' shares, have been taken up, of which 4,000 Ordinary and all the Deferred shares have been issued as fully paid. Resulting from a call of the full amount on the remaining 5,531 Ordinary and 2,000 Founders' shares, £28,375 has been received, leaving £1,280 still unpaid.

ELECTRICAL FINANCE CORPORATION (LIMITED).—Although this concern was registered on November 18, 1891, no statutory return or office has been filled, and should these not be speedily forthcoming the name will be struck off the register.

ELECTRIC AND GENERAL CONTRACT CORPORATION (LIMITED).—The annual return of this Company, made up to December 17th, was recently filed. 805 Preference and 1,000 Deferred shares have been taken up out of a nominal capital of £50,000, divided into 9,000 Preference and 1,000 Deferred shares. 799 Preference shares have been issued as fully paid. Consequent on a call of £5 per share on the remaining six Preference and the Deferred shares, the sum of £5,030 has been received.

ELECTRIC FITTINGS HIRING AND MAINTENANCE COMPANY (LIMITED). The annual return of this Company, made up to December 3rd, has just been filed. Out of a capital of £200,500, divided into 40,000 shares of £5 each, and £500 shares of £1 each, the seven subscribers' shares have been taken up, but no calls have as yet been made.

ELECTRIC LIGHT REGULATING SYNDICATE (LIMITED).—The statutory return of this Company, made up to January 2nd, has just been filed. 865 shares have been taken up out of a capital of £1,000, in £1 shares, and 625 of these have been issued as fully paid. The full amount has been called and paid on the remaining 240 shares.

ELECTRIC METER COMPANY (LIMITED).—The return for 1894 of this Company was recently filed, when 2,007 shares were taken up, out of a capital of £50,000, in £10 shares. Of these 2,000 have been issued as fully paid, and the full amount has been called on the remainder. In response to this call, £30 has been paid, leaving £40 in arrears.

ELECTRIC NOVELTY SYNDICATE (LIMITED).—The statutory return of this Company, made up to November 9th, was recently filed. Out of a capital of £4,500 in £1 shares, 992 have been taken up, and the full amount called, resulting in the receipt of £960, and leaving £32 as yet to come in. The 2,900 vendors shares have not yet been issued.

MADRAS ELECTRIC TRAMWAYS COMPANY (LIMITED).—The annual return of this Company, made up to December 27th, has just been filed. The capital is £100,000 in shares of £1 or Rs.15 each ; 34,077 under the former, and 47,066 under the latter name have been issued, and 19,650 have had the full amount considered as fully paid. The full amount has been called on the remaining 14,427 £1 shares, and also on the Indian shares, resulting in the payment of £54,128. 9s. 3d., and leaving £7,364. 10s. 9d. in arrears ; 1,500 shares have been forfeited, together with the £600 paid in respect thereof.

MILDE TELEPHONES AND ELECTRIC SUPPLY COMPANY (LIMITED).—The statutory return of this Company, made up to June 11th, and recently filed, shows that only seven shares have been taken up out of a capital of £20,000 divided into 15,000 Preference and 5,000 Deferred shares of £1 each. On these seven Preference shares no calls have as yet been made.

MORECAMBE ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return of this Company, made up to December 6th, has just been filed ; 50 Founders' and 6,702 Ordinary shares have been taken up out of a capital of £15,000 in £1 shares, of which 50 are Founders' shares ; 761 Ordinary shares have been issued as fully paid, and the full amount has been called on the remainder, resulting in the receipt of £5,903. 15s. (which includes a sum of £11. 15s. paid in respect of two Founders' and 116 forfeited Ordinary shares), and leaving £99 as yet not paid.

MUNICIPAL ELECTRIC LIGHT AND POWER CORPORATION (LIMITED). The annual return of this Company, made up to January 1st, has just been filed. The nominal capital is £25,000, divided in 2,490 Ordinary shares of £10 each, and 100 Founders' shares of £1 each ; 37 Ordinary and 30 Founders' shares have been taken up, the full amount per share called, and £400 paid.

NEW ZEALAND ELECTRICAL SYNDICATE (LIMITED).—The annual return of this Company, made up to September 24th, has just been filed. The whole nominal capital of £30,000, in £10 shares, has been taken up, and of these 2,000 have been issued as fully paid. The full amount has been called on the remainder, resulting in the payment of £9,500, leaving £500 yet unpaid.

CITY NOTES.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended February 10, 1895, were £1,022, as against £937 in the corresponding week of 1894, being an increase of £85. The total receipts for the half-year amount to £6,041, as against £5,727 for the corresponding period of 1894, an increase of £314.

CITY OF BATH ELECTRIC LIGHTING AND ENGINEERING COMPANY (LIMITED).—The annual meeting of this Company was held on Wednesday. Mr. T. O. Callender (the Chairman) presiding, when the Directors' report (given in our last issue) was adopted and the retiring Directors elected.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED). The Directors of this Company have resolved to recommend, subject to audit, the payment of the following dividends for the half year to 31st December : The full dividend on the Six per cent. Preference shares and 5s. on the Ordinary shares, being at the rate of 5 per Cent. per annum. The transfer books and register of members will be closed from the 13th to the 27th inst. inclusive.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY (LIMITED).—Subscriptions are invited for a first issue of 10,000 Six per Cent. Cumulative Preference shares at par, and of a further issue of 10,000 Ordinary shares of £10 each at 5s. per share premium in the above Company. These shares are offered for subscription by the Electric and General Investment Company (Limited), of 1 and 2, Great Winchester-street, E.C., who are acting on behalf of the County of London and Brush Provincial Company. The payments on the Preference shares are £1 on application, £1 on allotment, and £2 on June 29, September 30, and December 31, 1895, and March 31, 1896, and on the Ordinary shares £1 on application, £3. 5s. (including premium) on allotment, and £6 on March 30th. The subscriptions opened yesterday (Thursday) and close to-day (Friday) at 4 p.m. for both town and country. The prospectus states that the Company was registered in June, 1891, and an issue was made in March, 1891, of 19,900 Ordinary shares of £10 each, which were fully subscribed. The present issue of Ordinary shares will rank for dividend with this previous issue. The Directors consider that the earnings of the Company during the present year will be amply sufficient to pay the amount required for dividend on the present issue of Preference shares. Considerable progress has been made with the works in connection with the Provisional Orders obtained for lighting the parishes of St. James and St. John, Clerkenwell, St. Luke, Middlesex, and St. George the Martyr, Southwark, and the area covered by the district of Wandsworth Board of Works. The Company has a controlling interest in the Bournemouth and District Electric Supply Company (Limited), the Dover Electricity Supply Company (Limited), and in other provincial companies applying for Provisional Orders. Prospectuses and forms of application can be obtained from the bankers of the Company, Messrs. Glyn, Mills, Currie and Co., 67, Lombard-street, E.C. ; of the brokers, Messrs. Foster and Braithwaite, 27, Austinfriars, E.C. ; of the Electric and General Investment Company (Limited) ; and at the offices of the Company, 49, Queen Victoria-street, E.C. Mr. A. J. Lawson is engineer and manager, Mr. J. S. Raworth consulting engineer, and the secretary (*pro tem.*) is Mr. B. Broadhurst.

GAS LIGHT AND COKE COMPANY.—In the report of the Directors presented to the meeting of shareholders held on Friday last, it is stated that the weather during the months of November and December had proved unfavourable to the sale of gas, and the nett result for the past half-year was an increase of ·33 per cent. only.

GREAT NORTHERN AND CITY RAILWAY.—We regret that, owing to the capital asked for by the promoters of this undertaking not having been subscribed, it has been decided to return the subscription received, and to await a more favourable opportunity before again inviting the public to subscribe. The authorised capital of the Company is £1,500,000, and the recent issue was for £1,000,000 in £10 shares. The subscription list was only open three days, and this may account for the small response made by the public. Promotors of electric undertakings might well consider the advisability of allowing their projects the benefit of a longer period for consideration. Investors require the fullest information before subscribing to these issues, and undoubtedly look to the technical press for guidance in such matters. Prospectuses are issued, and the subscription lists are hurriedly closed before the public has time to thoroughly digest the technical details furnished in engineers' reports and similar documents. Moreover, for some reason which it is difficult to comprehend, the technical and trade organs are usually omitted from the list of publications in which these prospectuses appear. It is surely reasonable to suppose that where a sound home electric railway stock is offered for public subscription, many persons engaged in the electrical industries would, if the undertakings showed reasonable prospects of profit, be inclined to invest in many cases where the general public might hold aloof.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED). Notice is given that an extraordinary general meeting of this Company will be held at Cannon-street Hotel, London, E.C., on Thursday, the 28th inst., at three o'clock, to confirm as special resolutions the resolutions passed at the extraordinary general meeting held on the 5th inst.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 10th inst., amounted to £859. The amount for the corresponding week last year was £691.

LONDON AND SOUTH-WESTERN RAILWAY COMPANY.—The shareholders in this Company are the proprietors of the City and Waterloo Electric Railway, and it is gratifying to learn that the report of the past half-year's working shows the largest receipts on record, and that the dividend is in excess of any paid during the past 50 years. The Chairman of the Company, Mr. W. S. Portal (who is also Chairman of the City and Waterloo Railway Company), announced to the shareholders that the progress of the Company was continuously improving, which he properly attributed to the ability displayed by the officials of the Company, and Mr. Portal specially mentioned in this connection Sir Charles Scotter, who was recently the recipient of a special compliment from Her Majesty ; Mr. White, the energetic superintendent of the line ; the Company's engineer ; and the secretary, Mr. F. J. Macaulay. As all these gentlemen are intimately associated with the extension to the City, the remarks of the Chairman of the South-Western Company have an interest for our readers.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to allow 3,000 Seven per Cent. Preference Shares (Nos. 1 to 3,000) and £50,000 Four and a-Half per Cent. Mortgage Debenture Stock of W. T. Henley's Telegraph Works Company (Limited) to be quoted in the Official List.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended February 8th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,283.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Feb. 6.		Price Wednesday, Feb. 13.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 13.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	14 0	Angle-American ... xd	40	41	40	41	4 17 7	Jan., Apr., July, Oct.	40⅝	..
£2,993,560	Stock	28 0	Do. Preferred	75½	76½	75½	76½	5 4 7	,, ,,	76⅛	75½
£2,993,560	Stock	5/0	Do. Deferred	6¾	7	6½	6¾	..	,, ..	6⅝	6 7/16
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 17 4	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	11½	12	11½	12	5 8 4	Mar., June, Oct., Dec.	12	11⅝
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	109	113	109	113	4 9 3	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	147	152	148	152	4 12 1	Jan., Apr., July, Oct.	148¾	148½
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	13½	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	,, ,,	..	..
12,931	5	1/8	Direct Spanish (fully paid)	4	4½	4	4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9	9½	10	5 0 0	,, ,,	9⅝	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8½	9	8½	9	5 0 0	Jan., Apr., July, Oct.	9	8¾
400,000	10	2/6	Eastern	16¼	16½	16¼	16½	3 18 9	,, ,,	16¼	16¼
70,000	10	6%	Do. 6 per Cent. Preference	17½	18	17½	18	3 6 8	,, ,,	17 3/16	17 1/16
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	124	127	124	127	3 3 0	May and November	124½	124
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899 ... xd	104	106	105	108	4 12 7	February & August	..	..
250,000	10	2/6	Eastern Extension	16¾	17	17	17¼	4 1 2	Jan., Apr., July, Oct.	17¼	16¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock ... xd	123	126	123	126	3 3 6	February & August	125½	124½
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	102	106	102	106	4 14 9	January and July ..	105½	105
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1906	102	106	102	106	4 14 9	,, ,,	105½	—
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.) xd	106	109	106	109	3 13 5	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 2	May and November	..	..
180,227	10	1/6	Globe Telegraph and Trust	9⅜	9⅝	9½	9¾	4 12 4	Jan., Apr., July, Oct.	9⅝	9⅜
180,042	10	6%	Do. 6 per Cent. Preference	16⅝	16⅞	16¼	16¾	3 11 8	,, ,,	16¾	16½
150,000	10	5 0	Great Northern	21¾	22¼	21¾	22¼	3 17 2	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	106	109	4 11 9	March & September	107½	—
17,000	25	12/6	Indo-European	50	52	52	54	4 12 7	May and November	53	52½
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	105	109	105	109	5 12 11	March & September	..	—
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	105	108	3 14 5	..	..	—
11,839	8	4/0	Reuter's	3	4	3	4	..	April and October	..	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	117	122	118	123	4 17 7	,, ,,	120¾	..
15,609	10	5/0	West African Telegraph	4	5	4	5	..	January and July	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	102	105	102	105	4 17 4	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	98	103	7 15 4	June and December	..	..
88,321	10	6d.	West India and Panama	1	1½	1	1½	..	..	1	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	5 6 8	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 10 4	June and December	..	..
64,242	15	6d.	Western and Brazilian	10½	10¾	10½	10¾	3 5 1	May and November	10¾	10 5/16
33,129	7½	6/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	—	..	..
33,129	7½	6/0	Do. 5 per Cent. Deferred	4¼	4¾	4	4½	..	..	4½	—
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910 .. xd	100	104	100	104	5 15 5	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910 .... xd	100	104	100	104	5 15 5	,, ,,	..	—
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115	120	115	120	5 18 8	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	104	106	5 16 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2½	3½	2½	3½	—	..	3¼	3 3/16
224,850	10/0	2⅝d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	—
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	¼	⅜	3/16	5/16	..	Yearly	—	..
484,597	5	3/4	National	5⅜	5⅝	5⅜	5⅝	4 8 11	June and December	5 9/16	5 7/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	17	15	17	3 15 0	,, ,,	16½	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	,, ,,	15½	..
119,234	5	3/4	Do. 5% Non-Cumulative 3rd Pref.	6	6½	6	6½	4 0 0	..	6 5/16	6 1/16
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	105	107	104	106	3 6 0	January and July	105½	104½
58,600	5	1/0	United River Plate	1	2	1	2	..	,, ,,	..	—
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	86	91	86	91	5 9 11	,, ,,	..	—
			ELECTRICITY SUPPLY COMPANIES.								
46,000	£10	..	City of London Electric Lighting (fully paid)	14	15	13½	14½	..	—	14 1/16	13⅞
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15¼	15¾	15¼	15¾	3 16 2	..	15½	15¼
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	134	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	5	5½	5	5½	3 12 9	—	5¼	5⅛
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	—
8,322	£5	..	House-to-House Electric	..		..		—	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		—	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		—	January and July	—	—
45,000	£5	2/6	Liverpool Electric Supply (fully paid)	7 1/16	7 7/16	7¼	7⅜	—	—	..	—
111,000	5	..	London Electric Supply	¼	½	¼	½	..	..	..	—
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	9¾	10¼	9¾	10¼	2 8 9	..	10 3/16	10
£150,000	Stock	4½%	* Do. 4½% Debs.	118	120	118	120	3 16 1	June and December	119½	..
6,452	£10	..	Notting Hill Electric	7	7½	7	7½	..	..	..	..
19,980	£5	2/0	St. James and Pall Mall	7¾	8¼	7¾	8¼	..	..	7¾	..
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 15 8	..	8¾	..
59,900	5	2/0	Westminster Electric Supply (fully paid)	..		..		2 16 3	..	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅝	2¾	2⅝	2¾	5 5 3	..	2¾	—
90,060	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2⅜	2⅝	4 11 5	—	2⅝	2 7/16
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	115	118	115	118	3 17 9	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	3	3½	3	3½	—	January and July	..	..
12,139	5	..	Edison and Swan United	—		—		—	—	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		..	—	—	..
126,000	2	..	Electric Construction	¼	½	¼	½	..	—	..	..
12,845	2	2 9½	Do. 7 per Cent. Cumulative Pref.	1½	2	1½	2	—	—	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1½	1¾	1½	1¾	..	—	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	—	—	1 3/16	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	22	23	22½	23½	5 6 4	February & August	23	21½
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 8 3	March & September	..	—
15,995	£10	6/4	International Okonite Ordinary	..		..		—	—	..	—
16,000	£10	..	Do. 8 per Cent. Preference	—		—		—	December and June	..	—
20,000	0	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	½	½	—	—	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	41	43	43	44	5 9 1	March and July	44	43¾
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 13 6	January and July	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	—		—		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	—		—		..	—	..	..
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	9½	10½	9½	10½	4 15 3	..	..	..
£30,000	10	..	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1%	City and South London Railway	48	50	48	50	2 0 0	May and November	48½	48
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	14½	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	128	130	128	130	3 1 7	May and November	130	..
37,500	£10	1%	Liverpool Overhead Railway	8½	8¾	8¾	8⅞	1 2 10	..	—	..
6,295	10	5%	Do. 5% Preference	13	13½	13	13½	3 15 6	..	—	—
126,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July ..	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

THE ELECTRICIAN:

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NOTES.

The Paper read by Mr. Mordey before the Royal Society, the first half of which we print in full elsewhere, records a number of experiments which have been conducted with the view of explaining the increase of iron loss which has been observed in transformers. The experiments are, however, not yet complete, and, as they naturally require a long time, we must patiently wait for further information. Mr. Mordey was good enough to allow us to publish his conclusions in our issue of December 21, 1894, and his full Paper does not add much to them; but his experimental results are worthy of careful examination, and will, no doubt, help to explain the matter.

As in the case of the curves which embody Prof. Ayrton's long researches on the electric arc, Dr. Fleming's curves which we publish this week contain a large amount of valuable scientific and practical information, and it is only by careful study and analysis that this information can be elicited. Some curves speak volumes, and he that runs may read; others at first convey but little even to an expert. We hope that Dr. Fleming will do for these curves what Mrs. Ayrton is doing for those of the arc experiments, and what Mr. Mordey might perhaps do for the diagrams which are given in his recent Royal Society Paper.

One simple practical result seems to be established by Dr. Fleming, namely, that a water resistance is a suitable one for loading an alternator under test. Prof. Mengarini's experiments on alternate-current electrolysis suggested that there was an effect resembling self-induction, and this suspicion led Messrs. Willans and Robinson to put up, at a large expense, a non-inductive resistance for testing alternators. It is a pity that this matter was not settled before, but it is a still greater pity that no test of an alternator at Thames Ditton seems to have been worth publishing.

That Hertzian rays would exhibit the phenomenon of double refraction was, of course, to be predicted, the only question being the discovery of a suitable substance through which to send the waves. As is so often the case, the material needed lay ready to hand. Herr K. Mack, whose interesting investigation on "Double Refraction of Electric Rays" we publish in another column, had longings for "gigantic specimens of Iceland spar" until he bethought him of the fact that Hertzian waves went right through deal boards, and that wood, with its well-differentiated structure, might *a priori* be expected to render the phenomenon experimentally demonstrable. With slabs of wood from 25cm. to 40cm. thick, analogues of all the well-known optical experiments were produced with the aid of oscillators, mirrors, and spark-gaps.

If the Paper on "Light Railways" read before the Society of Arts last week by Mr. W. M. Acworth permeates downwards to that particular section of the public for which light railways have been prescribed, it will have served a useful purpose. A perusal of the Paper cannot, we think, fail to show that unless the local authority is prepared to regard these enterprises with a truly benevolent eye, and the local population is prepared to pay more per ton mile than on the main lines, not a mile of light railway will ever be built; the relaxation of Board of Trade regulations and the reduction of legal costs notwithstanding. As Mr. Acworth puts it, it is not possible by a mere fiat of the Board of Trade to make a local population forego its prejudice in favour of expensive safety, nor is it possible for the freights of a small concern serving a sparsely populated district to compete with those of a main line. If the farmer will not hear of a charge of 3d. per ton per mile, because the main line charge is only half that, then he must remain contented with road cartage at 6d. As to the way in which the capital is to be raised, it is refreshing to find that Mr. Acworth at any rate would prefer to see private enterprise given a fair trial before invoking the aid of State or county. With capital, as he expresses it, being "jettisoned into colonial *gold* mines for sheer lack of suitable investments at home," it is worse than folly not to give private capital a chance of building the light railways we are said to need so much.

We would call the attention of our readers to Mr. Raworth's letter criticising our remarks on the parallel running of alternators by gas engines at Coatbridge. From our Note last week (page 459) it should be inferred that our remarks on this subject were directed only to "certain kinds of alternators." We do not, of course, mean that it is impossible ever to design alternators and gas engines which will run in parallel. Is it not the fact, however, that certain alternators which will run in parallel most satisfactorily at half or three-quarter load give trouble when run up to their full output? If so, may this not be the explanation of the behaviour of the Coatbridge plant? At first, as Mr. Raworth tells us, the engines were not powerful enough to develop the rated output of the alternators, and parallel running was satisfactory. But when newer and more powerful engines replaced these it became necessary to use only one engine at a time, or else to put the alternators on separate districts. May it not have been that the defects arose from the amount of load put on the machines? It is a question of rating, we know; but still we believe that an alternator can safely be rated higher when designed to run by itself than when intended for parallel work. Mr. Raworth's experience of parallel running has not been altogether happy, and we should not be surprised to find that he is a rather small minority in his ideas on what constitutes satisfactory parallel running. Our readers will be very glad to learn from another letter that Mr. H. M. Sayers is very pleased with the Bournemouth plant, and Mr. Mahood with the Worcester machines; and their unsolicited testimonials will, no doubt, be properly appreciated by the makers. Finally, we would ask Mr. Raworth if he knows of any public supply station, other than Coatbridge, where alternators are run in parallel by gas power, and where this system is found to be satisfactory?

Now that so many little towns and villages are debating the question whether to replace their obsolete oil lamps by gas or electric light, a few remarks on the relative initial cost of plant for the two latter illuminants may be of some service. Quite apart from the relative merits of gas and electric light in regard to the working cost, it may come as an item of refreshing news to more than one local authority that electric light plant is far cheaper than gas to erect in the first instance. An average-sized gas works will cost from £600 to £700 for every 1,000,000 cubic feet per annum of capacity. Taking 5 cubic feet of gas as equivalent to 12 c.p. for an hour, and 60 watts as equivalent to 16 c.p., it will be found that this amount of gas is equivalent to about 9,000 B.T. units. Assuming the same amount of lighting to be done by an electric supply station with an annual load-factor of only 15 per cent., it will require a plant capacity of about 6·8 kilowatts to do the work electrically. The initial cost of electric light works and mains per kilowatt depends upon the system adopted; but Mr. Crompton's estimate of £80 for the low-pressure system may be regarded as being well above the average price. If we accept this basis of £80 per kilowatt, the cost of an electric light station and mains, equivalent to a gas works giving 1,000,000 cubic feet of gas per annum, works out to only £534, a figure which compares very favourably with the £600 or £700 for gas works.

"Sweet are the uses of advertisement," and especially so when the advertisement as such is not obvious to the uninitiated. All manner of things are carried out "for the sake of the advertisement," the prospective and uncertain profit being taken as an offset to the immediate and certain loss, on the well-known principle of "cast thy bread upon the waters, for thou shalt find it after many days." There is nothing particularly immoral about this well-nigh universal practice, and since it is of the nature of a gamble, one may be sure that no amount of solemn sermonising will ever put a stop to it. It combines the excitement of a stock exchange speculation with the added pleasure of inducing the public to become acquainted with one's wares without any of the blatancy of an ordinary advertisement, and with the certainty that if the *coup* succeeds there will be a handsome return for the money expended.

The electrical industry has in the past been very partial to this *sub rosâ* method of disseminating useful commercial information, and even now, when its salad days are over and it is in the sere and yellow leaf, the industry is not altogether unacquainted with such devices; nor indeed would we have it so—variety is the salt of existence, and plain straightforward advertising is apt to become monotonous. But, like everything else, this practice, harmless in moderation, becomes pernicious in excess. Until a few years ago, when a stand was made by the Electrical Trades Section, the gratuitous lighting of exhibitions was the rule and not the exception, and to-day the same pleasant custom in Germany has aroused the Verband Deutscher Elektrotechniker. In view of the numerous local exhibitions at Stuttgart, Posen, Königsberg, Lübeck and elsewhere, and the repeated requests made to electrical firms to undertake the lighting of these "for the sake of the advertisement," the Verband has circularised its members and advised them to do nothing of the sort, its dictum being that such lighting should never be undertaken at anything less than cost price. The only really sound basis for this kind of lighting, as for all business transactions, is cost plus usual rate of profit. Exhibition lighting, however, lends itself so admirably to advertising, that the Verband no doubt concluded that it would be a counsel of perfection to advise that the work should be done on a true business basis. Even as it is, if Germany is blessed like England with an ever-growing army of young firms, the ukase of the Verband will go for naught. To light an entire town at an entire loss is too big an undertaking, even for a small firm; but a local exhibition is just the very thing.

Electric Traction in North Wales.—It is proposed to lay an electric tramway from Colwyn Bay to Conway through Deganway to Llandudno.

Electrical Execution.—A Bill has been introduced in the West Virginia Legislature providing for the infliction of the death sentence by electricity.

Northern Society of Electrical Engineers.—The Council of this Society have elected Mr. S. Z. de Ferranti a Vice-President in place of the late Mr. G. E. Preece.

Cable Interruptions:

	Date of Interruption.
Latakia—Cyprus	Nov. 27, 1894.
Hongkong—Macao	Dec. 31, 1894.

Three-Wire System at St. Louis. A Correction.—The blocks, Fig. 1 and Figs. 3, 4, 5, 6, on pp. 467 and 468 of our last issue, should have been transposed, as is obvious by the figuring engraved on the blocks.

The Telephone Draft Agreement.—Mr. Benn proposes, on March 1st, to call attention to the proposed agreement between the Post Office and the National Telephone Company, and to move a resolution.

Portsmouth.—Some difficulties having arisen at Portsmouth on account of an alleged interference of the arc lighting current with the telephone service, the Electric Light Committee have undertaken, without prejudice to any legal action, to complete some experiments with a view to determine the cause of the disturbance.

Cable Rates to South Africa.—The negotiations between representatives of the South African States and the cable companies for the reduction of the cable rates between England and South Africa have reached an important stage, the Transvaal Government having agreed to pay an annual subsidy of £10,000 for 15 years, provided that the tariff is reduced from 8s. 11d. to 5s. per word.

Royal Society.—The following Papers were down for reading yesterday: Lord Kelvin, P.R.S., M. Maclean and A. Galt, "Electrification of Air and Gases by Bubbling through Water and other Liquids." T. Wrightson, M.P., "Iron and Steel at Welding Temperatures." H. F. Newall, "Note on the Spectrum of Argon." Frank Clowes, "The Composition of the Extinctive Atmospheres Produced by Flames."

Royal Institution.—Lord Rayleigh will deliver a course of six experimental lectures on "Waves and Vibrations" at the Royal Institution on Saturdays, March 2nd, 9th, 16th, 23rd, 30th, and April 6th. He will also deliver the Friday evening discourse on April 5th, when his subject will be "Argon, the New Constituent of the Atmosphere." The Friday evening discourse this week (February 22nd) will be delivered by Prof. A. Schuster, F.R.S., his subject being "Atmospheric Electricity."

The Proposed Pacific Cable.—According to a cablegram, dated Ottawa, February 15th, the Minister of Trade states that the lowest tender for laying the Pacific cable has been received from a London firm, the amount being £1,517,000. The route proposed is from Vancouver to Fanning Island, Fiji, and Norfolk Island, the cable dividing at the last-named place into branches to New Zealand and Australia. The amount of the tender is about half the estimate made by the British Postal authorities.

The Results of a Short Circuit.—An American newspaper of recent date says that the engineer at the Main-street electric railway power house at St. Bernard lost his eyesight while at work on one of the generators. He was engaged in sandpapering one of the machines when, in some manner, he grounded it, and there was a flash of fire that lighted up the whole engine room. The engineer fell back as though shot, and when he made an effort to get away he discovered that he could not see. He was totally blind, and had to grope his way from the machine. It was feared that the injury would become permanent, but ultimately his sight was restored.

Municipal Tramways.—On the motion for the second reading of the London County Tramways Bill, in the House of Commons, Mr. Kimber said it was proposed apparently not only to take over the whole of the tramways of the metropolis, but to work them without limit as to time or conditions. He did not know whether it was the intention of the Council to exercise that power, if they got it, to that unlimited extent. This would place an enormous amount of patronage in the hands of the County Council, and he might say tens of thousands of their employés would be voters. He was not going to oppose the Bill, but he thought there should be some limitation. The Bill was read a second time.

Absit Omen.—For some unexplained reason, says *The Times* of Friday, the electric bells which it is the duty of Mr. Jennings, the senior doorkeeper, to set ringing the moment the Speaker orders the House to be cleared for a division would not act last night. The consequence was that when the question was put on Mr. Clancy's amendment messengers had to be despatched to the library, newspaper-room, tea-room, dining-rooms, and smoking-rooms to apprise members of the fact, and a longer interval than usual had to be allowed before the doors were locked. The bells are always tested before the House meets for the purpose of ascertaining whether they are in working order; and, as a matter of fact, the authorities discovered the defect early in the afternoon, and "experts" were at once sent for to try and locate the interruption in the current. Up to a late hour, however, the electricians were still at fault.

Explosion.—According to the *Leicester Post*, a mishap occurred in connection with the electric light service near the Granville Hotel, Market-street. The lid of an underground chamber was fractured, while the chamber itself was filled with smoke. This disturbance was said to have arisen from some waste and oil having become ignited. About seven o'clock what appeared to be a blue flame arose from the chamber, and in consequence the police kept the space in the neighbourhood of the chamber clear. The smoke from the chamber increased to such an extent that it was found inexpedient to further investigate the cause of the mishap until it had somewhat cleared and a man from the gasworks was kept on duty for the public safety until 8:30, when the oil seemed to have been burnt out.

Edison's Plated Joint Lamp Patent.—To-morrow will expire Edison's patent No. 768 of February 23, 1881. Its title was "Improvements in Connecting the Ends of the Carbon to the Conducting Wires in Electric Lamps," and the claim was for: The method of uniting the carbon filament and conducting wires thereto in an electric lamp, consisting in first uniting them mechanically in any ordinary manner, and then securing the union by *electro-plating*. Originally there were four claims, the three struck out being (*a*) the combination of carbon filament, conducting wires and electro-plated joint; (*b*) an incandescent lamp with an electro-plated joint; (*c*) an electroplating cell provided with a perforated bottom for receiving the support of the article to be plated. The disclaimer states that it was considered that the second and third claims were "unnecessary and may be held to be misleading," and that the fourth claim was "for a detail which is not a necessary part of the said invention."

The Australasian Cable Guarantee.—At the recent Inter-Colonial Postal and Telegraph Conference, held at Hobart, the question raised by the Victorian Government of withdrawing from the guarantee arrangement entered into with the Eastern Extension Telegraph Company was fully discussed, with the result that the arrangement on a modified basis is to be continued for a fixed period of five years, commencing from May 1st next. It has also been decided that the Queensland Government, which has hitherto held aloof, will take part in the guarantee, and have the benefit of the reduced tariff—viz., from 9s. 5d. to 5s. per word. The question of the Australian land line communication was also fully discussed at the Conference, when the West and South Australian delegates promised that everything possible should be done to prevent interruption of the service by erecting a duplicate line between Adelaide and Perth, and improving the existing line between Perth and Roebuck Bay. It is probable that a third land line route will be provided by the connection of the Queensland and the South Australian telegraph systems at a point near the Gulf of Carpentaria.

The Electric Supply Business in the United States.—The annexed table gives the gross and net receipts and the proportion of the latter to the former in each of the last five years of the Edison Electric Illuminating Company of New York. Dollars are converted into sterling at the rate of five dollars to the sovereign :—

——	Gross.	Net.	Net %.
1890	£97,719	£45,815	46·8
1891	135,121	69,445	51·2
1892	192,604	95,027	49·2
1893	249,105	121,128	48·4
1894	292,867	157,893	53·9

Within the last four years the number of customers of the Company has increased from 1,698 to 5,877, of incandescent lamps supplied (16 c.p.) from 64,174 to 234,494, of arc lights from 254 to 3,014, and the number of motors from 697 to 7,616. The Company has paid dividends on its shares for 1894 at the rate of 6 per cent., and has carried over out of the year's profits £25,000 to the depreciation and reserve fund, which now amounts to £41,612.

An Electrode Sensitive to Light.—In the *Zeitschrift für Physikalische Chemie*, H. Luggin describes a new form of electrode which he claims to be much more sensitive to light than any that has hitherto been made use of in previous investigations. Briefly, its essential features are as follows: A plate of platinum is coated with silver bromide and is then duplicated with a similarly coated plate in an aqueous solution of bromide of potassium. A quadrant electrometer of the usual type is employed in observing the rise of potential. Luggin states that in some of his experiments exposure to diffuse daylight was sufficient to cause a rise of potential of 0·5 volt. When illuminated by any weak light it appears that this electrode shows a rise of potential which is uniform, and can be represented graphically in a system of co-ordinates by means of a straight line until a maximum is reached, after which it remains constant or may show a slight fall. The rate of increase of potential is much more marked when a stronger light is employed, but for all that the maximum value attained is not higher. The rate of rise, however, is not directly proportional to the intensity of the impinging light, whilst it is also lowered by a previous exposure of the electrode to a powerful light. Continuous and intermittent lights of the same intensity do not appear to produce the same effect on the potential. These plates, though scientifically interesting, do not remain constant as regards their sensitiveness, and even after long rests they show with the same sources of light very different increases of potential.

The Southwark Bridge Explosion.—At the meeting of the South Metropolitan Gas Company last week we are glad to see that Mr. George Livesey thought he ought to make some reference to the combined electric and gas explosions in different parts of London:—

> With regard to the recent remarks of the President of the Board of Trade, he (Mr. Livesey) could only inform the President that they would respond in the heartiest manner to any suggestions he might have to make; but, at the same time, all possible means were adopted by their Company to detect escapes. They offered a money reward to any of their own people, or to anyone else, who would bring them notice or information of an escape: and they were also constantly looking out for this contingency. With regard to the cause of the Southwark Bridge explosion, there had been an excavation beneath their main. It was an old, but perfectly sound, Phœnix main, possibly laid 40 years ago—certainly it was down in 1880. It was laid well, and rested partly on the brickwork of the bridge; but the City authorities, when doing something to their sewers, excavated under the main, and afterwards left it unsupported. He did not say that information should be given to them whenever a passage was made under their mains; but he did ask that great care should be taken afterwards in making the ground beneath the mains solid. When they examined into this matter they found that the main was unsupported. One could get his hand beneath it; and the earth was all loose. The surface of the ground was frozen, and the gas could not escape into the air. It therefore percolated probably through the loose earth into the electric light conduits, and when it got there it might be conducted anywhere. How it became ignited, however, he could not say. He mentioned this to show that the Company were quite alive to these things, and to indicate the difficulties against which they had to contend.

An Old Electric Railway Patent.—On February 24, 1881—that is to say, 14 years ago on Sunday next—Profs. Ayrton and Perry took out their well-known patent, No. 783, for "Improvements in Electrical Conductors Applicable to Electric Railways and to Electric Signalling, and in Apparatus connected therewith." The invention, it is stated, was "designed for the better and more convenient insulation of the electrical conductor for the transmission of power in electric railways, and for furnishing an automatic block system without the use of signalmen, and, further, by that method of insulation to give an easy and simple indication of the position of a train or carriage at any point of its travel." The inventors state that neither the third rail nor overhead conductor have been found to be satisfactory, and that their idea is to bring a sectional insulated conductor into temporary contact at stated intervals with a thoroughly well-insulated conductor. The method by which this required contact was insured was by making use of the pressure of a contact-brush on the car, or of the actual wheels to depress a stud on to the end of the insulated cable; the connection once made continued so long as the car remained on the section, and was broken electro-magnetically in the case of long sections as the car quitted the section. This device lent itself to the registration of the motion of the stud-depressing car, and to an automatic block being placed upon the following car if it tried to enter a section upon which there was already a car. The specification was a very lengthy one, and contained five claims—for the division of an *elastic* conductor rail into short insulated sections, the use of contact-boxes of the kind described, the automatic and graphic method of showing the position of a car, the division of the conductor rail into comparatively long insulated sections, with automatic devices for disconnecting the conductor rail as the car or train left the section, the absolute block system.

Melting Points.—It has been pointed out by *Locomotive Engineering* that at least one species of literature very badly in want of reform is engineers' books of reference. We have, says our contemporary, been for years in the habit of consulting engineers' handbooks for facts relating to work we were engaged in, and it never occurred to us to doubt the accuracy of the information found. We were aware that some men preferred one book of reference and others another, and we had heard the remark made that such and such a work was no good; but we supposed the objections were raised to the arrangement and not to the accuracy of the data. A new light has dawned upon us lately. It came in this way. Two questions had been answered which related to the melting point of grey cast iron, and on reading the proof we discovered that there was over 1,000 degrees difference in the melting points given. One question had been answered by one editor of the paper, the other by the other, and each consulted his favourite engineer's book, with the result stated. Then it was determined to compare a few books used for reference. Here is what we find:—

	Melting point of cast iron Fahr.	Melting point of steel Fahr.
Haswell	2.000 to 2,250	2,500
Trautwine	1,920 to 2,800	2,370 to 2,500
Clark	2,786	2,372 to 2,552
Ramapo Company's Handbook	2.786	1,873
Scranton Colliery Engineering Company's Handbook	2,192	2,520
Jones and Laughlin's Handbook	2.210	2,462
Greenwood	2,912 to 3.452	3,272
Bolland's Iron Founder	3.477	2,501

Blackburn.—The system adopted at Blackburn, where the electric supply station has recently been opened, is the direct current, low-pressure, three-wire system. The works adjoin the Corporation Gas Works. The buildings comprise engine and boiler houses, accumulator, meter, and engineer's rooms and stores. Two Lancashire boilers are at present fixed, and accommodation is provided for a third boiler, which will shortly be placed in position. The boilers are 28ft. in length and 7ft. 6in. diameter. They are constructed for a working pressure of 120lb. per square inch. Proctor's mechanical stokers have been fitted, and are driven by a small motor supplied by Messrs. Siemens and Co. Meldrum's furnaces have been adopted, and it is expected that by the employment of forced draught cheap fuels, such as coke, breeze, or other waste fuels, obtained from the adjoining gas works, can be utilised. The water is supplied from the River Blakewater or from the Corporation mains, and is fed by two Worthington vertical marine pattern pumps, each capable of delivering 4,000 gallons per hour into the boilers through a Berryman exhaust-steam feed-water heater. Four compound Willans engines have been put down, the dynamos being direct driven. The dynamos are by Messrs. Siemens Bros., and are of their usual central station type, with drum armatures, the field coils being shunt-wound. The two larger machines each have an output of 500 amperes at 240 volts, with a speed of 330 revolutions per minute, and the two smaller machines each have an output of 300 amperes at 150 volts, with a speed of 450 revolutions per minute. The storage plant consists of 120 cells, each containing 87 "K" type E.P.S. plates. These cells are capable of giving a discharge of 300 amperes for 3½ hours, or, on an emergency, are capable of discharging 850 amperes for one hour. The cables have been supplied by Messrs. Siemens Bros. They are insulated with pure and vulcanised rubber, and have been laid on stoneware insulators in iron culverts. At present the feeders from the station on to the distributing network are only two in number, each having a cross sectional area of 0·8sq.in. for the outer cable, and 0·5 square inch for the inner. The public lighting sanctioned at present consists of only 12 arc lamps. Already upwards of 3,000 lights have been applied for, not including the Town Hall, municipal offices, &c.

CORE LOSSES IN ALTERNATE-CURRENT TRANSFORMERS.

BY ERNEST WILSON.

(*Concluded from page 463.*)

(2) *Transformer "loaded."*—When a transformer is in action with a current in its secondary circuit the resultant magnetising force at any moment is the algebraic sum of the forces due to the primary and secondary current turns. The current in the secondary is opposite in sign for nearly the whole of the period to the current in the primary; that is, the currents have nearly a phase difference of a half period. The current turns at any epoch due to the primary are nearly equal to those due to the secondary, and, therefore, to get the resultant force at any epoch we require the difference of two nearly equal magnitudes. If we observe each magnitude separately, this difference will be afflicted with the whole proportion of error arising from the error made in either determination, and between the two observations conditions may change. Fig. 3 gives a diagram of connections of the method adopted to determine the difference in the current turns due to the primary and secondary coils. As before, R and r are the primary and secondary coils. The primary current x passes through r_5, which has a resistance of 10·19 ohms; the secondary current y passes through r_6, which has 2·04 ohms resistance. The direction of the currents in r_5 r_6 are opposed, and, therefore, a measurement of potential difference between the points a and b gives the difference of potential difference due to the two currents into the respective resistances. Call this difference D, then $D = r_5 x - r_6 y$; and $\frac{r_5}{r_6} = \frac{m}{n} = 5$. y is measured as a direct quantity since we observe the potential difference at the extremities of r_6: thus we have H_2 and the difference between it and H_1 (which we call H) as two direct quantities which are observed simultaneously.

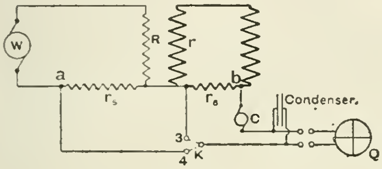

FIG. 3.

Fig. 4 gives the connections for obtaining potentials; and as in the case of currents we measure as direct quantities the potential difference across the secondary E_2, and the difference in turns between it and the primary potential E_1. In order to bring this difference $\left(\frac{E_1}{5} - E_2\right)$ within range of the electrometer, reducing resistances r_1 r_2 r_3 r_4 are introduced, the relation between them, on account of the ratio $\frac{m}{n}$, being

$$\frac{r_1+r_2}{r_2} \quad \frac{r_4}{r_3+r_4} = \frac{m}{n} = 5.$$

In the actual experiment $\frac{r_1+r_2}{r_2} = \frac{90{,}940}{1{,}819}$ ohms, and $\frac{r_3+r_4}{r_4} = \frac{10840}{1082}$ ohms. The following resistances, R, $r+\rho$, r were taken immediately after the experiment and found to be 5·92, 12·38, 0·1798 ohms respectively, the temperature of the transformer being about 40°C.

The frequency was 98 as before, the primary and secondary volts ($\sqrt{\text{mean}^2}$) being 685 and 130 respectively. The electrometer readings for the curves

1. Difference of potential difference $\frac{r_2}{r_1+r_2} E_1 - \frac{r_3}{r_3+r_4} E_2$,
2. The potential difference $\frac{r_3}{r_3+r_4} E_2$,
3. Secondary current, y,
4. Difference of potential difference, $r_5 x - r_6 y$,

were observed, and these are tabulated for a half period in Table II., from which the other data in Table II. have been obtained.

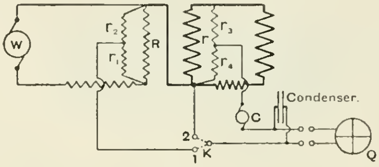

FIG. 4.

From Table II. we find that

$$\Sigma_0^{\frac{1}{2f}} \mathsf{H}_1 \frac{\delta \mathsf{I}_1}{\delta t} - \Sigma_0^{\frac{1}{2f}} \mathsf{H}_2 \frac{\delta \mathsf{I}_2}{\delta t} = 27{\cdot}5,$$ as against 45·9 on open circuit.

An independent set of figures taken at the same frequency, and under practically the same conditions as to load, give $\Sigma_0^{\frac{1}{2f}} \mathsf{H}_1 \frac{\delta \mathsf{I}_1}{\delta t} - \Sigma_0^{\frac{1}{2f}} \mathsf{H}_2 \frac{\delta \mathsf{I}_2}{\delta t} = 35$; but in this case the currents only were taken by difference; therefore the former figure, 27·5, is the more trustworthy. In either case we find a diminution in the core loss when the transformer is loaded, although the E.M.F. of the secondary is larger than on open circuit.

STRAY MAGNETIC FIELD.

It was thought that a careful investigation of the stray magnetic field on full load might throw some light on the subject under investigation. Exploring coils were wound round

Table II.

of a period.	Volts. $E_2 \frac{r_4}{r_3+r_4}$	Volts. $E_1 \frac{r_2}{r_1+r_2}$ minus $E_2 \frac{r_4}{r_3+r_4}$	Volts. $E_1 \frac{r_2}{r_1+r_2}$	Volts. E_1	Volts. Rx	Volts. $m \frac{d\mathsf{I}_1}{dt}$	Volts $\frac{d\mathsf{I}_1}{dt}$	$\mathsf{H}_1 \frac{d\mathsf{I}_1}{dt}$	Volts. E_2	Volts. ry	Volts. $n \frac{d\mathsf{I}_2}{dt}$	Volts. $\frac{d\mathsf{I}_2}{dt}$	$\mathsf{H}_2 \frac{d\mathsf{I}_2}{dt}$	Volts. $r_5x - r_6y$	Volts. $r_6 y$	Volts. $r_5 x$	Amperes x	H_1	H_2	H
0	13·45	0·426	13·02	651·0	15·72	635·3	1·588	61·20	134·7	2·18	136·9	1·711	60·23	2·313	24·71	27·02	2·652	38·54	35·20	3·34
2	11·65	0·633	11·02	551·0	14·05	537·0	1·342	46·23	116·7	1·91	118·6	1·482	45·66	2·538	21·62	24·16	2·371	34·45	30·81	3·64
4	9·04	1·293	7·75	387·5	11·82	375·7	0·939	27·22	90·54	1·55	92·09	1·151	28·76	2·794	17·54	20·33	1·995	28·99	24·99	4·0
6	5·21	2·034	3·176	158·8	8·68	150·1	0·375	7·980	52·20	1·05	53·25	0·666	11·28	3·029	11·89	14·92	1·464	21·28	16·94	4·34
8	0·854	2·362	*1·508	*75·4	4·64	*80·0	*0·200	*2·276	8·55	0·426	8·976	0·1122	0·772	3·145	4·832	7·977	0·7828	11·38	6·884	4·50
10	*3·567	2·379	5·946	297·3	0·23	297·5	0·744	0·426	*35·73	*0·213	*35·943	*0·4493	*1·546	2·818	*2·416	0·402	0·0394	0·573	*3·442	4·01
2	7·098	2·232	9·330	466·5	*4·18	462·3	1·156	*11·85	71·10	0·803	71·90	0·8988	11·68	1·931	9·118	*7·187	*0·7052	*10·25	12·99	2·74
4	9·73	1·860	11·59	579·5	7·69	571·8	1·429	26·94	97·48	1·25	98·73	1·234	24·84	0·912	14·13	13·218	1·297	18·85	20·13	1·28
6	11·86	1·728	13·59	679·4	10·6	668·8	1·672	43·42	118·8	1·61	120·41	1·505	39·10	0·017	18·23	18·21	1·787	25·97	25·98	0·0
8	13·93	1·868	15·8	790·0	13·1	776·9	1·942	62·34	139·5	1·93	141·43	1·768	55·20	*0·597	21·91	22·507	2·209	32·10	31·22	0·88
20	16·35	1·981	18·33	916·5	15·9	900·6	2·251	87·77	163·8	2·32	166·1	2·076	77·80	1·031	26·31	27·34	2·683	38·99	37·48	1·51
2	18·44	1·476	19·92	996·0	18·1	977·9	2·445	108·40	184·7	2·62	187·3	2·34	99·20	1·335	29·76	31·09	3·051	44·34	42·39	1·95
4	18·74	0·468	19·21	960·5	19·2	941·3	2·353	110·90	187·7	2·77	190·5	2·38	106·70	1·608	31·45	33·06	3·244	47·14	44·81	2·33
6	17·36	*0·431	16·93	846·5	18·8	827·7	2·069	95·28	173·9	2·68	176·6	2·208	95·78	1·845	30·45	32·29	3·169	46·05	43·38	2·67
8	15·23	0·588	14 64	732·0	17·5	714·5	1·786	76·62	152·5	2·47	155·0	1·938	77·38	2·067	28·02	30·09	2·953	42·90	39·93	2·97
								763·45					735·93							

* The asterisk indicates where the curve crosses the axis.

the core at positions 1A, 2A, 3, 4, 5, as in Fig. 1. E.M.F. curves have been obtained from each coil, and these are plotted in Fig. 5 from Table III., and are numbered 1A, 2A, 3, 4, 5. respectively. No. 1A is marked ×, and No. 2A is marked ⊙. On the assumption that the changes of induction are symmetrical in the halves of the transformer, the E.M.F.'s given by coils 3, 4, 5 have been doubled before plotting. For the sake of comparison, curves $\frac{d I_1}{d t}$, $\frac{d I_2}{d t}$, and H have been plotted from data obtained at the same time. Maximum $I_1 = 390 \times 10^3$. Maximum $I_2 = 381 \times 10^3$ C.G.S. units. The curves I_{1a}, I_{2a}, I_4 are the integral curves of 1*a*, 2*a*, 4 respectively. No. 1*a* agrees well with 5. No. 2*a* agrees well with 3. Nos. 1*a* and 5 are in fair agreement with the average curve $\frac{d I_1}{d t}$; but this is not the case with $\frac{d I_2}{d t}$ and 2*a*, 3, on account of the stray magnetic field.

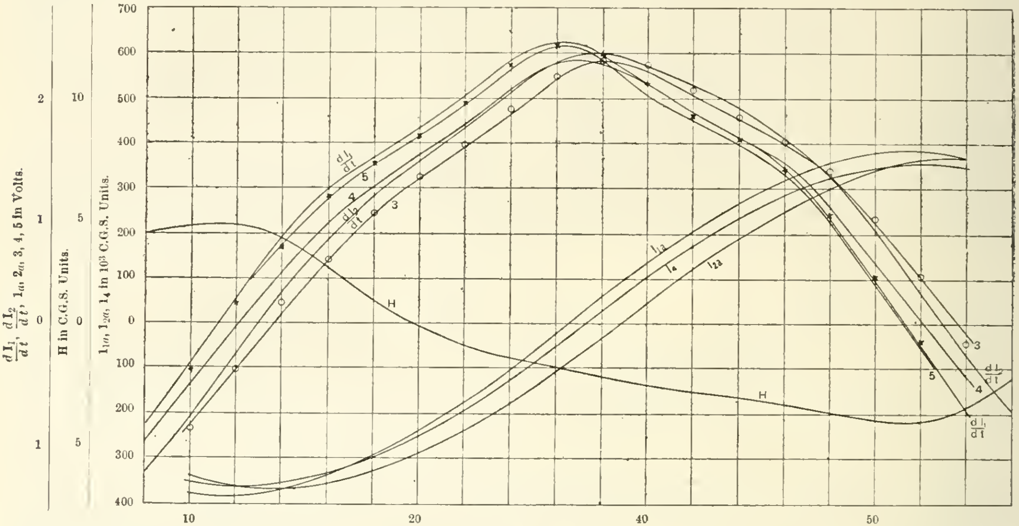

FIG. 5.

Table III.

Angle in 60ths of a period	Curve 1A.		Curve 2A.		Curve 3.	Curve 4.		Curve 5.
	Volts.	Total ind'ction in C.G.S. Units. I_1a.	Volts.	Total ind'ction in C.G.S. Units. I_2a.	Volts.	Volts.	Total ind'ction in C.G.S. Units. I_4.	Volts.
		10³		10³			10³	
0	+2·11	+137·0	+2·29	+ 47·6	+2·23	+2·11	+104·0	+2·05
2	+1·84	+204·0	+2·08	+123·4	+2·05	+1·87	+172·0	+1·79
4	+1·62	+265·0	+1·82	+189·0	+1·81	+1·63	+232·0	+1·58
6	+1·36	+316·0	+1·61	+248·0	+1·59	+1·41	+284·0	+1·31
8	+0·961	+355·0	+1·35	+299·0	+1·31	+1·04	+326·0	+0·897
10	+0·417	+378·0	+0·929	+338·0	+0·881	+0·529	+352·0	+0·352
		+383·0 †						
2	−0·168	+382·0	+0·417	+361·0	+0·416	+0·032	+361·0	−0·224
				+367·0 †			+361·5 †	
4	−0·785	+367·0	−0·192	+366·0	−0·088	−0·465	+354·0	−0·705
6	−1·12	+336·0	−0·577	+354·0	−0·561	−0·889	+331·0	−1·10
8	−1·41	+291·0	−0·985	+327·0	−0·961	−1·20	+294·0	−1·41
20	−1·65	+239·0	−1·29	+289·0	−1·28	−1·49	+252·0	−1·67
2	−1·96	+177·0	−1·58	+239·0	−1·55	−1·76	+193·0	−1·94
4	−2·28	+105·0	−1·91	+181·0	−1·85	−2·07	+127·0	−2·24
6	−2·46	+ 22·8	−2·19	+109	−2·16	−2·299	+ 51·0	−2·45
8	−2·37	−59·8	−2·33	+ 30·9	−2·32	−2·291	− 28·2	−2·32

† Max.

Maximum I_1 390 × 10³. Maximum I_2 381 × 10³ C.G.S. units.

An examination of these curves shows, so far as one can judge, that, on the assumption of uniform distribution of induction, every element of the core experiences each half period a maximum induction density about as great as on open circuit,* although at any epoch the linear distribution is not the same, on account of the stray magnetic field. The loss observed on full load is less than one might reasonably expect from magnetic hysteresis alone.

The losses due to magnetic hysteresis and to eddy currents for the same maximum average induction, might be different for different distributions of the induction. This point has not been investigated by us, but insulated wires could be threaded into the mass of the core in order to see if the maximum induction density varies at different parts of the core as the transformer is loaded up.

My best thanks are due to Messrs. Cobb and Evans, Student demonstrators in the Siemens Laboratory, King's College, London, for the assistance they have given in these experiments.

ON SLOW CHANGES IN THE MAGNETIC PERMEABILITY OF IRON.†

BY WILLIAM M. MORDEY.

When iron is magnetised for a long time by rapidly alternating currents, its magnetic permeability is usually reduced, a gradual increase taking place in the amount of energy absorbed in producing a given magnetisation. This effect has been observed in connection with the working of transformers on alternate-current systems. Although it has been known for some time to a few electrical engineers, the author is not aware that any investigation or proof has been published as to the cause of this change.‡

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* The inductions on open circuit have been judged from the average curves, which in the case of the secondary would be larger than the exploring coil 2*a* would give.

† Paper read before the Royal Society, December 19, 1894.

‡ The following are the only published references to this subject, so far as known to the author. In *The Electrician* of December 7, 1894, the subject is introduced by Mr. G. W. Partridge, with some examples of the increase, and a statement that the effect is due to a "molecular change or fatigue in the iron." There is also a note by Prof. Ewing referring to Mr. Partridge's article, also ascribing the effect, if confirmed, to "a progressive magnetic fatigue." In the same journal for December 14, 1894, there is an article on the subject by Dr. Fleming, stating that the effect is not general, that he has failed to find it in some cases, and pointing out that differences of temperature at the time of testing may account for the variations observed. Mr. R. T. Smith states that in one sample of iron he has found considerable increase after about 240,000,000 reversals. Mr. O. T. Blathy, of Buda-Pesth, states that he is familiar with the effect, that the loss in magnetising transformers increases from 20 to 25 per cent., and that artificial heating of the transformer for several hours to about 150 C. will have the same effect, which he states is permanent. Sir David Salomons also states that he has referred to the effect in a work written some months ago.

When the author first became aware of this increase he investigated the subject in connection with the work of the Brush Electrical Engineering Company, and to that company acknowledgments are due for permission to publish the results so far obtained. It may be mentioned that the investigation is still in progress.

In the first place explanations were sought in direct connection with the magnetic or electric actions that take place.

The explanation that first suggested itself was that eddy currents were being set up in the coils by leakage or partial failure of the insulation between adjacent portions of the conductor, or that eddy currents were being set up to an increased degree in the iron by disturbance or change of the insulating material interposed between the thin plates of iron of which the transformers were composed. A careful examination showed that this explanation was untenable. The increase was found in transformers the coils of which were thoroughly dry and well insulated, and in which no change had occurred in the separating material between the plates. This was confirmed by removing the iron and trying it with new coils specially insulated—also by trying the old coils with other samples of iron which had been separately tested.

Another explanation suggested was that the effect was a sort of magnetic fatigue—that the iron deteriorated somewhat in the same way as with steel springs, which suffer from "fatigue" after a great number of extensions or vibrations.

The gradual increase in the energy absorbed pointed to a physical change in the iron, which behaved exactly as if it slowly hardened, and so became less permeable—as if the softening results of the process of annealing were being gradually lost.

Effect of Annealing.—On carefully re-annealing some of the iron by heating it to redness and cooling slowly, it entirely recovered its original high permeability.

Having thus found that the iron was not permanently or irremediably affected—although apart from annealing the effect seems to be permanent—it remained to ascertain whether the change was due directly to the magnetic action, or whether it was caused by some secondary condition, having the reversals of magnetism as a primary cause.

Effect of Heat.—An investigation was therefore made as to the effect of heat on the iron.

Under the conditions of working, the temperature of the iron in transformers is raised, both by the energy dissipated in the iron itself by hysteresis and eddy currents, and also by conduction and radiation from the copper windings forming the primary and secondary conductors. The rise of temperature varies according to the conditions of working and the construction of the transformer; usually it is from 20°C. to 60°C. above the surrounding atmosphere.

In order to investigate the action of heat, as distinct from magnetic or electric action, some samples of iron were kept for some months in an oven maintained at temperatures varying from about 60°C. to about 75°C. These samples were of iron obtained for transformer construction, and were built up in the manner of transformers, having windings which were used simply for testing purposes.

Method of Measuring.—The coils used were of known turns and resistance. The wire was of such a size as to make the C^2R loss negligible in comparison with the losses in the iron. The power was measured by a very sensitive wattmeter, constructed by Dr. Fleming, the volts by a Cardew voltmeter checked against a Kelvin multicellular electrostatic voltmeter, and the current by a Siemens electro-dynamometer. These were instruments in regular use for manufacturing purposes, and used in fixed positions. The readings of watts and volts are reliable within about 0·5 per cent. The current readings are less accurate, as the range of the instrument was not very suitable. The source of current was a 37-kilowatt alternator of the author's type, working at 100 periods per second, and at a high E.M.F. The low E.M.F. required for the tests, from 20 to 60 volts, was given by the secondary of a transformer, the primary of which was connected to the alternator. Variations of E.M.F. were obtained by adjustment of the field excitation of the alternator.

There are irregularities in the tabulated readings which are probably not entirely due to errors of observation, but to differences of the conditions under which the tests were made. For example, the iron when removed from the oven was allowed to cool, but the exact temperature was not taken, and it certainly was not the same in all cases. In August it would probably be higher than in December. And although the alternator used to supply the testing current was the same in all cases and was run at the same periodicity, there were differences of condition of the circuit and load which may have had a slight influence on the results.

Sample No. 1. This consisted of a block built up of stampings arranged as in Fig. 1, which shows section and plan, the outside dimensions of the plates being 16½in. by 11in. The sheets were 0·014in. (0·354mm.) thick, varying slightly; they were built up to a certain thickness with 100 stampings separated by paper, the total weight being about 55lb. The winding is shown at C.

Samples Nos. 2 and 3 were made up exactly the same as No. 1, but were taken from different supplies of iron.

They were occasionally removed from the oven, allowed to cool, and then returned to the oven after a test had been taken of the loss of energy with a given magnetisation.

The results obtained from these three samples are given respectively in Tables 1, 2, and 3, and graphically in Diagrams 1, 2, and 3. For ease of comparison the watts are plotted as percentages in all the diagrams.

The magnetising coil in each of these cases consisted of 100 turns of copper strip 0·16in. by 0·09in., having a resistance of 0·15 ohm, or so low as to make the C^2R loss negligible as compared with the loss in the iron. For example: with the maximum current used, 0·7 ampere, $C^2R = 0{\cdot}0735$ watt, the total loss being 29·3 watts.

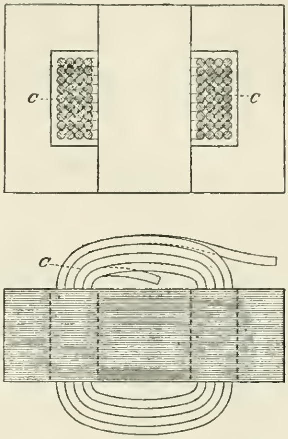


Fig. 1.

In the foregoing examples the iron magnetic circuit is not quite continuous; it is interrupted in part by butt joints and in part by lap joints.

Sample No. 5. In order to eliminate any errors that might conceivably be caused by alterations at the joints, a rectangle was made up as follows:—

A number of iron plates were taken, each 16½in. by 11in. by 0·014in., there being stamped out from the middle of each plate a piece 11in. by 5½in., as in Fig. 2, showing side and edge views.

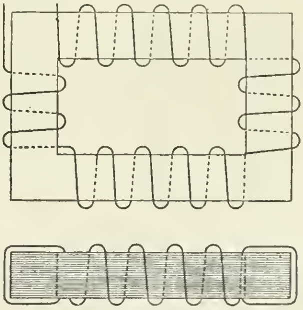


Fig. 2.

The plates were separated by paper and bound together by tape. They were then overwound, as in the figure, with a continuous winding, consisting of 140 turns of insulated copper wire 0·049in. diameter (resistance 0·4 ohm) so disposed as to magnetise the block almost evenly throughout the magnetic circuit.

The measurements made with this sample are given in Table V. and Diagram 5.

On the occasion of each test, measurements were made at three densities; viz., B 2,500, 2,752, 3,050.

The sample was kept in the oven between each set of tests, at the same temperature as the others; that is, an average of about 67°C.

It will be seen that the hysteresis is still rising, the change being about in the same order as in the other samples, showing that the question of joints has no noticeable effect. The change also follows closely the same order, whether measured at 2,500, 2,762, or 3,050 B.

Effect of Pressure.—An attempt was made to find if the increase was due directly to heat or to a mechanical condition brought about by the heat.

A possible explanation of the increase of hysteresis suggested itself in connection with the method of construction. In transformers the iron laminæ are usually bolted together very firmly, in order to ensure good contacts at the magnetic joints, to prevent noise, and for ordinary purposes of mechanical construction. It appeared possible that the expansion of the iron, due to heat, caused the plates to be pressed together more firmly when hot than when cold, and that this state of compression, if long continued, had a hardening effect on the iron similar to that caused by cold rolling or hammering.

One objection to this explanation was, that as the iron bolts holding the plates together were heated nearly as much as the plates, and therefore expanded nearly as much, the pressure could only vary slightly.

TABLE I. (*see* also Diagram 1).
Magnetisation = 2,500 B. Section of iron, 49·7 sq. cm.

Amperes.	Power-facter.	Watts.	Date.
0·41	0·74	16·54	August 24, 1894.
0·50	0·75	20·76	September 20, ,,
0·53	0·87	25·65	,, 27, ,,
0·54	0·88	26·6	October 5, ,,
0·56	0·83	25·71	,, 12, ,,
0·58	0·85	26·9	,, 23, ,,
0·59	0·89	28·77	,, 29, ,,
0·60	0·81	26·71	November 5, ,,
0·60	0·84	27·4	,, 13, ,,
0·59	0·82	26·31	December 6, ,,
0·61	0·85	28·88	,, 12, ,,
0·62	0·85	29·03	,, 27, ,,
* 0·61	0·81	27·9	January 7, 1895.
0·62	0·81	27·3	,, 25, ,,
0·62	0·85	28·96	February 7, ,,

TABLE II. (*see* also Diagram 2).
Magnetisation = 2,500 B. Section of iron, 49·7 sq. cm.

Amperes.	Power-factor.	Watts.	Date.
0·55	0·7	20·12	August 27, 1894.
0·66	0·71	25·8	September 20, ,,
0·66	0·84	30·75	,, 27, ,,
0·67	0·86	30·55	October 5, ,,
0·71	0·75	28·79	,, 12, ,,
0·70	0·8	30·99	,, 23, ,,
0·71	0·85	33·08	,, 29, ,,
0·71	0·8	30·05	November 5, ,,
0·714	0·8	31·46	,, 13, ,,
0·7	0·79	29·3	December 6, ,,
0·74	0·745	32·54	,, 12, ,,
0·72	0·87	34·7	,, 27, ,,
* 0·73	0·77	30·85	January 7, 1895.
0·74	0·75	30·8	,, 25, ,,
0·74	0·8	32·87	February 7, ,,

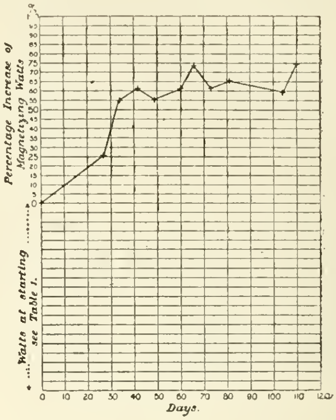
TABLE III. (*see* also Diagram 3).
Magnetisation = 2,500 B. Section of iron, 49·7 sq. cm.

Amperes.	Power-factor.	Watts.	Date.
0·43	0·7	16·61	September 20, 1894.
0·46	0·8	21·5	,, 27, ,,
0·51	0·86	24·28	October 5, ,,
0·53	0·8	23·7	,, 12, ,,
0·55	0·84	25·61	,, 23, ,,
0·56	0·89	27·67	,, 29, ,,
0·56	0·82	25·4	November 5, ,,
0·55	0·8	26·16	,, 13, ,,
Coil short circuited			December 6, ,,

This sample was then removed from the oven and left in repose. It was again tested on January 25, 1895, with the following result:—

Loss at 2,500 B, 25·4 watts, showing that repose for fifty days had produced no effect.

It was thought that in some forms such a gradual hardening might also be caused by the pressure exerted by the weight of the upper plates on the lower ones. But the increase was found where there was no superincumbent weight, in transformers in which the plates rested on their sides or edges.



DIAGRAM

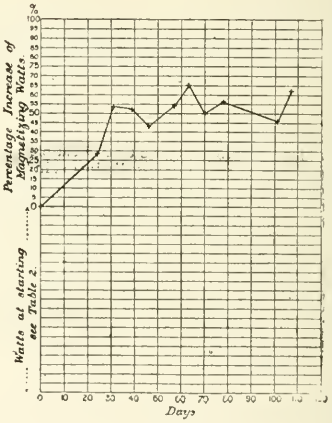


DIAGRAM 2.

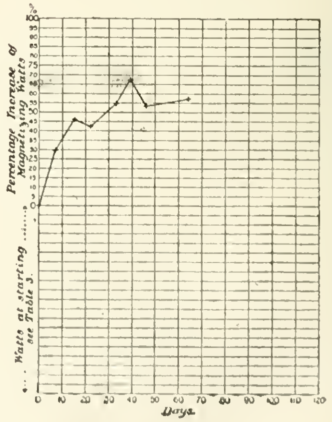


DIAGRAM 3.

In order to investigate this point two experiments were tried. The first was with the sample marked No. 5. In order, as far as possible, to avoid any compression, the plates in this sample were not bolted or clamped together, but, as described above, were merely held together by a binding of insulating tape and by the layer of copper wire with which they were covered. The results given in Table V. do not differ materially from those of Nos. 1, 2, and 3.

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* Added since diagram was engraved.

TABLE V. (*see* also Diagram 5).

Amperes.	Power-factor	Watts.	B.	Date.
0·46	0·76	8·9	2,500	September 29, 1894.
0·48	0·85	10·3	2,762	
0·50	0·85	12·1	3,050	
0·46	0·83	8·81	2,500	October 5, ,,
0·48	0·8	9·91	2,762	
0·51	0·84	12·08	3,050	
0·49	0·79	8·85	2,500	,, 12, ,,
0·51	0·78	80·18	2,762	
0·53	0·81	12·18	3,050	
0·56	0·86	11·15	2,500	,, 23, ,,
0·59	0·85	12·82	2,762	
0·61	0·87	14·79	3,050	
0·58	0·88	11·73	2,630	,, 29, ,,
0·60	0·9	14·9	2,762	
0·61	0·92	15·94	3,050	
0·60	0·38	12·13	2,500	November 5, ,,
0·61	0·9	14·22	2,762	
0·64	0·87	15·67	3,050	
0·60	0·9	12·35	2.500	,, 13, ,,
0·62	0·91	14·5	2,762	
0·65	0·88	16·18	3,050	
0·65	0·87	13·1	2,500	December 6, ,,
0·69	0·88	15·5	2,762	
0·71	0·88	17·68	3,050	
0·67	0·9	14·28	2,500	,, 12, ,,
0·70	0·95	16·96	2,762	
0·72	0·92	18·76	3,050	
0·64	0·9	13·83	2,500	,, 27, ,,
0·67	0·9	15·74	2,762	
0·71	0·9	18·37	3,050	
0·67	0·82	12·7	2,500	January 7, 1895.
0·69	0·86	15·1	2,762	
0·72	0·84	17·0	3,050	
* 0·67	0·83	12·9	2,500	,, 25, ,,
0·71	0·81	14·64	2,762	
0·54	0·81	16·82	3,050	
0·69	0·87	13·9	2,500	February 7, ,,
0·72	0·87	16·0	2,762	
0·74	0·88	18·4	3,050	

An observation which tends to indicate that pressure is not the cause of the change of condition was made some time ago. Different parts of the iron of a transformer, which had been in use some time, were examined, when it was found that the middle portions were rather more affected than the end portions. As the end portions, being most exposed, are least heated, and as in this instance all parts were subject to the same amount of pressure by the clamps or bolts, this observation does not support the supposition that pressure is the cause of the change. As, however, commercial iron varies in its hysteresis, even in the same sheet, the observation is of doubtful value.

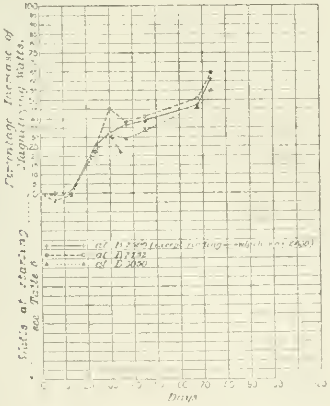

DIAGRAM 5.

A second set of tests is that marked No. 6. In this case the iron used was of the same size as in Nos. 1, 2, and 3, but of smaller amount.

It was arranged with a testing coil in the same manner, but instead of keeping the iron with its coil complete throughout the experiment, the coil was only put on for the tests, and was then removed, the iron being placed in the oven, arranged as a flat block (its upper surface being about 150 sq. in.), with a weight of about 300lb. on it till the next test was made. It was thought that perhaps the slight pressure produced in this way might affect the results. These are given in Table VI. and Diagram No. 6, and are markedly different from the tests of Nos. 1, 2, 3, and 5. The increase of hysteresis is greater, although the test has not been so long in progress.

TABLE VI. (*see* also Diagram 6).

Magnetisation = 2,500 B.

Amperes.	Power-factor.	Watts.	Date.
0·37	0·71	7·25	October 5, 1894.
0·38	0·77	17·99	,, 12, ,,
0·46	0·8	10·33	,, 23, ,,
0·46	0·9	11·55	,, 29, ,,
0·50	0·84	11·61	November 5, ,,
0·59	0·85	11·8	,, 13, ,,
0·55	0·82	12·63	December 6, ,,
0·56	0·94	14·8	,, 12, ,,
* 0·596	0·86	14·2	,, 27, ,,
0·586	0·80	13·0	January 7, 1895.
0·61	0·76	12·65	,, 25, ,,
0·616	0·82	13·9	February 7, ,,

This point deserves full investigation, and the author hopes to obtain further results from tests now in progress.†

Change of Power-factor.—The power-factor or ratio of watts to volts × amperes shows an irregular increase in all the tests. This increase in the power-factor indicates a possible (but improbable) increase in the eddies, such as would be accounted for by a decrease of the specific resistance of the iron. The author is proceeding to investigate this matter by continuously heating a ring formed by winding a volute of iron ribbon or wire, overwound with a testing coil of copper wire. The ends of the iron being brought out enable measurements of the resistance to be taken, the magnetising losses being measured as in the other samples.‡

Magnetisation not necessary to Production of Effect.—Having ascertained that neither magnetic nor electric action was necessary to the production of this effect, the author has endeavoured to find whether alternate-current magnetisation of iron can be carried on continuously, or for considerable periods, without producing any noticeable change, and, although the evidence is not sufficient to justify a positive statement, he finds that so long as the iron is kept cool it suffers no reduction of permeability. For example, a

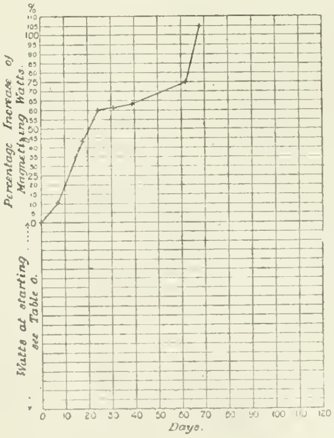

DIAGRAM 6.

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* Added since diagram was engraved.

* Added since diagram was engraved.

† See Appendix I.

‡ See Appendix II.

transformer in regular use for certain testing purposes, and used several hours daily during the last fifteen months, has kept its permeability. It is magnetised at various densities up to about 2,700 B. It is a specially designed apparatus, of large size for the work it has to do (and therefore inefficient and costly), and the temperature of its iron probably never rises more than about 6°C. to 8°C. above the room in which it is placed. It may be that its daily periods of rest account for the absence of change. This supposition is, however, not supported by other cases where iron, which has been in regular use, but with daily periods of rest, has shown the increase of hysteresis very clearly.

(*To be concluded.*)

DOUBLE REFRACTION OF ELECTRIC RAYS.*

BY K. MACK.

Since Hertz in his fundamental work on electric rays demonstrated the analogy between these and light rays in various points, especially as regards reflection, interference, polarisation, and refraction, numerous other workers have further pursued and extended these analogies ; so that at the present time a far-reaching parallelism between the two classes of phenomena is experimentally established. As in optics, the phenomena of double refraction play an important and interesting part, whilst a demonstration of corresponding phenomena in the case of electric radiation has not come to my knowledge, I have endeavoured to find suitable natural substances in which a double refraction of electric rays might be exhibited. The greatest difficulty is evidently that of procuring such suitable material. If gigantic specimens of Iceland spar existed, the double refraction of electric rays might doubtless also be shown with their aid in some way. Although it does not seem impossible that, if we produce electric rays of short wave-length by means of small apparatus, like Righi's arrangement†, that crystalline substances of the requisite dimensions might be procured wherewith to demonstrate double refraction ; still, I have from the first attempted to make this demonstration with a substance easily obtained in large pieces. Some guidance was given by the expression used by Hertz in the work referred to : "The electric ray penetrates through a wooden partition or a wooden door ; it is surprising to notice the appearance of sparks inside a closed room." Now, since wood possesses a different structure along and across the fibre, it is easily surmised that a double refraction of electric rays might occur in it. The investigation has confirmed this supposition ; with all varieties of wood which I have hitherto tested, a double refraction of electric rays may be distinctly exhibited.

The Apparatus.—The parabolic mirrors used for the experiments had been already made several years ago for the repetition of Hertz's fundamental experiments ; they were constructed exactly according to Hertz's data, only with somewhat smaller dimensions, the height of the mirrors being reduced to 1m., and their aperture also to 1m., with a focal length of 10cm. The primary conductor also has the form indicated by Hertz ; each half consists of a cylindrical piece 3cm. in diameter, upon which is set a sphere 4cm. in diameter. The total length of the half amounts to 10·5cm. With these dimensions of the primary conductor, and the focal length of the mirror, the wave length of the electric rays emitted, as shown by special measurements, is from 50 to 60 cm. For the production of the oscillations of the primary conductor a medium-sized Ruhmkorff apparatus had been used ; but afterwards I found it much more advantageous and convenient to use an influence machine in the manner described by Topler.‡ I abandoned the induction coil after having found the first decided traces of double refraction ; in the latter part of the investigation the influence machine was exclusively used. The latter is one of the self-exciting Voss machines recently introduced ; the diameter of the movable disc is 46 cm, and the machine is capable of giving sparks 18cm. long when jars are introduced. The connection with the primary conductor was made in the following manner, after Töpler's instructions. The copper wires 1mm. thick, which were soldered to the primary conductor, were taken through the wall of the mirror under good insulation, and were attached to brass rods 70cm. long and 0·5cm. thick by means of binding screws. These two rods pointed towards the machine, and were placed horizontally, parallel to each other and 12cm. apart. From the further ends of the rods short copper wires led to the outer coatings of the two Leyden jars attached to the machine. These outer coatings were insulated from each other. When the pole spheres of the machine are drawn apart by about 12mm. and the machine is working, sparks pass between the pole spheres and between the two halves of the primary conductor inside the concave mirror. Töpler has shown that the latter sparks have a markedly oscillatory character. The current of sparks produced by the influence machine has the special advantage, pointed out by Töpler, that the effective sparks in the arrangement described are much less apt to lose their oscillatory character than this is known to be the case with Ruhmkorff discharges. The polar surfaces of the primary conductor are only slightly attacked, so that I was able to continue the work five or six hours without having to polish up the surfaces. The interposition of oil between the pole surfaces, after Sarasin and De la Rive, I also experimented with, using olive oil, petroleum, and vaseline oil. But this complication of the arrangements is superfluous with Töpler's method ; at least, with the kinds of experiments here described. As regards the length of spark gap of the primary conductor, it was made 1mm. or 2mm. in most of the experiments. Even at distances of 3mm. or 4mm. good results were obtained, when the distance between the polar spheres of the machine was simultaneously increased to about 3cm.

The receiving concave mirror was exactly equal in size to the emitting one, the secondary conductor was placed in its focal line, in the shape of two brass rods 5mm. in diameter, from which, as in Hertz's arrangement, thin wires led to the spark micrometer behind the mirror. The length of each half of the secondary conductor was 20cm. As regards the spark micrometer, I found that in the double refraction experiments an especially careful preservation of the copper point and brass sphere is necessary. I therefore made both parts detachable ; it thus becomes feasible to repair the copper point, which experiences a small unavoidable blunting during the experiments, from time to time in the lathe with fine emery paper. The brass sphere, also, which was screwed to the wire holding it, was sometimes taken off and newly polished. To facilitate handling of the point when taking it off or replacing it, its bottom surface was screwed into a circular brass piece 9mm. in diameter, and this piece could be again screwed on to a small brass plate soldered to the watch-spring as employed by Hertz. It should be mentioned that in contradistinction to Hertz's arrangement the axis of the point was turned in a horizontal direction towards the sphere; *i.e.*, at right angles to the focal line of the mirror. For the observer this arrangement appears to me more convenient, especially when the parallel and crossed position of the mirrors is frequently changed.

The Experiments.—Let me first recall some results obtained by Hertz. When two hollow mirrors, with parallel focal lines, are turned towards each other, and an electric ray proceeds from one and illuminates the spark gap of the other, the spark gap is darkened when the other mirror is turned 90° about the ray as an axis. This experiment corresponds to the optical fact that two parallel Nicolls gave a bright field, while crossed they gave a dark one. In the electrical experiment the spark is restored when the focal lines are crossed and that of the receiving mirror is, say, horizontal, as soon as a Hertz wire grating is brought into the path of the ray at right angles to its position, while the wires make an angle of 45° to the horizon. This phenomenon is analogous to the brightening of the field of two crossed Nicolls by a tourmaline plate, when its axis bisects the angle between the principal planes of the Nicolls. This restoration is a proof of double refraction in the plate. The behaviour of the tourmaline plate is different from that of other doubly refracting crystals in this respect, that it only transmits one of the two rays produced by double refraction, while the other ray, vibrating at right angles to the first, is extinguished by absorption within the crystal. But in every case where a substance between two crossed Nicolls produces a brightening, we must infer double refraction in the substance. In the same way, when a substance between two crossed concave mirrors produces a restoration of the spark, it must be regarded as doubly refracting for electric rays. Using this arrangement of crossed concave mirrors, I endeavoured to show double refraction of electric waves in wooden plates. The direction of the grain had, of course, to be equal in every piece of a compound apparatus. The first experiments, made in the deal boards 0·5 to 1 square metre in area, and 2 to 3cm. thick, gave an entirely negative result. The same was the case when using an oak table top 1 square metre in area and 3cm. thick. Then a plate of deal 20cm. thick was made, in the shape of a regular octagon, with two opposite sides 60cm. apart. The plate was composed of three pieces of a beam 20cm. thick. The pieces were connected by wooden joints without glue.

First it had to be found whether a layer of wood of that thickness transmitted electric rays at all. When both mirrors were placed vertical and parallel, and the wood was introduced between them, the restoration of the spark showed that the ray passed through the plate, whether the grain was horizontal or vertical. In order to prevent the rays passing round the sides of the plate from having any effect upon the receiving mirror, a tin plate of one square metre was placed just in front of the wood, leaving a hole in the middle for the latter. In these experiments it appeared already that when the plate was placed with the fibre vertical, and thus the incident ray vibrated parallel to the axis of the tree—*i.e.*, in optical language, in the principal section, the intensity of the ray leaving the plate was distinctly feebler than when the fibre was horizontal ; *i.e.*, when the ray passed vibrating at right angles to the principal section.

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* *Wied. Ann.*, LIV., pp. 342–351, 1895.

† *Lumière Electrique*, XLVIII., p. 601, 1893.

‡ *Wied. Ann.*, XLVI., pp. 306, 464 and 642, 1892.

Then the plate was turned in its own plane through 45deg. and the receiving mirror through 90deg., so that now the plate was between crossed concave mirrors, while at the same time the fibre bisected the angle between the two focal lines.

In this arrangement, in which any double refraction present had to show itself, a brightening of the spark gap was actually observed in the micrometer. When the wooden plates were removed out of the way of the ray the sparks disappeared at once, and were at once restored on re-introducing the plate. Also when the plate was turned in its plane through 45deg. in one direction or the other, so that the ray vibrated in the principal section, or at right angles to it, the spark disappeared. These experiments were made with distances of 2m. to 4m. between the focal lines of the two mirrors. With distances of 2m. to 3m. the stream of sparks was quite uninterrupted and of uniform intensity, so that the experiments were convenient and easy ; while, with a distance of 4m. the play of sparks was still fairly uniform, but only feeble. For the success of the experiment it is essential to adjust the spark-gap very carefully. The following method appears to be convenient :—First, a Hertzian grating was introduced between the two mirrors instead of the wood, so that the sparks appeared. A strong current of sparks was thus obtained with the distances mentioned. When in this manner the micrometer was provisionally adjusted, the grating was replaced by the wooden plate, and now a small diminution of the distance between the point and the sphere sufficed to re establish the sparks, which are perceptibly fainter than in the case of the grating.

To decide the question, what thickness a deal plate must at least have, in order to show double refraction, further plates were made, one of 10cm. and two of 5cm. thickness, whose circumferences were the same as those of the plate used hitherto. The first experiment was made with a plate 5cm. thick, but the spark gap was not illuminated ; when the plate 10cm. thick was introduced, the stream of sparks set in, feeble but uninterrupted ; with a thickness of 15cm., produced by joining the 10cm. and the 5cm. plates, the sparks were made brilliant, and were further increased by bringing the thickness up to 20cm. The illumination of the spark-gap continued without sensible diminution when more and more plates were introduced in parallel positions, thus bringing the thickness up to 25cm., 30cm., 35cm., and 40cm.

When the plates were introduced in such a manner that the thickest remained in its position, while the thinner ones were turned in their own planes through 90deg., so that there were two thicknesses of 20cm. each, in which the fibres crossed, the sparks disappeared, a result which has its analogue in a well-known optical experiment.

Reviewing the phenomena described, it might appear remarkable that double refraction phenomena can be perceived at all under the conditions given. For between two crossed nicolls, with suitably placed crystal plates, a brightening of the field occurs in general only when between the two rays produced by double refraction a difference of phase of half a wave length, or an odd multiple of it, has taken place. But in the electric experiment we find illumination of the spark gap, while the thickness of the wood is less than half a wave-length, so that it is impossible that a difference of phase of half a wave-length could have been produced between the two rays. The phenomena exhibited by the wood are evidently explained by the inequality of the intensities of the two transmitted rays, which has already been mentioned. When one ray leaves the plate much enfeebled, the other little enfeebled, the horizontal components incident upon the second mirror will not be able to compensate each other, even without a decided difference of phase, but a portion of the less enfeebled ray will be capable of illuminating the spark gap. Thus we may have to do with a differential effect due to unequal absorption of the two rays. Such an inequality of absorption in the principal plane, and at right angles to it, occurs in many crystals, notably in tourmaline.

To corroborate this explanation the following further experiments were conducted :—The concave mirrors were placed facing each other, at a distance of 4m. apart, with their focal lines vertical, and the deal board 20cm. thick was brought into the path of the ray with its fibres vertical. A tin screen of 1 square metre area was placed in front of the plate, leaving a square hole of 25cm. side in the middle of the screen, so that the ray entering the plate was reduced to a smaller section, and to a smaller intensity. The spark gap was fairly well illuminated ; on adding a further plate 10cm. thick parallel to the first the sparks were very feeble, and they disappeared altogether on further increasing the thickness by 5cm. Hence, with this arrangement an electric ray vibrating in the principal section of the wood was quite extinguished by a layer of deal 35cm. thick. This layer was now turned through 90deg. in its own plane, while the rest of the arrangement, especially the spark gap, remained undisturbed. The electric ray, therefore, traversed the wood vibrating at right angles to the principal section, and it was seen that the spark gap was brightly illuminated again, and that the same was the case on adding the last deal plate 5cm. thick parallel to the rest.

In order to extend the investigation to other kinds of wood, plates of oak and beech were made of the same thickness as the deal plates, 4 of oak 5cm. thick, and 4 of beech 3, 4, 6 and 7cm. thick. The results were in close agreement with those hitherto obtained. In both species of wood I could, as in the case of deal, only perceive the sparks when the thickness of the wood was 10cm. With smaller thicknesses the spark gap was dark even with the most sensitive adjustment, whilst when the thickness was increased the brightness of the spark at once increased. As regards the strength of the sparks obtained with the three different kinds of wood it appeared to me that with equal thickness of wood deal shows the phenomena in the greatest intensity, beech in about the same manner, and oak somewhat feebler.

The experiments described prove that wooden plates cut along the grain behave towards electric rays in the same manner as crystal plates cut parallel to the optic axis behave towards light rays ; it is, therefore, natural to inquire whether wooden boards cut across the fibre are simply refracting in the direction of the latter, as might be expected from the optical analogy. The forestry collection of this academy provided the material for performing such experiments ; they confirmed the accuracy of the supposition mentioned. A plate of Scotch fir (*Pinus sylvestris*), about 1m. in diameter and 16cm. thick, cut at right angles to the tree axis, was introduced between the crossed mirrors, and it left the spark gap dark even with the most sensitive adjustment. The same result was obtained when a smaller plate of the same kind of wood (70cm. in diameter and 14cm. thick), was placed in the path of the rays, and also when the two plates were combined to a layer 30cm. thick. A third plate, made of a dense and heavy kind of wood (*Sophora Japonica*), was examined ; in this case also the spark gap remained dark. It may be added that whilst the last three plates mentioned consisted of old and perfectly dry wood, the rest of the material used was made of younger wood, just as the carpenter had it in stock.

ELECTRICITY AS APPLIED TO MINING.*

BY G. S. CORLETT.

Electricity has been used in mines for (1) signalling ; (2) telephones ; (3) blasting ; (4) lighting ; (5) transmission of power.

1. *Signalling.*—Electric signals were introduced into some Yorkshire collieries about 20 years ago. The arrangement of the apparatus is now so well known that a very brief description of the simplest form of signalling—viz., engine plane signalling—will suffice. In the engine-house is fixed a powerful bell with a 6in. or 8in. gong, a battery of Leclanché cells, and a plug switch. Along the roadways, two galvanised iron wires are tightly strained on small bobbin insulators and very securely bound on these insulators in the usual manner. At the distant end is placed a strong ringing key. Signals can be given by means of this key or by pressing the wires together at any point on the roadway. The size of iron wire varies from No. 8 to 11. The present Coal Mines Act provides that signals must be arranged to ring in both directons ; that is, a bell at each end. The advantage of electric signalling for mines is the speed at which signals can be transmitted over any distance. This speed in signalling also tends very largely to safety in working. In case of accident the haulage rope carrying loaded trucks can be stopped by pressing the wires at any point along the roadway, and in my own experience this has been directly responsible for saving several workmen's lives. There is the further advantage that the attendant at each station knows by the signal where the train is starting from or proceeding to, as the case may be.

2. *Telephones.*—Telephones have also been used very largely for surface work for communicating with the various departments, but only to a limited extent below ground.

3. *Blasting.*—Following the strong recommendation, almost amounting to an instruction, of Her Majesty's Inspector of Mines, most collieries have now adopted the electrical method of shot-firing. There has been even in this small branch of electrical work a battle between high and low tension. High tension was adopted first, but is now being gradually replaced by low tension apparatus. Many important advantages are possessed by the latter, and I think in the near future high tension exploders will be very little used. Exploders are small magneto machines with a simple shuttle-armature, which is wound with fine wire for high tension and comparatively coarse for low tension. One end of the armature coil is connected to the frame and the other led through the spindle and

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* Abstract of a Paper read before the Northern Society of Electrical Engineers.

an insulated ebonite bush to a contact. In the high tension exploders this ebonite bush is one of the most fruitful causes of failure. Dampness is usually unavoidable, and as this ebonite bush is necessarily small breakdowns are frequent. Detonators are now being manufactured of a fairly uniform quality, but until recently enormous variations occurred. High tension detonators are fired by means of a spark passing across the ends of the two wires inside the copper cap of ¼in. diameter. Low tension are similar in appearance, but the ends of the above wires referred to are joined by a thin piece of platinum wire which is heated by the current. From a manufacturing point of view I think the low-tension detonators are simpler, and, so far as my own tests go, are of a much more uniform quality.

4. *Lighting.*—One of the earliest attempts at colliery lighting was at the Earnock Colliery in Glasgow about 14 years ago, and I believe the plant worked very successfully for some time. The first colliery lighting job that I have any personal knowledge of was at one of the Durham pits. This was completed in or about the year 1882, and worked for a number of years. The dynamo was of the old B Gramme type with a wooden hub, series-wound field magnets, and coupled in parallel, supplying current for about 50 Swan lamps of the type of the type then called 20-c.p. The wiring was hardly done in modern style. It is true that the wires were run in casing; the casing had only one groove, which was big enough for all wires. Fuses were entirely absent. The lampholders were of the original Swan spiral spring type, and I think switches were considered altogether unnecessary; the engine stop valve had also to do duty for the main switch. A Paterson and Cooper's permanent magnet voltmeter with a loose keeper was also fixed.

Most collieries have a fan engine, with a large surplus of power, and it is often suggested that this be used for dynamo driving. The average speed of a fan engine may be taken at 50 revolutions. This involves a countershaft, and fast and loose pulley, or a friction-clutch. This gearing, with the additional belting required, often costs almost as much as a small engine, and is not so satisfactory. Five to ten per cent. variation in the speed of a fan is not uncommon. The best arrangement is to drive the dynamo with a separate engine. Usually there is space in the fan engine-house to receive an engine and dynamo, and a more suitable place could hardly be found. The man is constantly in attendance, and is, as a rule, not overworked, and can therefore do all that is necessary for the electric light plant. The steam consumption of a colliery electric light engine need not, as a rule, be considered, and an ordinary belt-driven engine seems to answer the purpose. I have found small vertical engines running at from 200 to 250 revolutions a very satisfactory type.

As the electric lighting plant at a colliery has to stand a considerable amount of rough usage it follows that the wiring should be particularly well done. The advantage of distributing the lighting from certain points at which the switches and fuses are grouped is perhaps more apparent in this class of work than in any other. In almost all the places the lamps should be enclosed in very strong fittings, absolutely dust-proof and with a thick outer glass which in some instances must be protected by a stout wire guard. In this district the screening and coal cleaning arrangements are undoubtedly the most important part of a colliery, from an electric lighting point of view. A liberal amount of light should always be provided, so that when the glasses become a little dusty, as is just possible, there may still be sufficient light to detect the impurities of the coal. In South Wales very little coal screening or picking is required, while in Leicestershire house coal collieries, the small waggons from the mine are drawn into a special shed for the purpose and the best pieces are carefully selected and packed by hand in the railway waggons adjoining. Between these two extremes there is almost every possible variation, so that each individual case has to be dealt with on its own merits.

In addition to the surface lighting arrangement of collieries, electricity has also been extensively used underground for lighting the main roads, engine-houses, &c., close to the bottom of the shaft. The same remarks as to fittings, &c., apply with equal if not greater force underground. Where the shafts are comparatively shallow and the number of lamps is small, the underground lighting can easily be effected by a cable from the surface installation led down the shaft; but where, as in this district, 600 yards is quite an ordinary depth for a colliery shaft, and 100 16-c.p. lamps or the equivalent have to be provided, the cost of such a cable becomes a very heavy item. The conditions of underground lighting may be briefly summarised thus: The whole of the lighting is required during the day, but at night only a few lamps at each pit bottom or mouthing are used. During repairs, certain sections of the underground lighting may also be wanted during the night. These conditions imply that the best arrangement is to have a cable connected with the surface installation, sufficiently large to supply the whole of the lighting with only a small loss, say four volts, and to use lamps of the same voltage as on the surface. To take a case which may be considered an average one, a shaft 600 yards deep, 25 amperes required at the bottom with three volts loss, the cable will be 37/13 size and, allowing 1,300 yards of 2,000 megohms vulcanised rubber, will cost £342.

Volts lost.	Cable.	£
3	37/13	342
4	19/11	310
10	19/15	119

If four volts the figures will be 19/11 and £310. In addition to these figures there will of course be the cost of specially strong casing and the fixing thereof, as well as the lamps and wiring underground. Taking the cost of the latter at 30s. per lamp, it will be seen that the total capital outlay required for 50 lamps will be £425. This is a fairly large sum, and owing to the present state of the coal trade colliery managers are not inclined to lay it out in such work. It is, of course, possible to provide for a larger loss, say, of 10 volts in the shaft cable, and use, say, 110-volt lamps on the surface, and 100-volt lamps underground; the cable would then be 19/15 and cost £119. Assuming that the cables are provided for a 10-volt loss at full load and that the lamps required all night are only 20 per cent. of the full load, it follows, of course, that when these lamps are burning, the volts at the pit bottom will be 108; but as this pressure would very soon destroy the lamps, it is necessary to either switch in a resistance or to wire them in duplicate, one set for 110 and the other for 100 volts. There is the further inconvenience that the other lights cannot be used at all unless almost the whole lot are switched on.

There are two other alternatives open—1st, to lay down a separate engine and dynamo at the pit bottom, but this is generally impracticable; 2nd, to fix a separate dynamo to give 220 volts, and couple the lamps two in series underground. This will effect a very large saving in the cables. In the case previously referred to, with the same percentage of loss, the sizes of cables would be as follows:—

6 volts loss	19/15	cost	£119
8 ,, ,,	19/16	,,	96
20 ,, ,,	19/20	,,	45

Usually it would also be practicable to allow the 20-volt loss, as during the night dynamo volts could be lowered by a resistance in the shunt. It seems to me that for fairly large underground installations it would pay to adopt this 220-volt arrangement, in spite of the fact that two dynamos would be running all through the night at extremely light loads, one for the surface, and one for the underground.

Again, it is quite an open question whether vulcanised rubber enclosed in wood casing is the most suitable form of conductor for shaft work, although, speaking from my own experiene, I have had most excellent results from this quality of cable. There are, however, various other types of insulation and protection, such as lead-covered and armoured, which certainly to a colliery engineer have the appearance of mechanical strength. They are, however, very heavy, and sometimes considerable difficulty arises through not properly securing them to the sides of the shaft. This type generally costs more money than vulcanised rubber, but in my opinion it is certainly very much open to question whether it makes a better job. Where cables of a fairly good size have to be carried along the roadways of a mine, then I think it best to adopt the armoured type.

The question of providing suitable hand lamps for miners is one that has occupied electrical engineers' attention for a long time, and although very much has been done in the way of experiment and very many different types of lamps have been brought out, yet up to the present I know of none which I could with any confidence recommend to a colliery engineer to place in the hands of his workmen generally. For some of the officials and for certain special purposes underground portable electric lamps fitted with accumulators can now be obtained which work fairly well if the instructions as to charging are carefully attended to, and the lamp itself is kept in a vertical position, but should there be a little carelessness on either of these points, trouble and annoyance immediately result. Another very great difficulty is that up to the present no practical apparatus has been devised which can be attached to such lamps to indicate the presence of gas.

5. *Transmission of Power.*—Mining engineers have for some time past been considering the possibilities of electricity as a means of transmitting power in their mines. A certain amount of work has been done, for the most part successful; but excepting in a few cases, the plants installed have been of small size, and of a somewhat experimental character. I mean experimental more from a mining engineer's point of view than that the electrical machines were of an unfinished or imperfect character, or, in other words, that the colliery manager was feeling his way as far as electricity was concerned. Colliery managers, it must be remembered, are directly responsible for the lives of their employés, and, not unnaturally, looked with some doubt upon the new power, especially

since every failure was by interested parties brought into prominence. Then the wildly incorrect statements made by electrical men have done much to deter electrical work. Colliery managers have been assured that the combined efficiency of engine, dynamo, cable, and driven machinery would be 90 per cent. Such a statement is of course absurd, but its very absurdity is prejudicial to our interests, as the colliery manager naturally concludes that we know nothing of our business. Again, some electrical engineers have laid down power plant in mines of a very inferior character. They have not taken the trouble to ascertain the difficulties of working, the rough usage, the scanty attention and the large increase of power occasionally demanded. The result has been constant breakdowns, with the consequent expense and annoyance. Such cases cannot be too strongly condemned; it is the whole trade which suffers, and not the individual that does the job. On the other hand, however, much good work has been done. One of the earliest, if not the first, power plant was put in by Mr. Frank Brain, in the year 1882, at his Trafalgar Colliery, and this I understand is still at work, but has since been considerably extended. Electricity has been applied to pumping, hauling (by fixed motor and by locomotives), coal-cutting, fan driving, and drilling. Electrical engineers who undertake this class of work are pretty well agreed that the current should be supplied at a constant pressure, and I think 500 volts a very suitable standard to adopt. This will, I think, be found in practice sufficiently high to make it commercially practicable to transmit power to the ordinary distances of a mine without an extravagant outlay in cable, yet not so high as to cause a dangerous shock; nor too high for the very small motors that are occasionally required for pumping small quantities of water. It must be remembered that one of the great advantages of electrical power transmission in mines is its flexibility. It can be as readily applied to small powers as to large, and if the volts are raised much above the limit I have suggested, practical difficulties will arise in the manufacture of motors under 2 H P. These small motors are really required in practical work, I have one or two motors working underground driving pumps which are only taking $\frac{3}{4}$ E.H P. Cables: Quality and sizes of cables must be almost entirely regulated by the circumstances of the particular case. For shaft work I have found good vulcanised cables last remarkably well, while for the roadways of the mines, where heavy currents are required, cable insulated with bitumen or one of the resinous compounds protected with a heavy steel armouring, and laid directly in the ground, makes an admirable job. I think in all cases it is advisable to have insulated lead and returns; although I have myself one job where an uninsulated return is used, though with only moderately satisfactory results. The return consisted at first of a steel-wire rope, but on account of its very high resistance, presumably at the joints and splices, bare copper wires were used to increase the conductivity. In a mine it is impossible to insulate such a conductor, and, generally speaking, I think it pays to spend the additional capital required, and provide an insulated return circuit. For most of the operations required in mining a series-wound motor is the most suitable. For pumping and hauling it is an absolute necessity, as an enormous torque is required to start the load. In laying down any system of power plant it is extremely difficult to obtain from the colliery engineer reliable figures as to the power required. Speaking from a somewhat intimate connection with colliery engineers, extending some ten years back, I am inclined to think that a very large number of them never trouble to ascertain what power is being expended on certain operations. For instance, if pumping plant by ropes or compressed air is being laid down, care is taken that there is an ample margin of power, and so long as the work is being done without a breakdown the colliery engineer does not measure the exact horse-power required for dealing with this particular quantity of water. Although it is a comparatively simple matter to determine the theoretical power required, the actual power is often a very much larger amount.

In pumping work, for instance, the friction of the pump and its gearing does not vary in any fixed proportion to the total horse-power. A moment's consideration will show that the friction of the pump itself will be about the same, whether the pump is worked against 50ft. or 500ft. of head.

Pipe friction is also an item that requires careful consideration. In the majority of cases electrical pumping work at a colliery is for a fairly large quantity of water on a comparatively small head, and the friction in the pipes may absorb quite as much power as the raising of the water. In one instance under my own charge, the pipe friction is just double the power required to raise the water.

In calculating the pipe friction I have used the following rule, which has the advantage of being easily remembered, and as far as I have been able to check it, is very correct. It is due to Prof. Merivale, of Newcastle-on-Tyne, and is $G^2L/(3d)^5 = H$, where $G =$ gallons per minute, $L =$ length of pipe in yards, $d =$ diameter of pipes in inches, $H =$ head due to friction.

In haulage work the amount to be allowed for friction is also very variable. On a wet road which is badly kept, with rails allowed to get slightly out of gauge, or not free from small pieces of stone or coal, the power due to friction is enormous as compared with a dry and well kept roadway. Again, provision has to be made for the additional loads that may be put on the plant. For instance, in an endless rope haulage system it often happens that the rope is for short periods much more heavily loaded than is usual. The motor must be big enough to respond to this demand; indeed, in all mining work an ample margin of power is necessary. The only haulage in a colliery in this country by an electric locomotive that I know of was installed at a Yorkshire pit. A rope was laid along the roadway and secured at each end; in front of the train was a special trolley carrying a motor driving a clip pulley. The rope passed round this pulley, and the train was, so to speak, wound along. This system is not likely to be generally adopted. Another interesting case involving the use of electric locos is at the Greenside Lead Mines, Ullswater. A full description of the plant will be found in the *Transactions* of the Federated Institute. In each of these cases the current is taken from overhead conductors by a sliding contact.

There is some difficulty in describing what has been done in coal cutting. A considerable amount of work has been done by the Coal Cutting Corporation, but I hear various reports as to the success of the apparatus, and as I have never been able to obtain permission to inspect the plant, I am unable to give any details of its performance. There is apparently no doubt that there is a large future for a practical coal-cutter, but I think such a machine has yet to be designed; certainly I do not know of one fulfilling all the requirements.

So far, I have not alluded to the risk of explosions from gas. This is one of the most important problems of all, and I think that its satisfactory solution will be found in alternating-current apparatus, probably di- or tri-phase type. So far as I know these have not been used in England, but their simplicity and the absence of brushes and commutators seems to point them out as the ideal mining motor of the future. The difficulty about low starting torque will no doubt be speedily overcome. Certain so-called safety devices have been devised for continuous-current apparatus, the most important of which probably are the steel-clad motor of Mavor and Coulson, in which the whole motor is enclosed in a steel case; the Goolden arrangement, in which the armature is enclosed; and the Davis-Stokes method, in which the commutator is enclosed —*i.e.*, the brushes bear on the inner periphery, and the whole enclosed by a revolving ring. The first method seems undoubtedly the best, though in all I fancy the skill of the attendants bears some proportion to the safety.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, February 22nd.

Institution of Electrical Engineers.

8 p.m. Students' Meeting at 28, Victoria-street. The following paper will be read:—"The Efficiencies of Dynamos and Motors and their Measurement," by E. C. Hoadley.

Royal Institution.

9 p.m. Evening Discourse:—"Atmospheric Electricity," by Prof. A. Schuster.

Physical Society.

5 p.m. The following Papers will be read: (1) "A new Harmonic Analyser," by G. H. Yule; (2) "The Electromagnetic Field," by H. N. Allen; (3) "The Communication of Heat between Bodies in Contact," by G. H. Bryan.

SATURDAY, February 23rd.

Institution of Junior Engineers.

9:20 a.m. Visit to Messrs. Siemens' Works, Woolwich. Reception by the President, Mr. Alexander Siemens.

TUESDAY, February 26th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. The following Paper will be further discussed: "Plant for the Extraction of Gold by the Cyanide Process," by C. Butters and E. Smart. The following Papers will be read, time permitting: (1) "Electrical Haulage at Earnock Colliery," by Robert Robertson; (2) "Electricity Applied to River Gold-Dredging," by R. Hay.

THURSDAY, February 28th.

Institution of Electrical Engineers.

8 p.m. Ordinary Meeting. Discussion on "Reversible Regenerative Armatures," by W. B. Sayers.

FRIDAY, March 1st.

Institution of Junior Engineers.

8 p.m. Meeting at the Westminster Palace Hotel. The following Paper will be read: "Locomotive Repairing Work," by A. H. Newsom Smith.

The Electrician.

(The Oldest Electrical Journal, 1861–1878.

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THE BORCHERS CELL.

It is significant of the interest in the problem of the conversion of the energy of fuel into electrical energy, an interest latent for long and at length aroused by Prof. OSTWALD's remarkable dissertation published last summer, that no sooner had an endeavour been made to realise in a practical form the conditions laid down by the ionic apostle than there appeared a crowd of critics, many clearly competent, to search out the weak places in the scheme by which realisation was claimed to have been reached. The appearance of the Paper by Dr. BORCHERS, translated into this journal immediately after its publication in Germany, was the signal for the initiation of a lively but somewhat one-sided correspondence, much of which has been contributed to our own columns. It may be convenient, in view of the time which has elapsed since the subject was first brought into the arena, to recapitulate with all possible brevity both the main proposition and the rejoinders thereto before undertaking to arrive at their algebraical sum.

Dr. BORCHERS (*The Electrician*, November 30, 1894) originally found that a current was produced in a cell having one electrode of copper and the other of carbon, both immersed in a solution of cuprous chloride, and having air supplied to the carbon compartment and carbon monoxide to the one containing the copper. The source of the current was stated to be the union of oxygen and carbon monoxide, the electrodes suffering no appreciable attack. An efficiency of 27 per cent. was observed with this arrangement. Mr. C. J. REED (*The Electrician*, January 4, 1895) wholly denied that the oxidation of carbon monoxide was the source of the current, and asserted that the corrosion of the copper electrode was the true reason for the production of electrical energy, but adduced no figures in support of his view. Mr. Robert Mond (*The Electrician*, January 11, 1895) gave a list of the voltages of a number of combinations of carbon, copper, cuprous and cupric chloride, air and carbon monoxide, tending to substantiate Mr. Reed's assertion, but did not record a trial under conditions identical with those adopted by Dr. Borchers. Mr. William Tatlow (*The Electrician*, January 18, 1895) supported Dr. Borchers' conclusions by an experiment of his own in which air was used in one compartment, and coal gas (containing carbon monoxide) in the other; he, however, employed two different electrolytes—viz., both cuprous and cupric chloride—thus preventing the institution of a valid comparison between his results and those of Dr. Borchers. Messrs. H. H. Barnes, jun., and E. Veesenmeyer (*The Electrician*, February 1, 1895) recorded the performance of experiments which appear to be strictly comparable with those of Dr. Borchers. The voltage results obtained by these experimenters, however, differ widely from those obtained by Dr. Borchers. Thus, an insignificant voltage (0·08) was observed from a cell having copper and carbon as electrodes, cuprous chloride dissolved in hydrochloric acid as an electrolyte, and fed on the one side with air, on the other with carbon monoxide (or coal gas). More weighty still is the statement that no carbon dioxide, which would result from the oxidation of carbon monoxide, could be detected in the escaping gases. A second letter by one of the writers already named—Mr. H. H. Barnes—appears in the current issue of *The Electrician*, and may be studied in conjunction with Dr. Borchers' reply, which is translated in another column. Particular stress is laid upon what appears to be a certain shifting of ground by Dr. Borchers—a point which is dealt with immediately below.

The reply by Dr. Borchers, which has been already referred to, seems to us to savour somewhat of special pleading. Certain purely polemical passages have, indeed, been omitted from the translation, as, in our judgment, they in no way contribute to the elucidation of the questions involved, but are purely personal. At the same time, no essential part of Dr. Borchers' defence has been deleted. The reply is undoubtedly an able criticism of the critics, and disposes of all fairly effectually on the ground of the want of identity of condition, in their experiments, with that obtaining in Dr. Borchers' own researches. The rejoinder to Messrs. Barnes and Veesenmeyer is less convincing. In his original Paper Dr. Borchers conveyed the idea that a hydrochloric acid solution of cuprous chloride was preferable to an ammoniacal solution of the same salt; whereas in his reply he bases his defence on the fact that oxidation of carbon monoxide to carbon dioxide, with corresponding reduction of cuprous chloride to metallic copper, takes place in an ammoniacal solution. It is only fair to point out that he does not admit that this reaction cannot proceed, under the conditions prevailing in his cell, in the absence of ammonia. Further, that if it were proved that the reaction could take place only in the presence of ammonia, the alteration would not in any way affect the correctness of the conclusion that electrical energy can be obtained by the oxidation of carbon monoxide in aqueous solution.

The matter may now be concentrated to a very small bulk. Several of Dr. Borchers' critics have brought forward evidence which clearly proves that, unless exceptional care be taken, it is extremely easy to mistake the electromotive force yielded by the attack of the copper electrode for that produced by the oxidation of carbon monoxide. But, with the single exception already named, they have failed to demonstrate that Dr. Borchers actually fell into this error. On the other hand, Messrs. Barnes and Veesenmeyer have promulgated a statement which, unless refuted, is absolutely fatal to Dr. Borchers' claims. This statement is that a cell identical in kind with that used by Mr. Borchers yielded no product of oxidation of carbon monoxide—viz., carbon dioxide—for it is improbable that it would be contended that any other oxidation product of carbon monoxide is likely to be formed. Dr. Borchers must disprove this allegation or his cell is discredited. It is much to be regretted that (as may be gathered from his letter) the claims upon his time preclude his returning to the subject for a considerable period.

A word of advice to all parties to the controversy will, we trust, be accepted in good part. Qualitative observations such as have been published are, in a matter of this kind, worse than useless. They darken counsel. It does not suffice to record the current and voltage obtained; a complete chemical balance-sheet must be made out; the solutions must be of known composition at the start, and must be analysed at the conclusion; the ingoing gases must also be known in nature and amount, and the exit gases must likewise be measured and analysed; alteration of the electrodes must be similarly controlled. Speaking quite generally, in many investigations of this class we find the electrical measurements carried out with all needful precision; but the chemical aspect of the question—and all processes of electrolysis are primarily in the domain of the chemist—is left unregarded, as of no account. Yet it is the root of the whole matter.

THE DELINEATION OF ALTERNATING CURRENT CURVES WHEN THE DYNAMO IS NOT ACCESSIBLE.

BY DR. J. A. FLEMING, F.R.S.

(Continued from p. 462.)

We proceed then, in the next place, to give some reproductions of alternating current and electromotive force curves taken with the curve tracer already described at the City of London Electric Lighting Company's Station at Bankside. The curve tracer was set up in a room at some little distance from the dynamo house, and leads taken from the machine or machines under test to this room. The field magnets of the curve tracer were excited from the exciter circuits of the Station.

Fig. 3 shows the curve of electromotive force of a single Mordey alternator (A 14) 100-kilowatt machine taken on open circuit or with its poles only closed with a non-inductive resistance taking half an ampere, and the armature circuit of the curve tracer taking two amperes. Horizontal distances in the diagram represent degrees of phase, the vertical lines being 30deg. apart, and each diagram represents one complete wave. Vertical distances represent electromotive force or current. In the former case the horizontal lines are separated by a distance equal to 1,000 volts. The dots represent the actual position of the observations. These observations are taken so closely together that there is no need to draw a curve "reconciling" the different observations. Where the curve is at all irregular the observations are taken very close together. Where the curve lines run fairly smoothly they are taken farther apart. This is entirely at the pleasure of the operator.

It will be seen that the curve of the Mordey alternator is a curve not very different in appearance from a simple sine curve, but a little flattened on the crest. The electromotive force of this alternator is 2,030 volts, as read on an electrostatic voltmeter. That is to say, the $\sqrt{\text{mean}^2}$ value of the electromotive force is 2,000 volts, and the maximum value during the phase is not very different from 2,750.

In Fig. 4 is shown the electromotive force curve of the same Mordey alternator on full load—namely, when sending out 50 amperes on to a water resistance. This curve is not very different from the curve at no load; but on comparing the two carefully it will be seen that the full-load curve is slightly pressed over on one side. These two curves taken together indicate that the armature reaction of the machine is very small, the curve of electromotive force being almost independent of the current sent out from the machine. The no-load E.M.F. of the A 20 Mordey alternator is much flatter at the crest than that of the A 14.

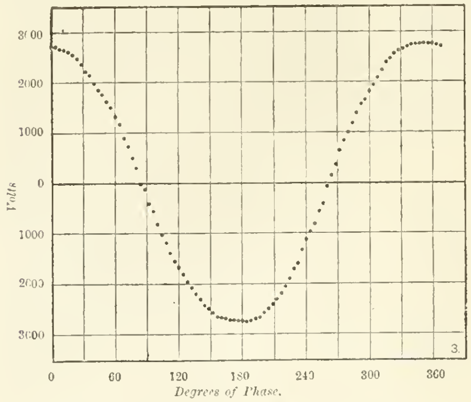

Fig. 3.—Electromotive Force Curve of Mordey Alternator at no load.

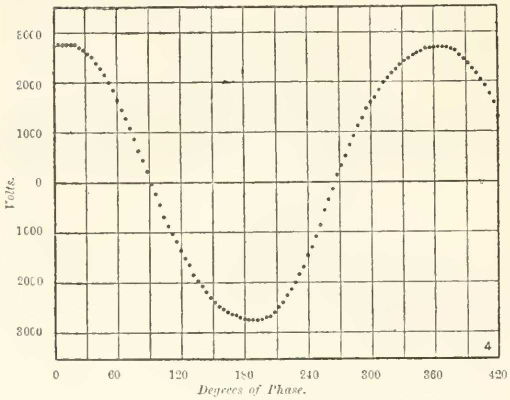

Fig. 4.—Electromotive Force Curve of Mordey Alternator at full load on water resistance.

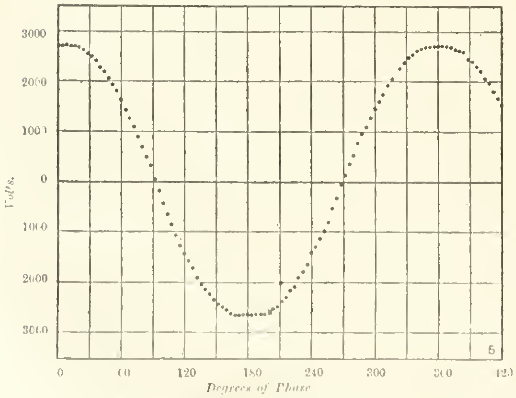

Fig. 5.—Resultant Electromotive Force Curve of Two Mordey Alternators on parallel.

Fig. 5 represents the curve of electromotive force of two Mordey alternators (A 14) taken in parallel. The machines were doing no work, and it will be seen that the resultant curve of the two machines in parallel is very similar to that of a single machine.

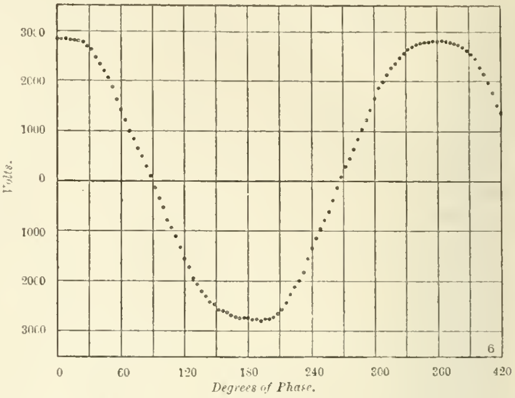

Fig. 6.—Resultant Electromotive Force Curve of Bankside Station, January 26, 1895, 11 a.m.

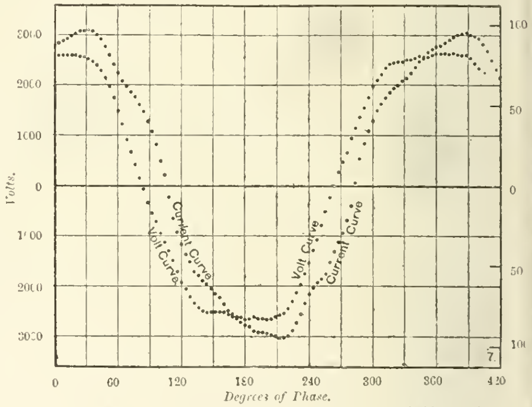

Fig. 7.—Electromotive Force and Current Curve of Bankside Station at night, February 7, 1895.

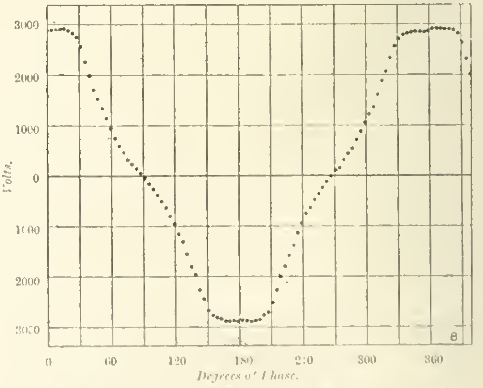

Fig. 8.—Electromotive Force Curve of Thomson-Houston 350-kw. Alternator, at Bankside, on no load.

Fig. 6 represents the resultant electromotive force curve of the whole of the Bankside station taken on the morning of January 26, 1895, beginning at 11 a.m. The machines then working were two Mordey A 10 machines and one Mordey A 20, working in parallel, and the current being sent out from the station was 300 amperes. The curve was taken off the omnibus bars in the station. It will be seen that the curve is rather flattened on the crest when compared with the no-load curve of a single machine.

Fig. 7 represents the electromotive force curve and the current curve of a Mordey A 20 alternator when sending out a current of 72 amperes during the night-time, when the load consists chiefly of transformers on open circuit. This curve was taken on the night of February 7th, at Bankside, between half-past one and six in the morning. It will be seen that the current lags behind the electromotive force, as might be expected, and that the electromotive force curve under these circumstances is much flattened on the crest, and has a depression in it when compared with the curve taken on non-inductive resistance. From these two curves it is, of course, possible to plot a watt curve, which would give the whole mean power given out of the station during the time of observation, and during which the outgoing current remains sensibly constant.

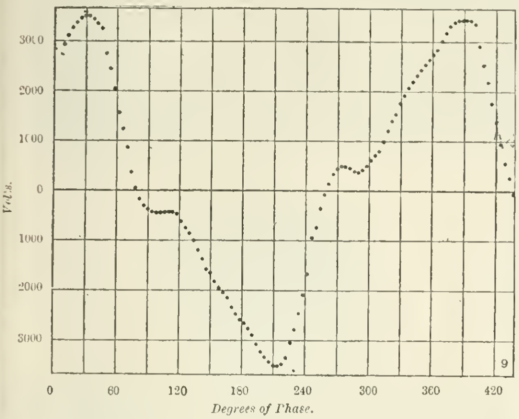

Fig. 9.—Electromotive Force Curve of Thomson-Houston 350-kw. Alternator, at Bankside, on night load.

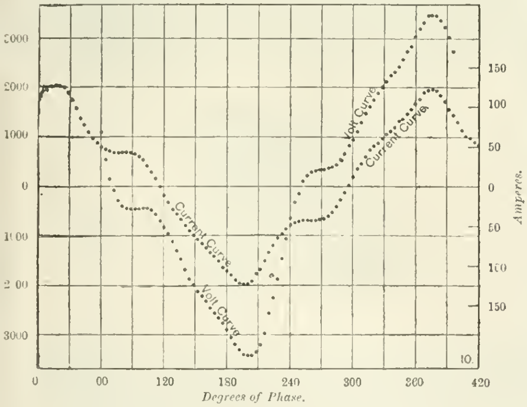

Fig. 10.—Electromotive Force and Current Curve of Thomson-Houston Alternator at Bankside, between 11 p.m. and 4 a.m.

Fig. 8 represents the electromotive force curve of a Thomson-Houston alternator at no load. This machine is a 350-kilowatt machine. It will be seen that the sides of the curve are very much recessed, or hollow, and that it has a flat and dimpled top very unlike a sine curve.

Fig. 9 represents the curve of electromotive force of the same Thomson-Houston alternator doing the night load at Bankside. The outgoing current was 75 amperes. We may note the sharp peak of the curve with its very steep ascent, and the flat ridge half-way down.

The $\sqrt{\text{mean}^2}$ value of the electromotive force is 2,100 volts, and the maximum value nearly 3,500 volts. This curve should be compared with that of the Mordey machine shown in Fig. 7, under exactly similar conditions.

Fig. 10 shows the current and electromotive force curves of the same alternator at Bankside, when doing the night load between eleven o'clock at night and five in the morning. Under these conditions the load is very largely an inductive load, owing to the sub-station transformers being slightly loaded.

One very curious point about these two curves is that while there is a lag of 50deg. of current behind electromotive force if we take the zero values, there is no lag at all apparently if we compare the maximum values of the current and electromotive force.

The current agrees in phase with the electromotive force if we compare the maximum values, but lags behind it if we compare the zero values.

The very sharp peaky form of these curves is quite different from the form of the curves of the Mordey alternator taken under the same circumstances. By the multiplication of the instantaneous values of current and electromotive force at corresponding intervals the watt curve of both cases can be drawn.

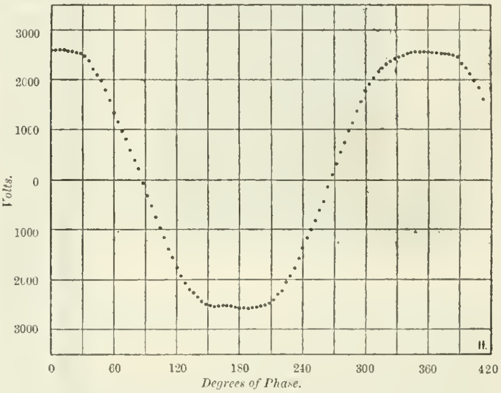

Fig. 11.—Resultant Electromotive Force Curve of Thomson-Houston and Mordey Alternators, working in parallel at Bankside.

In Fig. 11 is shown the resultant electromotive force curve when one Thomson-Houston 350-kilowatt alternator is working in parallel with one A 20 Mordey alternator on no load. The form of the curve seems to indicate that the "predominant partner" in this case is the Mordey machine.

The above is merely a selection from a large number of curves which have been taken at the Bankside station, and which are in process of being examined. The information which they reveal about the internal working of the machines is very interesting, and shows that this curve tracer will be of great use in examining the behaviour of alternators. Amongst other things, it has been established without doubt that a water resistance constitutes a perfectly non-inductive load for a 2,000-volt alternator, an assumption which has generally been made and which proves to be perfectly correct. In a continuation of this Paper we shall proceed to discuss the various methods for shortening this process for taking the indicator diagram of an alternator. At the present time, owing to the sluggishness of the voltmeter and the time required to charge the condenser associated with it to supply leakage, the operation of taking a curve is one which lasts from two to three hours or more, according to luck; but there appears no reason to doubt but that it can be reduced to ten minutes or a quarter of an hour, and that the process may ultimately become quite as easy to perform as that of taking the indicator diagram of an engine.

(To be continued.)

THE HEADLAND GRID.

Of the many devices to mitigate the internal strains consequent on heavy charges and discharges of secondary cells, one of the latest is to do away with "plates." Perforated cylinders, containing the active material, have been adopted by Dr. Tommasi of Paris; and Messrs. H. and E. Headland, of Leyton, Essex, have for some time past been making cells, the "plates" of which are composed of rows of rectangular "gridded" tubes burnt top and bottom to connecting strips. Cells of this type have been supplied for tramcar and omnibus lighting, and a very compact form is now being introduced for miners' lamps. "Plates" of this kind certainly make a highly flexible job, and afford great facility for the diffusion of the acid, a point the importance of which has only comparatively recently been fully recognised.

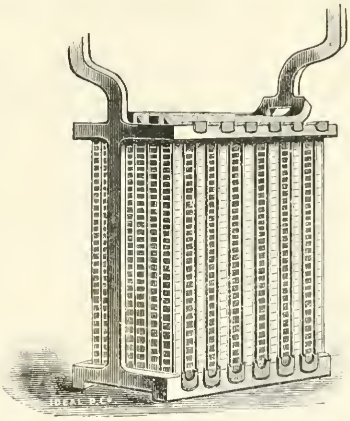

Fig. 1.

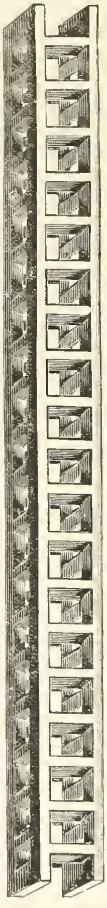

Fig. 2.

A Headland positive, weighing 5lb., may be discharged at the rate of 25 amperes, and at that rate has a capacity of 50 ampere hours. The 5lb. weight is made up as follows:—grid, 2lb. 11oz.; paste, 1lb., 8oz.; and connections, 10oz.

In Fig. 1 is shown a general view of a Headland cell, and in Fig. 2 a view of a single bar without paste.

Electric Service in Servia.—According to the *Engineer*, there are in Servia 378 miles of railway, 1,917½ miles of telegraph, and 200½ miles of telephone. In Belgrade, the capital, there are 12½ miles of tramways. The Franco-Servian Tramways Company inaugurated in June last their service of electric cars to Topchidere, a pleasure-resort district, about 3¾ miles from Belgrade, and a line almost encircling the town will shortly be completed for electric service. The Company has eleven electric cars, four being light ones for coupling to the ordinary cars, and all purchased from the Compagnie Française pour l'Exploitation des Procédés Thomson Houston, but two of the gradients on the line are so severe that the present power—about 30-horse—of each car has proved insufficient to draw two full cars, and consequently it has not been possible to run coupled cars. One of these steep gradients, with a rise of 1 in 13·13, is close to the Café London, and the other, with a rise of 1 in 11·11 on a 98ft. 6in. curve, is situated between the River Tave and the Kalemegdan. The Company expects to procure new electric motors early this year to furnish 50 H.P. power per car, which will be sufficient for all purposes.

PROPAGATION OF MAGNETISATION OF IRON AS AFFECTED BY THE ELECTRIC CURRENTS IN THE IRON.[*]

BY J. HOPKINSON, F.R.S., AND E. WILSON.[†]

It is not unfamiliar to those who have worked on large dynamos, with the ballistic galvanometer, that the indications of the galvanometer do not give the whole changes which occur in the induction. Let the deflections of the galvanometer connected to an exploring coil be observed when the main current in the magnetic coils is reversed. The first elongation will be much greater than the second in the other direction, and probably the third greater than the second—showing that a continued current exists in one direction for a time comparable with the time of oscillation of the galvanometer. These effects cannot be got rid of, though they can be diminished by passing the exciting current through a non-inductive resistance, and increasing the electromotive force employed. This, if carried far enough, would be effective if the iron of the cores were divided so that no currents could exist in the iron; but the currents in the iron, if the core is solid, continue for a considerable time and maintain the magnetism of the interior of the core in the direction it had before reversal of current. It was one of our objects to investigate this more closely by ascertaining the changes occurring at different depths in a core in terms of the time after reversal has been made.

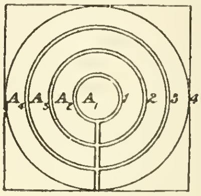

Fig. 2.

The experiments were carried out in the Siemens Laboratory, King's College, London, and the electromagnet used is shown in Fig. 1 [‡] It consists in its first form of two vertical wrought-iron cores wound with 2,595 and 2,613 turns respectively of copper wire—the resistance of the two coils in series being 16·3 ohms. The yoke is of wrought iron 4in. square in section and 2ft. long. The pole pieces are of wrought iron 4in. square, and all surfaces in contact are truly planed. One of the pole-pieces is turned down at the end, which butts on the other pole-piece for half an inch of its length to a diameter of 4in.; and three circular grooves are cut in the abutting face having mean diameters of 2·6cm., 5·16cm., and 7·75cm. respectively, for the purpose of inserting copper coils, the ends of which are brought out by means of the radial slot shown in Fig. 2. When the pole-pieces are brought into contact, as shown in Fig. 1, we have thus three exploring coils within the mass, and a fourth was wound on the circular portion outside. These exploring coils are numbered 1, 2, 3, 4 respectively, starting with the coil of least diameter.

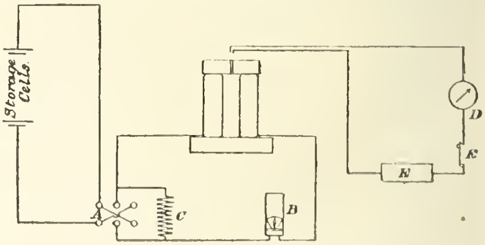

Fig. 3.

Fig. 3 gives a diagram of the apparatus and connections, in which A is a reversing switch for the purpose of reversing a current given by 10 storage cells through the magnet windings in series; B is a Thomson graded galvanometer for measuring current; and C is a non-inductive resistance of about 16 ohms, placed across the magnet coils for the purpose of diminishing the violence of the change on reversal. The maximum current given by the battery was 1·2 amperes. A D'Arsonval galvanometer, D, a resistance box, E, and a key, F, were placed in circuit with any one of the exploring coils, 1, 2, 3, 4, for the purpose of observing the electromotive force of that circuit. The method of experiment was as follows: The current round the magnet limbs was suddenly reversed, and readings on the D'Arsonval galvanometer were taken on each coil at known epochs after the reversal. The results are shown in Fig. 4.‡

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[*] Abstract of a Paper read before the Royal Society.

[†] The experimental work of this Paper was in part carried out by three of the student demonstrators of the Siemens Laboratory, King's College, London, Messrs. Brazil, Atchison, and Greenham. We wish to express our thanks to them for their zealous co-operation.

[‡] The figures marked with ‡ are not reproduced in this abstract. The reader is referred to the original Paper.

The general character of the results was quite unexpected by us. Take coil No. 2 for example, the spot of light, on reversing the current in the magnet winding, would at once spring off to a considerable deflection, the deflection would presently diminish, attaining a minimum after about six seconds; the deflection would then again increase and attain a maximum greater than the first after eight seconds, it would then diminish and rapidly die away.

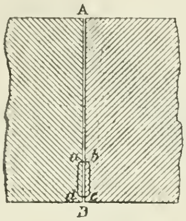


Fig. 5.

To attempt a thorough explanation of the peculiarities of these curves would mean solving the differential equation connecting induction with time and radius in the iron with the true relation of induction and magnetising force. But we may inversely from these curves attempt to obtain an approximation to the cyclic curve of induction of the iron.

The attempt to obtain an approximation to the cyclic curve of induction from the curves in Fig. 4 was a failure; that is to say, the resulting curve did not resemble a cyclic curve of magnetisation. This is due to imperfections of fit of the two faces, in one of which the exploring coils are imbedded. That this imperfection of fit will tend to have a serious effect upon the distribution of induction over the whole area is obvious on consideration. Take the closed curve *a b c d* in Fig. 5, where A B is the junction between the pole-pieces. If the space between the faces was appreciable, the force along *b c* and *a d* in the iron could be neglected in comparison with the forces in the non-magnetic spaces, *a b*, *c d*. The magnetising force is sensibly $4\pi c$, where *c* is the current passing through the closed curve. This may be made as small as we please. Therefore the force along *a b* is equal to the force along *d c*. In our case the space between the faces is very small, but has still a tendency towards an equalising of the induction per unit area over the whole surface.

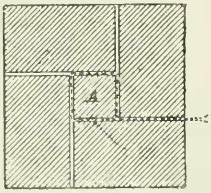


Fig. 6.

To test this the following experiment was tried. At a distance of 2½in. from the abutting surfaces of the pole-pieces four holes were drilled in one of the pole-pieces in a plane parallel with the abutting surfaces, as shown in Fig. 6. By means of a hooked wire we were able to thread an insulated copper wire through these holes, so as to enclose only the square area A, which is bounded by the drilled holes and has an area of 0·61 sq. inch. The wire is indicated by the dotted lines. Fig. 7 gives two curves taken by the D'Arsonval in the manner already described for a reversal of the same current in the copper coils of the magnets. No. 1 (Fig. 7) is the curve obtained from No. 1 coil (Fig. 2) near the air space. No. 2 (Fig. 7) is the curve obtained from the square coil shown in Fig. 6. The difference is very marked, and shows at once the effect of the small non-magnetic space which accounts for the large initial change of induction previously observed on the coils 1, 2, 3 in Fig. 4. Similar holes were drilled in the yoke of the magnet in a plane midway between the vertical cores, having the same area of 0·61 sq. inch; and on trial exactly the same form of curve was produced as is shown in No. 2 of Fig. 7.

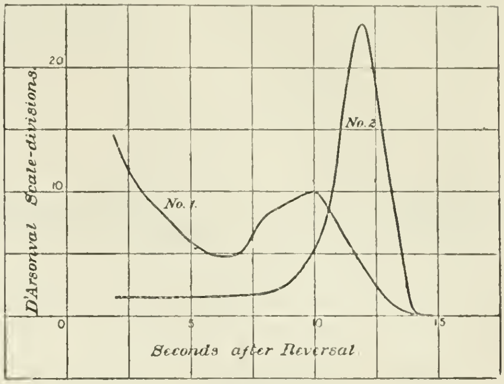


Fig. 7.

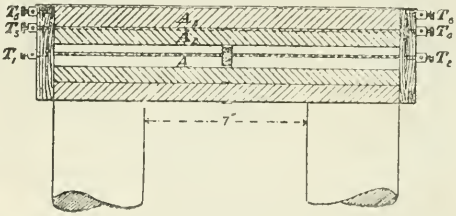


Fig. 8.

Whilst the above experiments were being made, the portion of the magnet to take the place of the pole-pieces previously used was being constructed as follows:—In Fig. 8 the portion of the magnetic circuit resting upon the vertical cores consists of a centre rod, A_1, of very soft Whitworth steel surrounded by tubes, A_2, A_3, of the same material. The diameter of A_1 is 1in. The outside diameter of A_2 is 2½ in., and A_3 is 4in. outside diameter between the cores of the magnet, but is 4in. square at each end where it

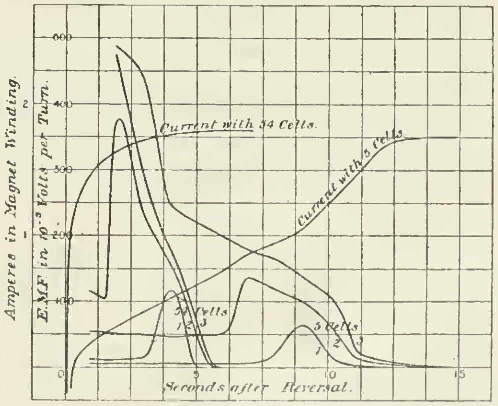


Fig. 9.

rests upon the magnet limbs. At the centre of the rod A_1 (longitudinally) a circular groove is turned down 1mm. deep and 5mm. wide, and also a longitudinal groove 1mm. deep and 1mm. wide is cut as shown in the figure for the purpose of leading a double silk-covered copper wire from terminal T_1 to nine convolutions at the centre and along the rod to terminal T_2. A similar groove is cut in the outside of the tube A_2, and a copper wire is carried from terminal T_3 to nine convolutions round the centre of the tube again along the groove to terminal T_4. Nine convolutions were also wound round the outside tube A_3, the ends of which are connected to the terminals T_5, T_6 respectively.

The magnetising coils on the magnet were placed in parallel with one another, and a total current of 1·75 amperes (that is, 0·87 ampere in each coil), due to five storage cells, was reversed through the coils. The arrangemrnt of apparatus is shown in Fig. 3, except that the pole-pieces are replaced by the soft steel tubes shown in Fig. 8, and the non-inductive resistance C is removed. We have now three exploring coils instead of four, and these are marked 1, 2, 3 respectively, starting with the coil of smallest diameter. For the purpose of obtaining the current curve, the D'Arsonval was placed across a non-inductive resistance of $\frac{1}{8}$ ohm in the circuit of the magnetising coils. Fig. 9 gives a set of curves obtained with the five cells, and also another set obtained by a reversal of 1·8 amperes given by 54 cells a non-inductive resistance being placed in the circuit to adjust the current.

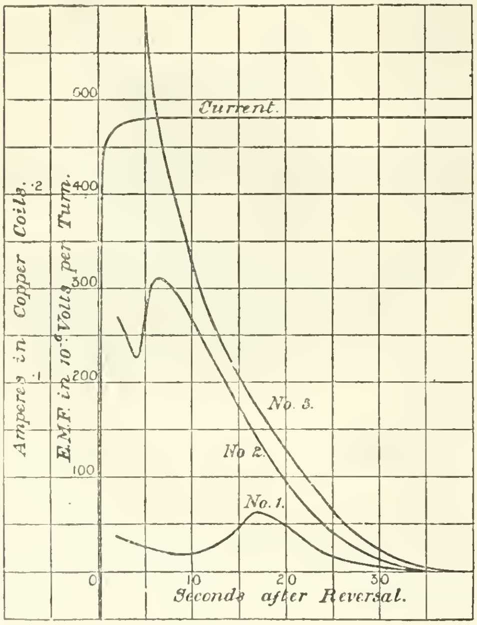


Fig. 12

Table I. gives a list of the experiments made with total reversal of current due to 54 cells, the magnetising coils being kept in parallel with one another, and the magnitude of current through them adjusted by means of a non-inductive resistance.

Table I.

—	Maximum amps. in magnetising coils.	Maximum force in C.G.S. units. H	Maximum induction per sq. cm. B
Fig. 10	0·0745	1·7	
„ 11	0·138	3·0	
„ 12, Table II.	0·24	4·96	8,000
	0·49	10·1	12,820
„ 13, „ III.	0·774	16·0	14,495
„ 9, „ IV.	1·80	37·2	15,480
	2·31	47·6	
	6·5	134·5	

In Fig. 12 the maximum current in the copper coils is 0·24 ampere, corresponding with a force in C.G.S. units of 4·96. The current in the copper coils has attained its maximum value at about 4sec. after reversal, and changes of induction were going on up to 35sec.

The results shown in Fig. 12B have been obtained as follows:—Take curve 1, Fig. 12B; the electromotive force curve of coil 1, Fig. 12, has been integrated, and the integral up to the ordinate corresponding to any time is equal to the total change of the induction up to that time, which divided by the area of the coil in square centimetres gives the average induction per square centimetre. In obtaining the areas we had to assume the path of the electromotive force curve up to 2sec.; but this we can do with a good deal of certainty.

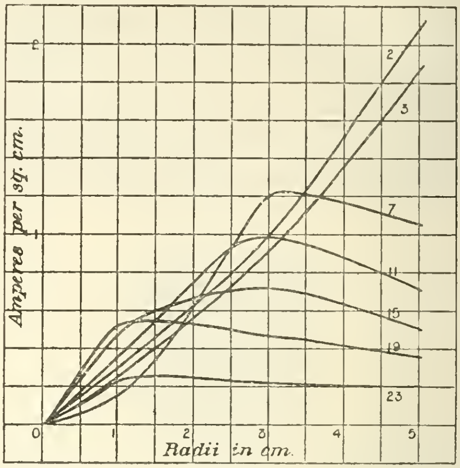


Fig. 12A.

The results, both of these experiments and of those which follow, have a more general application than to bars of the particular size used. From the dimensions of the partial differential equation which expresses the propagation of induction in the bar, one sees at once that if the external magnetising forces are the same in two bars differing in diameter, then similar magnetic events will occur in the two bars, but at times varying as the square of the diameters of the bars.

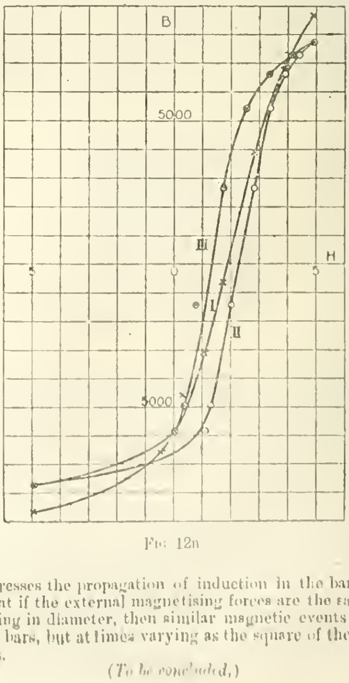


Fig. 12B

(To be concluded.)

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *February 2, 1895.*

Electrocution in New York.—The positive statement made by D'Arsonval last year to the effect that electrocution, as practised in New York State, does not produce true death, was the cause of reopening discussion on the subject of the use of electricity for criminal executions, much to the annoyance of the electrical fraternity. The opportunity for sensationalism thus afforded was not neglected by the newspaper press, and furnished a welcome occasion to seekers of notoriety. Among the latter was one P. J. Gibbons, a provincial doctor, who claimed that he could revive an electrocuted criminal by means of an apparatus of his invention, which was widely illustrated in the newspaper press, and appeared to be simply a double bellows for producing artificial respiration. In order to set at rest a most distressing subject, the State authorities finally concluded to invite a committee to witness an electrical execution, whose report would be accepted as authoritative by the public; and Mr. A. E. Kennelly and Dr. Augustin H. Goelet were requested to act in this capacity, which they did at the execution of a negro on January 28th. The results of the observations of these gentlemen are decisive as to the efficacy of this method of producing death, and definitely dispose of the sensational statements of D'Arsonval. They report that death was instantaneous and painless, and necessarily so, as nearly all of the blood in the body of the subject was drawn into the head and upper part of the chest and neck, causing numerous ruptures of blood vessels in the head, neck, and brain.

The Niagara Transmission.—The Niagara Cataract Company is meeting with some difficulty in securing permission under reasonable terms for the introduction of the Niagara current into the city of Buffalo. The city authorities wish to fix the price at which power is to be sold, and in the discussion that has followed these gentlemen have been unable to distinguish between the widely-varying statements made as to the minimum cost of steam power and the figure to which they propose to limit the charges of the Niagara Company. In the meantime the Niagara people are rapidly pushing to completion the 15,000-H P. plant which is to supply the demand for current in the vicinity of the Falls, and it is beginning to dawn upon the citizens of Buffalo that in the attempt to drive too hard a bargain they may be seriously injuring their city by assisting in building up a manufacturing rival at Niagara. It is therefore probable that before long we may see Buffalo change places with the Niagara Company as a suppliant, of which indications are already apparent.

February 8, 1895.

Meeting of the National Electric Light Association at Cleveland.—The annual convention of the National Electric Light Association, to be held at Cleveland, Ohio, next week, promises to be one of interest, if we are to judge from the list of papers to be read. Among these are a Paper by Messrs. Houston and Kennelly on "A New Method of Measuring Illumination." Others are: "On Arc Carbons and the Rating of Arc Lamps," by Prof. L. B. Marks; "On the Storage of Energy in Central Stations," by N. W. Perry; "Some Economies in Electric Light and Power Stations," by Edward Weston; and "On High Tension Underground Circuits," by E. A. Leslie. The programme also includes commercial Papers on large arc dynamos and the mono-cyclic system, and we note two that have already done yeoman's service elsewhere—"On Lightning Arresters," and "Automatic Cut-Outs.

The Brooklyn Strike.—This is now ended as far as the operation of cars is concerned, but wires are still being cut nightly. A resolution by the Board of Aldermen revoking the permission given to use electric traction has been vetoed by the Mayor, though had he signed it the revocation could have had no legal effect. An important result of the strike will probably be to make a definite issue in this country of the municipalization of urban means of transportation.

Electrical Transmission of Power.—This is rapidly coming to the front, though at present many of the projects brought forward are merely in the promotion stage. Among the water powers recently spoken of in this connection are one in Pennsylvania, near Harrisburg, of 50,000 H.P.; one near Atlanta, Ga., of 30,000 H.P.; one near St. Louis, Mo., of 25,000 H.P.; and one 16 miles from Washington, of 15,000 H.P.

CORRESPONDENCE.

◆

THE BORCHERS BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Dr. Borchers' long-looked-for statement in defence of his element having appeared in No. 15 of the *Zeitschrift für Elektrotechnik und Elektrochemie*, a few further remarks on the subject in connection with it may be of interest.

Passing over in utter silence the hydrochloric combination, with which, it will be remembered, he originally obtained the best results, he deals exclusively with the processes in a cell with ammonia as solvent, and advances the following equations as of primal importance:—

$$Cu_2Cl_2CO + 4NH_3 + 2H_2O = Cu_2 + 2NH_4Cl + (NH_4)_2CO_3. \quad (1)$$
$$Cu_2Cl_2CO + H_2O = Cu_2 + 2HCl + CO_2 \quad . \quad . \quad . \quad (2)$$
$$Cu_2Cl_2 + 2HCl + O = 2CuCl_2 + H_2O \quad . \quad . \quad . \quad . \quad . \quad (3)$$
$$2CuCl_2 + Cu_2 = 2Cu_2Cl_2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Eliminating from (1), a generally accepted equation, "all that does not really change," he deducts (2), and from (2)—(4), which are given without taking account of the presence of ammonia, he concludes that the sum total of *all* the reactions amounts practically to $CO + O = CO_2$.

Now, (2) is contrary to facts, and can only stand as (1) with NH_3 in abundance, in which case $(NH_4)_2CO_3$ is the final product of the element, and not CO_2 as such. This is a most vital difference, and not to be overlooked; but it is by no means the only vulnerable point.

It will be seen from (1), (3), partially altered, and (4) that theoretically no copper is consumed; but then (3) is only one of many ways in which higher salts can be formed, among others being, for instance,

$$3Cu_2Cl_2 + 3O = Cu_4Cl_2O_3 + 2CuCl_2.$$

It is, therefore, evident that, not being able to confine chemical action to the processes given in (1)—(4), the copper plates will be attacked by the $CuCl_2$ formed in other ways, and this with telling effect, as the salts resulting from (1) greatly facilitate corrosion.

Taken as a whole, Dr. Borchers' article contradicts his former statements, as his own equation (1) not only gives $(NH_4)_2 CO_3$ and not merely CO_2 as final combination, but he also says: "It must be left to future experiments to decide if elements (Betriebs-elemente) can be constructed in which copper is not attacked," whereas four months ago he laid great stress on the fact that no noticeable decrease in weight was ever observed.

From the above it will appear that it was premature to say his cell would undoubtedly remain prototype.—I am, Sir, &c.,

H. H. BARNES, JUN.

Stuttgart, Kriegsbergstrasse 21, Feb. 7, 1895.

Dr. Borchers has replied in a recent number of the *Zeitschrift für Elektrotechnik und Elektrochemie* to the criticisms which have been advanced on the cell devised by him for the direct production of electrical energy from the energy of gaseous fuel, and, seeing that the matter has led to a considerable amount of discussion in our correspondence columns we append a translation of his letter defending his position.

On the Reactions in the Borchers Cell.

A reference appears in this journal (*Zeitschrift für Elektrotechnik und Elektrochemie*) under the above heading, dealing with a criticism by Mr. Reed of my Paper read before the German Electro-Technical Society, or perhaps of an imperfect translation of it. I need not here repeat the objections urged by Mr. Reed, but may deal with them at once as follows:—

1. With regard to the confusion which Mr. Reed supposes me to have made between cuprous chloride and metallic copper,

I need do little but repel the insinuation as absurd. The behaviour of a solution of carbon monoxide in cuprous chloride is thus described by C. Winkler in his text-book on technical gas analysis:—

"For the absorption of carbon monoxide a solution of cuprous chloride is used, with which the gas forms a compound Cu_2Cl_2CO. The cuprous chloride can be used either in acid or ammoniacal solution; but the latter is generally to be preferred, as the carbon monoxide in presence of excess of ammonia gradually yields ammonium carbonate and metallic copper, which is deposited on the walls of the absorption vessel. The reaction takes place according to the equation,

$$Cu_2Cl_2CO + 4NH_3 + 2H_2O = 2Cu + 2NH_4Cl + (NH_4)_2CO_3;$$

and has as its result a continual suppression of the carbon monoxide absorbed, and also the protection of the solution from oxidation by the presence therein of the metallic copper which is correspondingly deposited."

2. I not only thoroughly recognise the possibility of the reaction expressed by the equation $O + Cu_2Cl_2 + 2HCl = 2CuCl_2 + H_2O$, but I have actually indicated that this equation is likely to occur primarily in the cathode compartment, as may be seen by reference to an article in the *Chemische Industrie*, XXII., November 15, 1894.

The final and sole product of my gas cell is never cupric chloride when its working takes place normally. We have seen above that carbon monoxide possesses the power of depositing copper from a solution of a cuprous salt, being itself oxidised to carbon dioxide, as may be demonstrated by taking the equation quoted above from Winkler, and eliminating all that is not essential to its occurrence. It then becomes

$$(\alpha)\ Cu_2Cl_2 + CO = Cu_2Cl_2CO, \text{ and}$$
$$(\beta)\ Cu_2Cl_2CO + H_2O = Cu_2 + 2HCl + CO_2.$$

Disregarding the presence of ammonia, a solution has been prepared by the action of carbon monoxide, capable, under certain circumstances, of depositing copper. These circumstances consist chiefly in the avoidance of the formation of too much free hydrochloric acid. Ammonia neutralises hydrochloric acid. The reaction given by Reed also needs hydrochloric acid, thus:—

$$O + Cu_2Cl_2 + 2HCl = {}^2CuCl_2 + H_2O.$$

If, then, we were to take this reaction to represent that occurring in the cathode compartment, and the former pair of equations for those taking place in the anode compartment and regard them as primary, or if we were to have in two vessels completely separated from one another cuprous chloride treated with carbon monoxide in the one and cuprous chloride saturated with air in the other, and were to unite these two liquids to form a circuit the reaction would then doubtless occur according to the equation $Cu_2 + 2CuCl_2 = 2Cu_2Cl_2$. In fact, a cell would be formed from the action of cupric chloride upon copper regarded as reduced by the carbon monoxide. I need scarcely cite an authority to justify the statement that cuprous chloride is formed by the action of cupric chloride upon copper, whether as actual metal or regarded as separated from solution. If, then, the four fundamental equations be added together, thus

$$Cu_2Cl_2 + CO = Cu_2Cl_2CO$$
$$Cu_2Cl_2CO + H_2O = Cu_2 + 2HCl + CO_2$$
$$Cu_2Cl_2 + 2HCl + O = 2CuCl_2 + H_2O$$
$$2CuCl_2 + Cu_2 = 2Cu_2Cl_2$$

their arithmetical sum will be found to be $CO + O = CO_2$.

3 and 4. These points have been in great measure dealt with. It is obvious that if carbon monoxide be absent, or present in insufficient quantity, the oxygen of the air will produce an undue amount of cupric chloride which will, of course, favour the solution of the copper as cuprous chloride according to the equation already quoted. It is not to be wondered at that approximately the same current can be obtained when carbon monoxide is not used, considering the small output of current and the possibility of the formation of copper and cupric chloride, but in that case the current is obtained at the cost of the copper composing the apparatus; that is, according to a method possible indeed but not proposed by me. Mr. Reed's remaining remarks can be dealt with together with those made by Mr. Robert Mond in No. 869 of *The Electrician*. The last-named investigator has experimented with various combinations and collected the results of his measurements in the following table:—

Anode.	Solutions.	Cathode.	Volts.
(1) Carbon ...	Hydrochloric acid, 25 per cent..........	Copper...	0·6006
(2) Carbon ...	Cupric chloride in hydrochloric acid...	Copper...	0·4655
(3) Carbon ..	Cuprous chloride in hydrochloric acid.	Copper...	0·3774
(4) Carbon	Carbon in copper oxychloride in HCl. Copper in cuprous chloride in HCl ...	Copper...	0·4315
(5) Carbon	Carbon in copper oxychloride in HCl. Copper in copper carbonic oxide chloride in hydrochloric acid.	Copper...	0·4407
(6) Carbon	Carbon in cuprous chloride in HCl and air. Carbon in cuprous chloride in HCl and carbonic oxide.	Carbon...	0·0015
(7) Carbon	Carbon in cuprous chloride in HCl and air. Carbon in cuprous chloride in HCl and coal gas.	Carbon...	0·0050

At the end of the table is the remark "these figures seem to me to throw a strange light upon the source of electricity in Dr. Borchers' cell." No details are given as to the method of carrying out the experiments; such details are especially to be desired for experiments 6 and 7. Experiments 1 to 5 support the view, already mentioned, that the first action of the oxygen at the cathode is to form cupric chloride, and the first action of the carbon monoxide tends to cause the separation of copper, so that the voltage measured is that proper to the action of cupric chloride on metallic copper. As regards experiments 6 and 7, I may say that I have not concealed that at first I worked with two carbon electrodes. But it very soon became clear to me that a carbon electrode is an excellent transferrer of oxygen, but does not similarly favour the solution of carbon monoxide; on the contrary, unless particular care be taken to remove all oxygen from a carbon plate previously exposed to air and to keep it free from contact with all air during the working of the cell, such a plate would, if only one part of it were in contact with the air, be capable of bringing oxygen directly, at the anode, to the carbon monoxide or to the copper regarded as separated thereby; to judge by the results, this appears to have happened in Mr. Mond's experiments. On account of these difficulties I have abandoned the use of a carbon electrode in the anode compartment; the exclusion of oxygen, which is necessary, would increase the technical difficulties of construction. When the use of copper is substituted for that of carbon, precautions must merely be taken so that the carbon monoxide prevents the attack of the copper thus employed. Whether that be possible in a large scale plant must be decided by further experiments. But yet another consideration restrained me from the use of two carbon electrodes. Mr. Mond has had the goodness to support my decision by his experiments quoted above. (1) According to his second experiment, the circuit "carbon—cuprous chloride—copper" gives a voltage of 0·3774. (2) On the other hand, however, according to the experience of all gas analysts, a solution of carbon monoxide in cuprous chloride tends to deposit copper. But if we examine the conditions of experiments 6 and 7 it is plain that there are three substances present in the anode compartment; viz., copper (regarded as separating from the solution), cuprous chloride, and carbon, which, according to Mr. Mond's second experiment, themselves constitute a cell. It is to be understood that I would not withhold any further experimental results whether favourable or the reverse. But I must ask for some consideration if delay occur. Besides my ordinary occupation, I have a good deal of literary work to be completed in the first half of this year, thus absorbing the whole of my time. I am therefore obliged to put off further experiments until I can give them my whole attention. I must beg those who make trial of my cell to turn to the original Paper, and not to trust to translations. I must also request those who publish experiments which are unfavourable in tendency to describe the conditions of experiment accurately. Discussion is otherwise valueless.

THE WELSBACH LIGHT: AN AID TO THE ELECTRIC LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: A good deal has been said and written lately with regard to the Welsbach gas burner as a possible rival to the electric light, and a number of correspondents interested in the progress of electricity have been anxious to draw the attention of the public to the disadvantages attending the use of the Welsbach. The question arises in my mind whether from an electrician's standpoint this is wise, for the incandescent gas burner is fulfilling a very useful purpose. It is training the public to the use of a better light than they have hitherto considered necessary, and any step in this direction is bound to prove advantageous to the electric light sooner or later.

There is no gainsaying the fact that the Welsbach burner gives more light for a given consumption of gas than was formerly considered possible, and when once used I question whether any consumer will be content to return to the old-fashioned burner. When, however, they have found out for themselves the drawbacks attending the use of this form of light, they will inevitably follow the example of many others during the past five years in adopting the electric light, which is the illuminant most conducive to health, luxury, and convenience.

I would suggest, therefore, that electricians should welcome the advent of the Welsbach gas as a means of arousing the well-known apathy of the British public, and an advance which is bound to react in favour of the electric light in the long run.—Yours, &c., Bernard Drake.

London, February 15, 1895.

PARALLEL RUNNING WITH GAS ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have noticed a short editorial in your issue of 15th on the running of alternators by gas at Coatbridge. You say with perfect truth "there is no need whatever to deduce from the Coatbridge failure that gas engines are unfitted for driving electric supply stations." Then you add, "the lesson which Coatbridge teaches is that parallel running of alternators must not be adopted in stations of this type."

I have an intimate acquaintance with the working at Coatbridge, and can assure you that the first engines supplied by the makers drove the alternators very well in parallel. The second sets would not drive them properly either singly or in parallel. The first set of engines were underpowered, the second set had some peculiar defects which were sufficient to condemn the engines, but have no bearing whatever on the general qualities either of gas engines or alternators.

If any lesson is to be deduced from Coatbridge it is that gas engines can be made to drive alternators successfully in parallel.—Yours, &c., J. S. Raworth.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of February 15th there are some editorial notes on the change of motive power at the Coatbridge Central Station, in the course of which it is stated that alternators of the type there employed present special difficulties in parallel running.

It is well known that these alternators are the Mordey machines. This is not the first time that similar statements have been made of the Mordey machines. No corroborative evidence has been adduced, however, and these statements are apparently merely based on opinion without experience, or on taking for gospel the allegations of trade rivals.

Since Mordey alternators are in daily use running in parallel in many stations, and since they run in parallel as smoothly and easily as direct-current machines, those engineers who are in charge of them can only express their astonishment at the dead set made at these machines by the technical Press, and ask the journals concerned to justify their condemnation of this type of A. C. plant for parallel working, or to admit that they have been mistaken.—Yours, &c., Henry M. Sayers.

Bournemouth and District Electric Supply Company (Ltd.),
Bournemouth, February 19, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The Editorial Note in your issue of 8th inst., referring to what is therein described as "a result which might well have been expected by anyone familiar with the difficulties of running alternators (especially those of a certain type) in parallel" will cause some surprise to central-station engineers and others conversant with the running of alternating-current plant. It will doubtless interest your readers to know that your views on the subject are not borne out by the experience of the running of at least one central station.

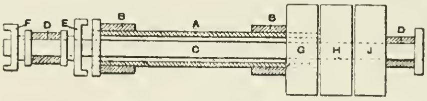
At the Worcester Corporation Electricity Works the alternators have been daily and regularly run in parallel since the opening day. We work under various conditions of driving—with steam or water power, or a combination of the two. There has never been the slightest difficulty as regards parallel running. The machines work perfectly in parallel.—Yours, &c.,

S. A. Mahood (Resident Engineer)

Worcester, February 20, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Your remarks as to the abolishing of the gas plant at Coatbridge, in consequence of the impossibility of running the alternators in parallel, lead me to enclose you particulars of a method I proposed some little time ago for entirely getting over all difficulty in regard to parallel running, and at the same time introducing the very great advantages that any engine can drive any alternator, and that a fresh engine can at any time be brought up to speed, and started without delay and without a self-starter. I may point out that, instead of the three pulleys shown in the sketch, one pulley would suffice if arranged so as to run loose or be clutched to either shaft at will. This would allow of rope-driving. In the illustration A is the hollow shaft of the alternator running in bearings B B; C is the central shaft running in bearings D D; E is a claw-clutch for connecting the shafts A and C; and F is a similar clutch for joining together two lengths of shaft C; G H J are three pulleys, G being on the shaft A, and J on the shaft C, while H runs loosely between them.—Yours, &c.



60, Castle-street, Liverpool, Feb. 19, 1895. W. S. Boult.

THE KENSINGTON COURT FIRE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: While much appreciating the reference to my name in your graphic account of the Kensington-court fire, I desire in justice to state that I consider that it should not have received any more prominence than those of several others who happened to be present, and whose identity is unknown to me, and I am much pleased to note that the conspicuous gallantry of two of the firemen has been officially recognised.—Yours, &c.,

Morgan I. M. Williams.

39, Victoria-street, S.W., February 20, 1895.

LEGAL INTELLIGENCE.

Cassell Gold Extracting Company (Limited) v. Cyanide Gold Recovery Syndicate (Limited).

In the Court of Appeal, before Lord Halsbury and Lords Justices Lindley and Smith, this action has been heard, and has occupied the Court the whole of the week. The plaintiffs claim that the defendants have infringed the McArthur-Forrest patent rights, of which they are the owners. In November last Mr. Justice Romer gave his judgment for the defendants. Against this decision the plaintiffs now appealed.

Sir RICHARD WEBSTER, for the plaintiffs, said that the question at issue was of immense commercial importance, and submitted that Mr. Justice Romer had not sufficiently applied the principle of law as laid down by the House of Lords and by the Court of Appeal, namely, that in order to destroy and invalidate a patent, you must get out of the prior anticipations such practical knowledge as would enable an ordinary skilled workman to carry out the process described in the patentee's specification. The plaintiffs' patent was of the highest utility, and yet it was said that the knowledge was as old as the days of Faraday, and that the fact that there was such knowledge was sufficient to invalidate the patent. The process claimed by the plaintiffs was the recovery of gold from tailings or waste which for centuries had been allowed to go free. The amount of gold so allowed to go to waste was small in percentage, but very large in bulk, and some idea of the value of gold to be recovered from tailings might be obtained from the fact that, since 1887, by the employment of the plaintiffs' process, from £1,000,000 to £2,000,000 sterling of gold had been recovered. There was long ago the fundamental knowledge that gold could be recovered by means of cyanide of potassium, but that knowledge was never put to practical use. Cyanide of potassium had a dissolving action upon gold, upon the precipitate of gold, and upon gold leaf. That knowledge was old, but had not been turned to useful commercial purposes until the plaintiff company turned it to account. The whole of the anticipation suggested by the defendants was a mere paper anticipation.

Lord HALSBURY: I thought that aqua regia was the strongest dissolvent of gold?

Sir R. WEBSTER: Certainly; but aqua regia is a combination, and if tried on the ore would fail, because it would be found that it acted also on the other metals—that was the great disadvantage of the combination. All that was wanted was to get the gold, and for that purpose a solution, but only a weak solution, was wanted. Gold was previously extracted by two processes known as the amalgamation and the chlorination processes. He relied very much on the evidence of Mr. McArthur, the patentee, for showing the state of knowledge at the date of the patent. Mr. McArthur stated that he experimented three times over with ores brought from different mines in various parts of the world before he learnt what was the action of cyanide of potassium for gold extracting. He found that in each of the three cases extraction was commercially complete, and he had no knowledge that cyanide of potassium could be applied as he subsequently applied it. He also experimented with regard to the strength of the solution, and found that, with a strength of 1 per cent. within a working margin, he got the best results. This weak solution of 1 per cent. had a selective action with the extraction of gold, and as the solution became stronger the selective action became impaired. With regard to the Pielsticker process, it was unfair to the patentee to say that his invention was not new because of the laboratory knowledge that cyanide of potassium had some solvent action. Infringement was not disputed by the defendants. In the action before Mr. Justice Romer, at the end of the plaintiffs' case, and after the evidence of Lord Kelvin and others, the plaintiff offered at once, at the suggestion of the learned judge, to have further experiments made with the defendants' process. The only defence for a long time was the alleged anticipations. The defendants' process was brought out by Mr. Pielsticker, who came to England for that purpose, and published opinions that his process was not an infringement. Although the process was to some extent worked in secret, the plaintiffs managed to obtain some information about it. Mr. Pielsticker used practically the same strength of cyanide of potassium as the plaintiffs did to dissolve the gold. He then ran the liquid off from the tank into another tank, and in that other tank he redeposited the gold by electricity on iron, and then got the gold off. But, in addition to this, Mr. Pielsticker sent an electric current through the bath, and this was supposed to be a distinction. This, if established, might have given a different aspect to the case. The defendant said "It was an error to suppose that they were using cyanide of potassium in order to dissolve gold out of the ore. What they were doing was this: They had got an anode below and a cathode at the top and were sending an electric current through the bath in which they put the crushed ore, which is then stirred about with a solution of cyanide of potassium. The result is that muddy water goes into the box and the liquid comes into the tank where it was deposited by electricity, and the gold was got off." The defendants' case came to this—that they were not operating by cyanide of potassium at all, but were carrying on an electrical separation, which was the development of an old patent by Rae. If this distinction had been made out, and had not been contradicted, it would have been a very substantial point of attack; but it had not been made out. The defendants were working their process by cyanide of potassium plus electricity, and Lord Kelvin and others who had made experiments had stated that in the process there could be no electrical action. It was shown that identically the same amount of action went on if cyanide of potassium were used, with electricity or without it; so that the use of electricity did not alter the question of infringement. No one denied that gold could be got out of this solution by electricity, and all that the defendants were doing was to apply an old and well-known process of re-depositing out of solution by the old process of chemical deposition on plates of metal put in the bath. The plaintiffs' patent was for obtaining a solution of gold from ore by an improvement in the zinc method. As to Simpson's specification, on which so much reliance was placed by the defendants, the only evidence given by them that Simpson's would act was one experiment, whereby one-thousandth part of a grain was got from two small pieces of ore. Whether that was an extraction of commercial value or not he could not say. The plaintiff's specification was taken out in 1885, and had been in general use in South Africa, and although the royalties paid had amounted to an enormous sum there had been no evidence adduced with the purpose of showing that Simpson's patent had been or could be used. It could not be of utility, because it was absolutely impossible to precipitate gold on zinc, or under the conditions named in the specification. That being so, Simpson's patent was not an anticipation within the principle laid down by the House of Lords. Simpson had written down what he thought pointed to the fact that cyanide of potassium and carbonate of ammonia could be used commercially as a solvent; but there was absolutely no evidence of its use in any part of the world, and they were therefore face to face with the question whether any useful patent or discovery had been invalidated by a mere paper anticipation.

Lord HALSBURY: I think it may be said with reference to chemical patents that the exact directions contained in the specifications are most important, because even a very small difference may determine the success or non-success of the patent.

Sir RICHARD WEBSTER was grateful for the observation, because in this case the plaintiffs' patent could commercially treat 2dwt. of gold to the ton, valued at 9s. Simpson put gold in the same category as the baser metals. As to the treatment of Australian ores, from beginning to end no suggestion has ever been made that prior to the McArthur-Forrest patent, of which the plaintiffs were the owners, any process had ever been commercially applied or used in Australia. There were instances of laboratory experiments in 1884 and 1885, but they failed, and there was no commercial use in Australia until long after the date of the plaintiffs' patent.

Sir EDWARD CLARKE (for the defendants): We say the cyanide process was applied in Australia in 1884-5—prior to the plaintiff's patent. The ores were such that the process failed to deal with them satisfactorily from a commercial point of view. The process is, however, applicable to South African ores.

Sir RICHARD WEBSTER: Taking Simpson's patent no one pretended that as described in the specification it would work. The argument was that any person conversant with the subject taking Simpson's specification would do precisely what the plaintiff had done, but the fact remained that no one had done what the plaintiff had succeeded in doing, and he was, therefore, entitled to the merit of his invention. The short answer to the defence that Simpson's was an anticipation was that the defendants themselves were not using Simpson's patent, which, in fact, was simply an abandoned experiment. The problem in 1884 was not merely dissolving gold in ore; if that had been so any experienced chemist or assayist would have solved it. The problem was to recover the gold in the shape of metallic gold as it came away with the sludge, just in the same way as the silver plater obtained his silver from a solution. This problem was solved by the plaintiff with such good commercial results that 2dwt. of gold, worth 9s., were recovered from a ton of ore. Mr. MacArthur did not use electricity or any substitute, which both Rae and Simpson believed to be absolutely necessary.

Mr. FLETCHER MOULTON (also for the plaintiffs): With regard to Simpson's specification, the real question was, was it practical and would it work? The answer was that it was neither the one nor the other. Persons might have gone on experimenting with Simpson's process down to the present day, and failing without knowing why, unless they did something, which McArthur did, and so produced a new invention. If Simpson's process was an anticipation, how was it that no one had adopted it, and so saved the royalties?

Sir EDWARD CLARKE supported the decision of the Court below, and hoped to be able to convince their Lordships that the judgment was right both in law and fact. In one respect the utility of the plaintiffs' patent was not denied, for no one doubted now that the use of cyanide of potassium in extracting gold from a solution or tailings or finely powdered ore was very useful; but a great deal was left to individual judgment and experience to decide what strength the cyanogen should be in order to obtain the desired result. The claim made by the plaintiffs was for any solution containing cyanogen, or any cyanide soluble in water (such as cyanide of potassium), or any other substance or compound containing or yielding cyanogen. There was no application of machinery, or device, or scheme of any kind required. All that was needed was to pour the solution on the ore, stir it about or not, and let the solution do its work. The patent was not to be tested by its practical, commercial, or industrial success, and yet it was on these grounds that the plaintiffs' claims were principally based. At the date of the plaintiffs' patent (1885) it was well known that a solution of cyanide of potassium would solve gold in a fine state, and that the finer the gold the more speedy the process, and in 1867 Rae took out his patent in the United States for the extraction of gold from powdered ore, and in 1884 Simpson took out his patent for the same purpose, also in the United States; and it was knowledge common to scientific men in 1885 that cyanide of potassium was the solvent of fine gold, there was not much invention on his part in applying such knowledge. The evidence given at the trial of the action showed that Prof. Faraday published in his works some of the results which weak solutions of cyanide of potassium had on finely powdered gold. The plaintiffs originally set up a true selective action; but that was apparently abandoned in the court below, and now a very different kind of action was set up. Prof. Dewar, Prof. Austin, Prof. Crookes, and Lord Kelvin all said that they had not tried experiments; but it was a matter of abstract knowledge that a strong solution would dissolve in a different order to a weak solution. A weak solution would attack gold and silver first; a strong solution would attack the iron and copper compounds and sulphides, and so protect the attack on the gold. That being so, the selective action would be quite the other way.

Lord HALSBURY: A strong solution would bring out all the baser metals, and the effect of that would be to prevent the gold being dissolved.

Sir E. CLARKE: A strong solution, according to Prof. Crookes, would not attack the gold simultaneously, and the sulphide-iron surface would prevent the gold being so readily attacked. The plaintiff's patent would be bad if all he had to do was to ascertain the degree of strength to be employed to bring gold into solution from the powdered ores, because there was a known law and a known solvent.

Lord HALSBURY: Is not that assertion a little too broad? Take gunpowder. It is known that sulphur, saltpetre and charcoal make gunpowder. Surely the man who discovered the proportion of the different quantities which produce the most effective explosive would be entitled to protect his discovery by a patent.

Sir E. CLARKE: Gunpowder is a compound; but here the only question is one of the degree of strength. A man reduces the strength of his solution by the addition of water, and when he arrives at a satisfactory result he takes out a patent; and can it be suggested that, having before him the operation of a known law and of a known solvent, his patent would be good? Prof. Crookes says it was known that a strong solution would act differently to a weak solution, which is simply as much as to say that a great heat would have a different effect than a small heat.

Lord Justice LINDLEY: Professor Crookes said in his evidence that until a few years ago he was not aware of the solvent action of cyanide of potassium on ores.

Sir E. CLARKE: Up to 1876, when Rae's patent was taken out in the United States, we had no specific mention in literature of the application of this solution to ore. This patent was claimed as an anticipation of McArthur's patent, because it made known that gold ore could be solved by a solution of cyanide of potassium, and then extracted pure by means of an electric current, the learned counsel admitted that the electric current which formed part of the defendants' process was not necessary, and that that part of the case was abandoned in the court below, the defendants paying the costs incurred in consequence of their having set it up as the material defence. The great objection taken by the plaintiffs to this patent was that it was an electrical process; but that objection did not apply to Simpson's, into which electricity did not enter. Simpson's specification claimed to be a new process for separating gold and silver from their ores by subjecting the crushed or powdered ores to a solution of cyanide of potassium and carbonate of ammonia, and then precipitating it.

Mr. NEVILLE, Q.C. (also for the defence): The plaintiffs must take their patent for one of two things—either for the extraction of gold ore by a solution containing cyanogen, or, secondly, for a dilute solution of cyanogen containing mixtures. In the first place, there was clearly anticipation, for it was well known that a solution containing cyanogen would extract gold from ore; and in the second place, the patent failed because the patentee did not show the selective action of a dilute solution. If the plaintiffs succeeded, then they would take away from the public the right of using cyanogen in any form for extracting gold out of ores, and this would give them a monopoly of a very important and far-reaching character. It had been frequently asked during this action whether there had been any attempt in this country to carry out the extraction of gold by cyanogen solutions commercially. The answer was "No," and for a very good reason, for, with the exception of Mr. Pritchard Morgan's mining efforts in Wales, there was no gold industry in England.

The case was continued yesterday (Thursday).

Youngs v. Morris and Bastert.

In the Court of Appeal on Wednesday the Master of the Rolls and Lord Justices Lopes and Rigby heard an appeal from the decision of Mr. Justice Charles at the Birmingham Assizes. The action was brought by Messrs. Youngs, of Birmingham, against Messrs. Morris and Bastert, of London, for infringement of the patent pulley-block and hoisting tackle. Mr. Justice Charles had found for the plaintiffs. After the evidence the Master of the Rolls said that he came to the conclusion that, as the plaintiffs' patent had not been attacked on the ground of want of invention, and it had not been anticipated, and it was not denied that it was proper subject matter for a patent, that the defendants had infringed, and that the appeal must be dismissed with costs.—Mr. Justice Lopes concurred.—Mr. Justice Rigby differed.—Mr. Graham, for the defendants, said this was a case of great importance to them, and if the injunction were continued it would greatly restrict their business pending an appeal to the House of Lords.—The Court said the injunction would not be enforced if the defendants kept an account of the machines made by them pending an appeal.—A stay of three weeks was granted upon the defendants paying into court the costs of the action below and of the appeal, together with security, to enable them to consider as to whether they would appeal to the House of Lords.

Glyn v. the Planet Electrical Engineering Company (Limited).

In the Westminster County Court on Friday last, before Judge L. Smith, an action was brought by a traveller in the electrical engineering trade to recover commission at the rate of 7½ per cent. on certain orders alleged to have been obtained by him. The plaintiff stated that he was formerly in the defendants' employ at a salary of £2 per week, and a small commission on all orders obtained, but this arrangement was terminated, and it was agreed that he should in future be paid a commission of 7½ per cent. on all orders introduced. It was for commission under this arrangement that the action was now brought. The defendants stated that the plaintiff was only to have 5 per cent. commission, and claimed that he was not entitled to this commission until they had received payment for work done under orders brought in by him. The amount due on the basis of the 5 per cent. was £3. 9s., and this sum had been paid into Court. After hearing evidence His Honour said he was satisfied that the sum paid into Court was sufficient, and gave judgment for the defendants, but without costs.

BOOK RECEIVED.

"Professional Papers of the Corps of Royal Engineers." Edited by Captain C. B. Mayne. Price 10s. 6d. Royal Engineers Institute Occasional Papers, Vol. XX. (Chatham: W. and J. Mackay and Co. 1894.)

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NOW READY.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Although about 100 pages are added to the book, no addition is made to the price, which is 7s. 6d., post free 8s. 3d., abroad 9s.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices:—*

The Large-Sheet Table, giving full particulars of the Electricity Supply Stations throughout the Kingdom, presented with our issue of January 4th, can be obtained mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s.—each post free. The Map showing positions of Supply Stations is mounted on the back of the Table. The Coloured Map issued with the Jan. 18th number and the Electricity Supply Statistics issued with the Feb. 1st number, are also mounted on some copies, and the price of these, complete, post free, is 5s.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is just out, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

Laboratory Notes and Forms.—With the above title, we are publishing a set of Elementary (ready) and Advanced Exercises (portion now ready, remainder shortly) for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"Electro-Chemistry."—This useful work, by Dr. G. Gore, is still on sale, the price being 2s., post free.

"The Work of Hertz."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. net., is now ready.

"Electrical Engineering Formulæ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"Drum Armatures and Commutators."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and Wilkinson, price 6s. 6d., post free.

Tenders Invited.—The Seaham Parish Council require tenders for lighting the streets and roads of the parish with gas or electricity. Tenders must reach the Chairman (the Rev. D. W. James) by the 28th inst.

——— The Electric Light Committee of the Yarmouth Town Council have accepted the offer of Messrs. Crompton and Co. (Limited) to supply carbons for the public lamps for one year at £8. 17s. per thousand pairs. This was stated to be a large reduction on the prices previously paid.

Tenders Accepted.—The Metropolitan Asylums Board have accepted the tender of Messrs. F. and B. Benest, of Cromwell-grove, West Kensington-park, London, W., for overhead electric fire alarm wires and posts between the Board schools at Darenth, the farm buildings, and the Gore farm hospital, for the sum of £72, and for the maintenance of the electric bell system throughout the asylum, schools, and pavilions at Darenth, for a sum of £75 per annum.

Tenders Received.—A Committee of the Edmonton District Council have decided to recommend the acceptance of a tender from the Consolidated Telephone Construction and Maintenance Company (Limited) for the supply and erection of fire alarms.

Appointment.—Mr. Thomas Cooper, M.A., assistant engineer to the Oxford Electric Company (Limited), has been appointed assistant engineer to the Regent's Park central station of the St. Pancras Vestry, at a salary of £156 per annum.

Personal.—Mr. George Duffitt, for some years connected with the Edison-Swan Company, has been appointed by Froggatt's Electric Lighting Company (Limited) to take charge of the lighting of the Glasgow Corporation tram cars, and to fit up a charging station at Coplaw Hill.

Vacant Appointment.—The Cardiff Corporation have decided to advertise for a practical man to take charge of the electricity station at Canton at a salary of £200 per annum.

Dissolutions of Partnership.—The partnership hitherto existing between Messrs. John A. Edmondson and Wilson Hartnell, and carried on under the style of Wilson Hartnell and Edmondson, Volt Works, Leeds, has been dissolved by mutual consent. The whole of the works have been taken over by Mr. Edmondson, and will in future be carried on by him at the same address, the style of the works being altered to the Globe Electrical Works.

———— Messrs. Money and Nash, electrical engineers, of 19, Palace-gardens-mansions, High-street, Notting Hill, W., have dissolved partnership.

———— The dissolution of the partnership between Percy Rosling and F. J. A. Matthews, carrying on business as electrical and mechanical engineers, at Trafalgar Works, Trafalgar-street, Bradford, and Porter-street, Hull, is gazetted. Debts will be paid by P. Rosling.

Liquidations.—At the meetings of the shareholders of the Electrolytic Caustic Soda and Chlorine Trusts (Limited), held on January 3rd and 24th, it was resolved to wind up the Company voluntarily, and Mr. R. Vogan, Walton Lodge, Surbiton, was appointed liquidator.

———— Mr. Justice Stirling has approved of the appointment of Mr. Claud Scott, secretary of the Planet Electrical Engineering Company (Limited), as receiver and manager. The plaintiffs in the action in which the appointment was asked for are holders of £2,500 Debentures of the Company, issued on the usual terms that principal becomes due and payable upon default of payment of interest. The Debentures were issued in 1893, the interest being payable half-yearly, but no interest has been paid. The Company consented to the application. Mr. Scott is not to act as manager longer than six weeks without leave of the judge in chambers.

———— The final meeting for the reception of the liquidators' report in connection with the winding up of the Faure Electric Accumulator Company (Limited) is to be held at 14, George-street, Mansion House, London, E.C., on March 18th, at noon. It will be interesting to remember that the undertaking was incorporated on February 15, 1882, with a capital of £1,000,000, divided into 80,000 Ordinary shares of £10 each, and 200,000 Deferred shares of £1 each, to acquire and develop certain patents, and to carry on the business of electricians, mechanical and chemical engineers, and workers of and dealers in electricity, motive power and light. The last return, made up to July 10, 1883, and filed on September 8th following, showed that 47,000 Ordinary and 100,000 Deferred shares were taken up. The resolution for voluntary liquidation was passed on July 10, 1884—nearly eleven years ago!

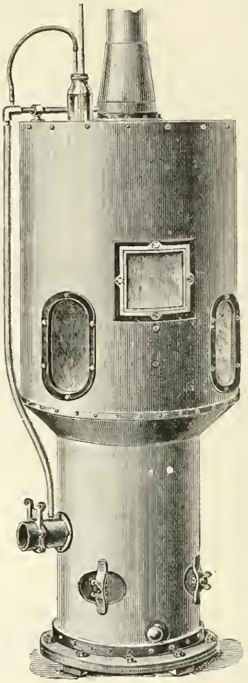
Bankruptcy.—The public examination of Walter Andreae, lately trading at 132, Hurlingham-road, Fulham, and 62, Vauxhall Bridge-road, London, as an electrical engineer, is to be held at the Bankruptcy Court, on March 6th, at 11:30.

———— The first meeting of creditors of Joseph Torr Todman, of Colombo, lately carrying on business at 36, Bermondsey-street, and 11, Queen Victoria-street, London, as an electrician, is to be held at the Bankruptcy Court on April 26th, at 11, and the public examination at the same place on April 30th, at 11:30.

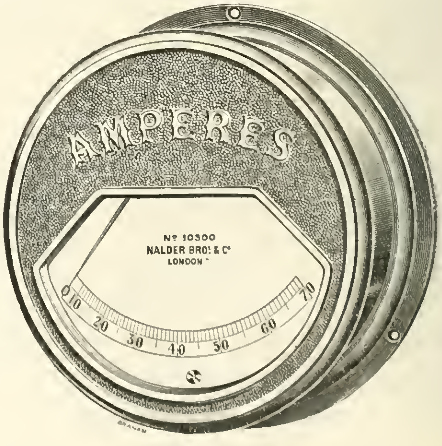
The Telautograph.—On the opening by the Prince of Wales of the Royal United Service Institution, Whitehall, London, his Royal Highness took part in some experiments with Prof. E. Gray's Telautograph, by which a number of facsimiles of handwriting were produced.

"A Town in Darkness."—Owing to an accident at the gas works at Axminster, a result of the frost, the whole town was in darkness on Sunday last. Evening service at the parish church had to be suspended. Gas journals, please copy.

Sand Blast Apparatus for Obscuring Incandescent Lamps.—The sand blast process is in almost universal use for obscuring and decorating lamp and gas moons and chimneys. But until lately the blast has been found too powerful for practical use in obscuring incandescent bulbs. Recently, however, the objectional features in the use of acid for this purpose compelled some of the lamp makers to apply to the Tilghman's Sand Blast Company, of Sheffield, for apparatus to do this work. The matter was at once taken up, and they have now placed upon the market a machine for this special purpose. The frosted surface so obtained is, as we have had opportunities of seeing, free from the greasy appearance so frequently seen on the acid-obscured lamps. From five to eight dozen lamps can be obscured per hour. The blast is created by a Sturtevant or Roots blower, the power required being about ½ H.P. The operator sits with his eyes to the window and his arms through the holes in the working chamber (*see* illustration). Inside the chamber there is an arrangement operated by the hand, to support the lamp and move it about so as to bring all parts of the surface under the action of the blast. The blast is upward, and the sand after doing its work falls back into the hopper and is used again.



Messrs. Nalder Bros. and Co.—The accompanying illustration shows the latest pattern of Messrs. Nalder Bros. and Co.'s ironclad gravity ammeter, the older forms of which are, no doubt, well known to our readers. This form of instrument is now made in various sizes, for both continuous and alternating currents, for from ½ to upwards of 2,000 amperes. Messrs. Nalder Bros. also manufacture various forms and sizes of ironclad gravity voltmeters, constructed on the same principle.



Telegraph Wire and Apparatus Exports.—The value of the exports from this country during last month of telegraph wire and apparatus connected with the erection of telegraphic communication showed a slight falling off as compared with the proceding month, when the value was £41,152. As compared with the corresponding month of last year January's total showed an increase of nearly 100 per cent., having amounted to £35,193, as against only £18,738 in January, 1894. That there is nothing like the activity in the trade as was noticeable two years ago will be seen from the fact that the exports during January, 1893, reached a value of £271,502.

Wire Catalogue.—Mr. Fernand Espir, of East India-avenue, E.C., agent in this country for Messrs. Lazare Weiller and Co,, of Paris, sends us a "Practical Handbook" of Messrs. Lazare Weiller's specialities. The works at Angoulême produce pure electrical high-conductivity copper, in ingots, plates, rods, bars, and rolled rods for wire drawing; all sections of drawn electrolytic copper, bars and rods; plain leads for use in telephone, electric light, traction, and power transmission work; red copper wire or rods for rivets, hooks, bolts, &c.; overhead line-holders, brackets, porcelain and glass insulators, and plant required in electric line work. The "Handbook" consists of a number of tables of diameters, areas, weights, resistances, &c., and a few illustrations are given of tools used in joint making, &c.

Alverthorpe (near Wakefield).—The Parish Council of this village decided that the district shall be lighted by either gas or electricity, and have appointed a committee to formulate a scheme.

Arizona.—A correspondent of the *Mining World* sends an interesting account of a big electrical project at Barrier Rocks, on the Colorado river, about 20 miles above Yuma, Arizona. The scheme provides for the erection of the largest electric power plant in the United States, and it is intended to supply power to about 500 gold, silver, and lead mines within an area of about 30 miles; to supply a large area of placer mines with water with which to wash out the gold; and to pump water for irrigation purposes for more than 6,000,000 acres of rich alluvial lands in the neighbourhood. A 1,000-kilowatt machine, "the largest ever built in America," is to be used. Electric light is to be supplied wherever required. It is said to have been estimated that 50,000-h.p. can be developed, and that within two years after the completion of the plant there will be 10,000 stamps working on the ore from the mines within 25 miles of the source of the electric current. It is expected that the introduction of cheap motive power will open up one of the richest mineral and fruit regions in the world.

Bath.—The local authorities do not seem quite easy in their minds in regard to the application to the Board of Trade for a Provisional Electric Lighting Order. At the last meeting of the City Council it was stated that the Board of Trade had been "informed informally, but not officially," of the intention of the Council to apply for an Order, and under these circumstances the Mayor said that the Electric Lighting Committee should be called together as soon as possible, "in order to prevent any tumbling between two stools."

Battersea (London, S.W.).—The recommendation of the Electrical Committee of the Vestry that £200 be expended in obtaining expert opinion as to the advisability of the Vestry undertaking the electric light supply for the district has been approved.

Bordeaux Exhibition.—British merchants and manufacturers do not seem to take kindly to this exhibition, and in order to induce these gentlemen to patronise the show it has been decided to extend the date for applications for space from intending exhibitors to March 1st next.

Bradford.—The report of the Gas Committee, presented to the Town Council last week, contained a request for permission to invite tenders for two new engines in connection with the electric supply works. Mr. Dixon pointed out that the works were now running at high pressure, and it was important that the additional motive power should be provided. After some discussion, it being the view of several members that it would be better to discuss the type of engine to be put down, the request was withdrawn.

Brentwood.—A number of ratepayers and other sufferers from the insufficient supply of gas, and generally through the excessive charges made for the same, have prepared a petition which is to be presented to the Lighting Inspectors at the next meeting of the Local Authority, asking that the whole parish may now be lighted by electricity. The petition states that in the opinion of the petitioners the whole of the parish roads can be lighted by electricity at a smaller cost than only a portion of the roads are now lighted by gas.

Brighton.—The Lighting Committee of the Corporation recommend the extension of the electric lighting works, and for this purpose propose the purchase, for £700, of a building adjoining the present works in North-road. The addition of a considerable number of street lamps has been approved.

Cardiff.—With regard to the Cardiff electric lighting scheme one thing is noticeable the local press appear to be particularly hostile. A canvass has been made of various districts outside the area at present supplied, but a universal demand for the electric light has not been shown as a result. The figures given are described as disheartening. The majority of those canvassed are naturally waiting for the mains to be brought to their doors; and it is reasonable to suppose that when this is done the electric current will be taken in this district as in many others. On Sunday and Monday last no less than 500 of the gas lamps were extinguished owing to the frost. At a meeting of the Lighting and Electrical Committee of the Cardiff Corporation on Tuesday a letter was read from Principal V. Jones, of University College, stating that the Technical Instruction Committee of that College had appointed a deputation to wait upon the Lighting and Electrical Committee of the Corporation to urge: (1) The feasibility of the utilisation of the new electrical works for the training of electrical engineers; (2) the advisability of the establishment of an electrical laboratory for the standardising of all electrical measuring instruments that may be in the town; and (3) the question of the improvement of the lighting outside the Stacey-road Hall. Principal Jones having stated the views of the deputation on the several proposals, it was decided that the consideration of the first two should be adjourned to a future date to enable Councillor Riches, a member of the Technical Instruction Committee, to be present.——In the Cardiff County Court on Tuesday a claim was made against Messrs. J. B. Saunders and Co., electrical engineers, for £12, for commission alleged to be due on orders obtained for that firm by Mr. H. G. P. Price. Messrs. Saunders were able to produce correspondence which clearly proved that the plaintiff was not entitled to the commission, and judgment was given for the defendants with costs, the judge stating that actions for commission were easily brought and required close investigation.

China.—The success of Japan in her struggle with China, and the restoration of Li Hung Chang to power, are considered in commercial circles as likely to have far-reaching results as regards the future of railway and electrical enterprise in China. It is well known that the efforts of the great Chinese statesman to induce his countrymen to look favourably upon the introduction of European methods of interior transport have hitherto met with little success; but his return to power, and the complete success of the Japanese arms, will place the question of the establishment of railways on quite another footing. It is stated that Li Hung Chang's plans for opening up the country include the construction of more than 3,000 English miles of railway, radiating from Pekin. With the construction of railways must come the introduction of electric light and power, and the present is undoubtedly the time for manufacturing firms to bring their specialities prominently before the officials of the Eastern Powers.

Church Lighting.—The new Catholic Church at Felling is being fitted for the electric light by Messrs. Rowland Barnett and Co., about 50 lamps of from 8 to 100 c.p. being used. The plant includes a battery of accumulators.

Commission of Sewers (London).—At the meeting of the Commissioners on Tuesday last, Mr. Johnson asked whether any progress had been made with regard to the negotiations with the companies on the question of the use of the telephone tubes. Mr. Barham called upon the Commission to use the greatest care lest the opportunity of securing to telephone users a cheaper rate than that at present demanded should be lost. It rested with the Commission to see that the people of London were not worse served in the matter of telephones than those in the provinces. Mr. Johnson further argued that the Commission was engaged in a visionary pursuit in supposing that it was going to secure a reduction in the cost of the use of telephones in London. The Commission was appointed to watch the interests of ratepayers, not to study those of telephone users. It was a rotten principle that the ratepayers should be prevented from participating in benefits because telephone users wanted the cost of telephones reduced. The speakers were reminded that the matter was *sub judice*, and, having aired their views, allowed the matter to drop.

County Council Candidates.—Earl Russell, head of the firm of Russell and Co., electrical engineers and contractors, is to be a "Progressive" candidate at the forthcoming London County Council election.

Coventry.—The Electric Lighting Committee have decided that the committee room and the electrician's room at the electricity works shall be heated electrically.

Dewsbury.—Alderman Robinson, at the last meeting of the Town Council, in moving the adoption of the minutes of the Lighting Committee, remarked on the fact that while the demand for electric current had considerably increased, the consumption of gas also showed a large increase.

Dublin Tramways.—The Directors of the Dublin United Tramways Company, as stated in our issue of January 25th, have recently examined the leading systems of electrical traction on the

Continent, and have awarded preference to the overhead wire system for their line to Clontarf. It has been decided to ask Mr. R. Hammond to prepare a report on the subject of the best system to be adopted for the use of the tramways belonging to the Company in the City of Dublin.

Edinburgh.—At a meeting of the Town Council on Tuesday Councillor Douglas asked what provision was being made for the ventilation of the electric lighting mains. Councillor Mackenzie stated that there was always a large escape of gas, and if that gas collected to the extent of 9 or 10 per cent. in the boxes which were placed at intervals for the purpose of allowing the mending and pulling through of cables, a very serious explosive mixture resulted, and if that was set fire to an explosion occurred. There had been an attempt made on the part of gas companies in various places to prove that electrolysis in the mains, which meant the decomposition of the water into its constituents, and, these constituent gases uniting again, were set on fire by electric sparks. But, with two exceptions, in the case of the explosions that had taken place, electrolysis had nothing to do with it. All the explosions had taken place from lights being brought in contact with the explosive mixture. The committee, he added, were giving the matter full consideration.

Electric Clocks.—Messrs. Stockall & Sons, of Clerkenwell-road, London, E.C., have recently put down their system of electric clock control at Woolwich Dockyard. Six miles of wire are used for connecting the numerous clocks in the yard, and periodical winding and differences of time are by this means avoided. We understand that Messrs. Stockall have a number of orders on hand for their system for public buildings in this country.

Electricity in the Theatre.—It is stated that the work on the stage usually performed by the band of scene-shifters is now being automatically performed by electricity at the Munich Opera House. The scenery is moved, the curtain raised, and other heavy stage work done entirely by the use of electrical apparatus. It is further stated that two Parisian managers who were present at the inaugural ceremony approved of the system.

The Fire at Kensington.—An inquest was held on Saturday at the Westminster Coroner's Court on the body of Kate Eliza Holland, the daughter of Mr. J. Holland, electrical engineer, who met her death at the fire which occurred last week at the Kensington and Knightsbridge Company's electric lighting station. Mr. Holland, who was foreman of the engineers at the station, resided on the premises. The firemen were able to save two of the children; but the third, owing to the smoke, they were unable to rescue. Superintendent Chalkley said that the result of his examination after the fire was that the conflagration originated in the accumulator room; but how it broke out there was nothing to show.

Hampstead (London, N.W.).—A recommendation in the last report of the Lighting Committee of the Vestry is to the effect that Messrs. Siemens Brothers and Co. be requested to keep in stock a mile of each kind of cable used for the lighting of the district for use in future extensions, the Vestry only to pay for so much as they may require from time to time. In reference to a letter received from the Vestry of Southwark, asking the Hampstead Vestry to oppose the construction of transformer stations in the main thoroughfares of the metropolis, the committee recommend that the Southwark Vestry be informed that the Hampstead Vestry are entirely opposed to the views expressed in the letter. The Committee are in communication with the Willesden District Council on the subject of lighting the High-road, Kilburn, by electricity, and have instructed the engineer to prepare a specification for an installation of the electric light for the town clock, for which work Messrs. Verity and Sons, F. Taylor, and W. Thompson are invited to tender.

Hertford.—The Lighting Committee of the Town Council at the last meeting of that body announced that a tender had been received from the Brush Company for a complete electric lighting installation for the town. This tender has not, however, received the consideration of the Committee.

Islington (London, N.)—A question was asked at the last meeting of the Vestry as to the steps taken to ventilate the electric lighting mains now being laid. Mr. S. Lambert, the chairman of the Electric Lighting Committee, said that Mr. Albert Gay, their engineer, had had several interviews with Major Cardew on the subject, and the work would be carried out entirely with his recommendations. The whole of the conduits would be connected with the hollow lamp columns which supply the street lighting, and low-level ventilators would be introduced into the conduits at intervals. The ventilating arrangements were, in his opinion, far more complete than those provided at any other electric lighting concern in London.

Japan.—It is said that since the establishment of the local electric light company at Tokio in 1887, no less than 31 similar companies have been started in Japan, and a number of further applications for leave to establish local electric supply companies have been received by the authorities.

Lambeth (London, S.E.).—A special meeting of the Vestry was held last week to consider the electric lighting question, at which Mr. J. Williams submitted a motion that the Vestry surrender the Electric Lighting Order to a private company. He pointed out that the question had arrived at a stage when it was necessary either for the Vestry to transfer their interest in the Electric Lighting Order to an outside body or to carry out the scheme themselves. It was not for them to stand in the way of the adoption of electric light; but he, for one, strongly opposed the Vestry themselves proceeding with the scheme. A letter was read from Mr. Sidney Morse, on behalf of the County of London Company, offering to take over the Provisional Order. The Company offer to pay the Vestry all amounts at present expended in obtaining the Order, and to consider any reasonable proposal as to future purchase that may be made. Mr. G. Holland alleged that if the Vestry lighted the streets of the district by electricity it would mean an addition of 3d. upon the lighting rate alone, and he affirmed that there was no demand for the electric light in Lambeth. Mr. Hubbard pointed out that 22 corporations were now supplying the electric light, and there were only three cases in which it did not pay. Twenty-eight other towns were now constructing their own works, and he was of opinion that it was the Vestry's duty to proceed with the scheme, and give the ratepayers the benefit which would ultimately accrue. After some further discussion, an amendment that the Vestry proceed to the next business was carried, the proposer objecting to the original motion on the ground that it would knock the whole scheme on the head. He thought it would be better for them to shelve the subject for the present rather than allow a private company to step in. The discussion was held by "candle-light," as the gas supply to the Vestry Hall was frozen.

Lectures.—Mr. A. P. Trotter's second lecture to the pupils and staff of Messrs. Crompton and Co., at Chelmsford, was upon "Royal Roads to Calculation." A considerable number of calculating machines, instruments, and slide-rules were shown. The mechanism of the Edmondson and Brunsviga calculating machines were explained by lantern photographs, showing these instruments in various stages of dissection. Some of the wide capabilities of the Edmondson machine and the great simplicity and durability of the Brunsviga machine were demonstrated.——Mr. G. W. Fairall, chief of one of the departments of the Electric Construction Company at Bushbury, delivered a lecture on "Some Applications of Electricity" at the Trinity Schoolroom, Wolverhampton last week. A number of illustrations accompanied the lecture, and a cordial vote of thanks was given to the lecturer at the conclusion.

Liverpool.—A meeting of the Special Lighting Committee of the Corporation was held on Monday, when the dispute with the gas company on the question of supplying the public lamps at a lower charge than that now made was discussed, to which reference is made below. With reference to the negotiations for the acquisition of the Liverpool Electric Supply Company's undertaking, it was stated that some progress had been made, and it is probable that it will be necessary for the Corporation to engage the services of an electrical expert. A conference is shortly to be held between the Directors of the Company and the Committee. A meeting was held on Tuesday of the proprietors of the local gas company, and, in moving the adoption of the Directors' report, the chairman, Mr. E. Lawrence, said that he considered the present position of the gas company a strong one; and, notwithstanding the competition of the electric light, they were holding their own in every way, and they were satisfied that, at present at any rate, the shareholders had no cause for anxiety. With reference to the negotiations now going on between the gas company and the Corporation, it was clear that some of the new members of that body intended to make themselves heard on lighting questions generally, whether in connection with the electric light or gas lighting.

London County Council.—In reference to the discussion on the transformer chamber question, the Highways Committee have reported that, with regard to the application by the County of London Company for provisional orders for Battersea, Newington, and St. Olave's District, the following clause should be inserted in the Orders:—"Provided always that nothing in this Order shall be held to authorise the undertakers to construct in or under the surface of any public street or place chambers or receptacles for transforming apparatus, of greater span than 3ft. and more than 2ft. 6in. in depth." The report was adopted.

Newcastle-on-Tyne.—Messrs. Rowland Barnett and Co. are erecting a lighting plant at New Olympia for about 170 16-c.p. and three 200-c.p. incandescents and several arc lights.

Newport (Mon.).—The Town Council have decided to borrow £1,775 for the electric lighting of the Town Hall, Market, Baths, Free Library, and Museum.

Portsmouth.—A very satisfactory balance-sheet has been presented by the Electric Lighting Committee to the Corporation. An actual working profit is shown of £1,514. 9s. 3d., sufficient to pay a 6 per cent. dividend on the capital outlay. Of course, the supply being in the hands of the Corporation, provision has to be made for the repayment of borrowed money within a limited period, together with interest, and this would require a sum about £126 in excess of the profit shown by the Committee. The result is considered "most satisfactory and encouraging."

SHREWSBURY.—The Shropshire Electric Light and Power Company have commenced the work of laying their mains in the public streets of Shrewsbury.

SOUTHAMPTON.—The blowing of the organ at St. Laurence Church is accomplished by an electric motor, which was started last week for the first time, and was found to answer satisfactorily. Current is obtained from the local company's mains. It is stated that the cost is rather less than when manual power was used, and that the sanitary arrangements are much improved, as the air now comes from the church instead of from the vaults below.

SOUTH LONDON.—The frost would appear to have been especially severe in this district. In many places the gaspipes have frozen, and several districts have been without gas. The discussion of the electric lighting question at the Lambeth Vestry took place under the beam of the farthing dip, as no gas was obtainable. The members of the Vestry appear to have been seriously affected by the eclipse of their old and tried friend, and accordingly decided to shelve the introduction of the "new illuminant" till "another day."

SOUTHPORT.—The report of the Electricity Committee was discussed at the last meeting of the Town Council. A new chimney is required at the electricity works, and a dispute arose as to the acceptance of the lowest tender for the work required. The Committee recommended the acceptance of a tender £138 above the lowest, and a long discussion arose as to whether the Committee's selection should be agreed to. The importance of the matter rests in the necessity for provision being made for an extension of the works to meet the increased demand for current. It was stated during the discussion that already current equal to 4,935 8-c.p. incandescents is being supplied, and applications for 1,458 additional 8-c p. lamps have been received. These would require current in excess of the safe working of the Council's present plant. It was, therefore, urgent that the question of the tenders under consideration should be settled. The point as to whether the advertisement inviting the tenders contained a stipulation that the Council would not necessarily accept the lowest tender elicited the fact that no such stipulation was inserted, and the town clerk, Mr. J. D. Williams, decided that this was not essential. The report of the Electricity Committee was subsequently adopted with the exception of a clause referring to a tender for extensions to the boiler and engine house, which was referred to the General Purposes Committee.

ST. PANCRAS (LONDON, N.W.)—After considerable discussion, the Electricity Committee of the Vestry have decided that for the present it is inadvisable to abolish the rent charge for electric meters.

STORES LIGHTING.—Messrs. Rowland Barnett and Co. (Limited). of Newcastle-on-Tyne, who some time ago supplied a small installation to the Silksworth branch of the Ryehope and Silkaworth Co-operative Society, have now received an order for a large plant for the headquarters at Ryehope. The installation will consist of about 270 incandescents and two arcs.

SOUTHEND.—The gas at this Essex seaport is described as a disgrace to the town, and Mr. Councillor Bowmaker seeks a remedy in the electric light. At the last meeting of the Town Council he moved for a special committee to consider a report upon the electric lighting question generally, and the motion was agreed to.

TAUNTON.—The Electric Lighting Committee have decided to allow discounts varying from 5 to 20 per cent. upon electric lighting accounts, these abatements to commence with the accounts rendered to December last.

WAKEFIELD.—The Electric Light Committee's report to the City Council was to the effect that deputations had visited the electric lighting works at Dewsbury, Leeds, and Burton-on-Trent, for the purpose of gaining information. At each place the deputation made inquiries of consumers as to the cost and efficiency of the lighting, the result being that in some cases the cost was stated to be nearly double that of gas, and in others not so much. It was, however, admitted in all cases that a very great saving had been effected in damage to goods, and a much better light had been obtained; and nowhere were the deputation informed that consumers would care to give up the electric light, even where the cost was said to be more than double that of gas. Information had also been obtained from Bolton, Blackpool, Lancaster, Oldham, Huddersfield and Whitehaven, and the result of the inquiries was that the members of the deputation were all convinced that the Corporation should at once proceed to construct works. The Committee had discussed the matter with R. Hammond, who (as stated in our last issue) has been instructed to prepare a specification of works and to lay the same before a future meeting of the Committee. Mr. Councillor Lee, the Chairman of the Committee, said the more they looked into the matter the more they were convinced of the necessity and prudence of proceeding with the electric lighting scheme at once.

WHITEHAVEN.—Attention was called at the last Town Council meeting to the long hours worked by the men employed at the Corporation's electric lighting station. It was alleged by Mr. Councillor Wilson that the men's hours were 84 per week, some of them receiving wages equal to 3¼d. per hour. In reply to this it was stated that during the five winter months the men worked 84 hours per week, and during the seven summer months 63. In 1893, owing to these long hours, the men's wages were advanced from 21s. to 24s. per week! It was further stated that the men received every year a week's holiday. Mr. Alderman Hastwell, therefore, considers that "the men's case is not so hard as it may seem." This, however, was not the view of several subsequent speakers, and now that the matter has come before the Council there should be a speedy amelioration of the conditions under which these poor men work. It says very little for the Electric Lighting Committee of the Council that such demands should be made upon their men, and public safety calls for an immediate alteration.

WORCESTER.—The Board of Guardians received last week a deputation from the City Council, who attended to invite the Guardians to adopt the electric light in the new workhouse buildings. Mr. Williamson pointed out that ultimately the City would spend about £60,000 in their electric lighting scheme, and it was therefore to the interest of the ratepayers that the Guardians should adopt the electric light for the workhouse buildings. He argued strongly that electricity was more economical than gas. The Mayor, who accompanied the deputation, pointed out that as to the comparison of the cost of the electric light and gas, Mr. Walter Holland, who was a large employer of labour, and owned extensive premises in the district, had found that his bill for lighting by electricity during the last quarter was just about half that of the corresponding quarter of the previous year, when the premises were lighted by gas. The Guardians' Building Committee is to report on the subject.

The Directors of the Theatre Royal have accepted a contract to light the auditorium by the electric light, for which upwards of 70 lamps will be required.

YARMOUTH.—At the last meeting of the Town Council it was stated that orders had been received up to date for 2,468 lamps, of which about 1,200 had been wired and were lighted. A letter was read from the Admiralty notifying that it was not their intention at present to light to light the Naval Hospital by electricity. The borough surveyor stated that written instructions had been given to the Corporation's foremen and others engaged in opening streets for various purposes as to notification of any uncovered leads, of which reports were to be at once made, either to Mr. A. W. Ranken or to himself.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

January 18, 1895.

1,234. J. A. ESSBERGER. London. Method of varying the speed of multipolar electric motors.

January 19, 1895.

1,279. S. S. ALLIN. London. An automatic resistance coil for the regulation of electric currents.

1,296. J. PITKIN. London. Improved india-rubber cushions for portable, storage, or other batteries.

1,317. R. HACKING and G. BRAND. London. Improvements relating to electric lamps.

1,318. R. E. B. CROMPTON, S. L. BRUNTON, and P. PRIVETT. London. Improvements in armatures for dynamo-electric machines.

1,353. F. HODGSON and G. A. EDWARDS. London. Improvements in the application of telephones to electric-bell systems.

January 21, 1895.

1,385. H. TIPPING. London. Improvements in galvanic batteries.

1,405. L. BARRIÈRE. London. Improvements in electric arc lamps.

January 22, 1895.

1,436. J. B. MILLAR, of the firm of George Smith & Co., Glasgow. Improvements in and relating to pillars or posts for electric lighting, carrying electric wires, railway signals, and the like.

1,442. C. L. CLARKE and W. P. THEERMANN. Manchester. Improvements in electrical ceiling roses.

1,446. C. B. Schoenmehl and C. M. Platt. Glasgow. Improvements in galvanic batteries.*

1,474. J. Hopkinson. London. Electro-magnetic brakes.

1,477. H. Bevis and G. Binswanger. London. Improvements in feeding mechanism for electric arc lamps.

1,478. H. Hirst. London. An improved insulated support for electrical conductors.

1,504. W. P. Thompson. Liverpool. Improvements in coin-controlled apparatus for producing various electrical phenomena or effects. (J. L Ketcher, United States.)

1,512. Sir C. H. A. F. L. Ross, Bart. London. Improvements in electric arc lamps.

1,526. E. A. Mathers. London. Underground conduit for electric roads.*

1,535. Brown, Boveri and Co. London. Improvements in or in connection with alternating-current electric motors. (Date applied for under Patents, &c., Act, 1883, Sec. 103, July 3, 1894, being date of application in Switzerland.)

1,544. E. D. Lewis. London. Improvements in and relating to electrical conductors.*

January 23, 1895.

1,546. F. Wright and E. J. Piper. London. An electric switch.*

1,550. C. L. Clarke and W. P. Theermann. Manchester. Improvements in electrical switches.

1,587. F. Hope-Jones and G. B. Bowell. London. Improvements in or appertaining to electrical clocks, bells, indicators, and similar instruments.

1,611. E. J. Preston, of the firm of J. Stone & Co., and A. B. Gill, London. Improvements in and connected with the electric lighting and heating, and also the ventilation of railway carriages and other vehicles.

January 24, 1895.

1,649. H. Crane, jun. Birmingham. Gas engines, ignition by electricity.

1,676. T. B. Marchant and J. Wooley. London. Improvements in electrical storage batteries.

1,697. H. Niewerth and R. Niewerth. London. Improvements in and connected with arc lamps.

1,698. H. Niewerth and R. Niewerth. London. Improvements in electric current regulators.

1,710. F. J. Curley. London. Safety fixing for the various decoration covers and lamp holders for electric light fittings.

1,714. Siemens Bros. and Co. (Limited). London. An improvement in electrical glow lamps. (Messrs. Siemens and Halske, Germany.)

1,717. O. Pirsch. London. Improvements in and relating to electric accumulators.

1,730. H. Edmunds. London. Improvements in electrical devices for lighting cigars, or for other like purposes.

1,731. C. A. Faure and F. King. London. Improvements in secondary batteries.

January 25, 1895.

1,744. C. M. Stead and L. W. Douthwaite, trading as The Electrical Mechanical Agency Company. Leeds. Improvements in microphones or telephone transmitters.

1,788. F. E. Elmore. London. Improvements in apparatus for the manufacture electrolytically of tubes and other articles of circular section.

1,797. P. Stiens. London. Improvements in filaments and carbons for electric lamps.

January 26, 1895.

1,835. H. V. Keeson. London. Improvements in electric exploders.

1,040. G. A. Nussbaum. London. An improved carbon transmitter or microphone.

1,854. G. R. Blackburn. Bradford. Improvements in electric burglar alarm for doors.

1,867. W. E. Gibson and H. Hirst. London. Improvements in shade holders for electric, gas, or other lights.

1,885. A. H. Weikman. Liverpool. Improvements in insulating devices or attachments for electric wires.

1,899. E. Mapple. London. Improvements in connection with electric railways or tramways.

1,906. G. Threlfall. London. Improvements in electric condensers. (R. Threlfall, Australia.)

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1893.

18,428. Draper and Fraser. Electric telegraphs.

1894.

489. Herbert. Electric clocks.

548. Thompson (Mellhuish). Telegraph signal receiving instruments.

669. Wollaston. Electric batteries.

764. Nisbett. Jointing and connecting electric cables.

2,118. Fabris. Electric lamps.

3,217. Joel. Electric arc lamps.

3,324. Dixon. Magnetic compasses.

4,325. Harris. Electro-deposition of aluminium.

4,554. Adams-Randall. Telephony and telegraphy.

4,572. Adams-Randall. Telephone transmitters.

4,610. Moy. Electricity meters.

8,808. McDonald, R. McL., and A. Electric batteries.

9,050. Boult (Farjas). Road vehicles.

10,149. Orme. Supporting electrical conductors, &c.

14,545. Thomas Parker (Ltd.) and T. Parker. Dynamo electric machines.

17,728. Sperry. Electrically-propelled vehicles, &c.

17,845. Devonshire (Thomson). Electric arc lamps.

21,549. O'Neill and Jewell. Electrically heated robes, towels, quilts, &c.

23,012. Walter. Electric signalling systems.

23,441. Fuller, J. C. and G. Galvanic batteries.

23,553. Wagner and Marr. Electrical treatment of beer. &c.

23,745. Teague. Electricity meters.

COMPANIES' MEETINGS AND REPORTS.

Kensington and Knightsbridge Electric Lighting Company (Limited).

The eighth ordinary general meeting of this Company was held yesterday (Thursday) at 1, Great George-street, Westminster, Mr. Granville R. Ryder in the chair.

The SECRETARY (Mr. R. S. Erskine) read the notice calling the meeting.

The CHAIRMAN: You will probably have observed from the newspapers that last week we had a serious fire at Kensington Court, and it may possibly interest you to have some particulars about it before I refer to the general transactions of the Company during the past year. The fire took place a few minutes after ten o'clock on Tuesday night in last week, breaking out in the floor above the machinery and engine room, which, fortunately, has a concrete floor. The damage done was very considerable. The whole of our batteries were destroyed, as well as a great many valuable test instruments and meters which were in store, and also the rooms above in which lived the foreman, his wife, and three children. The estimate of the actual damage done amounts to something between £5,000 and £6,000, which is, happily, covered by insurance. Mr. Crompton, our general engineer, and Mr. Miller were on the spot within a short time of the fire breaking out, and owing to their energy and intrepidity, not only was the fire got under speedily, but they managed to prevent there being any break in the continuity of the electric current for more than three hours, which, I think, was a wonderful feat considering the damage done to the place The most unfortunate occurrence was that one of the children of the foreman was suffocated. Since then an inquest has been held on the child, and the verdict returned was one of accidental death. A rider was added to the effect that the fire was not caused by any process connected with the manufacture of electricity. Various rumours have got afloat that some experiments were going on at the time which were the cause of the fire. There is no truth whatever in the rumours. We hope that in the course of three or four months the whole of our plant will be reinstated, and we shall return to the state of efficiency we were in before the outbreak. I think our thanks are especially due to Mr. Crompton and Mr. Miller for their energy on the occasion, and for the way in which they prevented what was, no doubt, a serious fire from becoming a disastrous one. There was a lapse of supply in the current for not more than three hours at the longest, it being restored by 1:30 with the aid of our Knightsbridge station. It is a curious fact that on the negative side the loss of light was greater than on the positive side of the system, for some reason I cannot explain. In no case was there more than three hours loss of current, and in some cases it was less.

Sir ARTHUR CLAY: I had no lapse of light at all. The light in my house never went actually out.

The CHAIRMAN: Perhaps you were on the positive side.

Sir ARTHUR CLAY: The light flickered for a short time, but it never went out.

The CHAIRMAN (resuming): With regard to the accounts, the first matter to which I will call your attention is the capital account, in which there has been an increase of £5,040 in the 5 per cent. second preference shares, and £8,000 in the 4½ per cent. mortgage debentures, making together £13,040. Of that amount we have £1,500, the other having been expended on new mains, meters, and other plant. Turning to the revenue account, you will observe that we have sold 977,797 units of electricity as compared with 724,308 units in the former year, showing an increase of 253,489 units. The net profit for the year is £4,000 larger than in 1893, being £24,738, against £20,746. It will be seen, therefore, that we have been able to increase the sale of electricity by nearly one-third at an additional cost of only one-fifth. In other words, we have succeeded in earning an additional £4,000 for an outlay of only £1,000. These, I think, are satisfactory figures, and are a great credit to our working staff. I will now ask you to look on the other side of the account while I say a word about the amount we have written off, which is, no doubt, rather large. We felt that the preliminary expenses constituted an item that should be written off as soon as possible, and also the £1,199 which are the expenses of certain legal proceedings. Then we have also placed £3,457 to the renewal account. We think it very important to strengthen this account. Our business is, of course, founded on a progressive science—that of electricity—which although, perhaps, not in its infancy, still has not reached a mature age. Improvements are continually being introduced, and consequently it is of very great importance that we should have some fund to fall back upon in case we have to write off antiquated plant, and, on the other hand, provide us with money to become possessed of the latest improvements. The next point to which I wish to draw your attention is that the price of our electricity to consumers has been reduced, from July 1st last, by 25 per cent., that is to say, from 8d. to 6d. per Board of Trade unit throughout the district. A shareholder met me in the street the other day and said he thought it was a Quixotic thing to lower the price as we were not compelled to do so. That is not my view. I think all the grace of the concession would have been lost if we had not taken the step until we had been forced. However, I am sure we should not have been able to have avoided reducing the price much longer, inasmuch as other districts, conterminous to ours, including the St. James's and Westminster, have all made a reduction to their customers. There was certainly some grumbling in our district with regard to the price, and we felt that by cheapening the product we should obtain an increased demand, and of course, the more electricity we make the cheaper rate we can make it at. We have not yet had much opportunity to test the results of this reduction, as it has only been in operation for one half of the year; but, so far as we can judge from the past six months, it has justified the steps we have taken. The increase in the units sold, as I said before, has been 253,489, 100,000 belonging to the first half of 1894, and 153,000 to the second half, which shows that since the price of the current has been lowered the consumption has increased more rapidly than previously. There is one other matter to which I wish to refer. You will recollect that last year we obtained powers under an Act of Parliament to purchase a small district belonging to the Chelsea Company, and I think it will be interesting to you to know how the purchase has turned out. Mr. Erskine has kindly worked out the figures for me. The amount we paid for the district was £7,000, and united to that we have had to spend about £2,000 on mains. Then there were legal and other expenses which brought the whole cost up to about £10,000. On that £100,000 we made a gross income during the past year of £1,777 and a net income of between £800 and £900. The money with which this purchase was made was procured on Debentures bearing 4½ per cent. interest. and therefore the result is that we have been able to earn about £900 per annum at a cost of something like £450. That, I think you will agree, is a satisfactory result. There are no other points to which I need call attention, I think; but I shall be happy to answer any questions. I now move :—

"*That the report and accounts for the year ended December 31, 1894, be adopted and entered on the minutes.*"

Sir FREDERICK J. BRAMWELL, Bart., F.R.S., seconded the motion, remarking that he endorsed all the Chairman had said, and that, speaking as a shareholder, he was gratified with the accounts.

Mr. PARKER YOUNG said he thought the charges which had been written off should have been spread over two years, and that the Board should have paid a dividend of 6 per cent. Considering the satisfactory position of the Company, he thought they ought to be able to raise money on debentures at 4 per cent., instead of paying 4½ per cent.

The CHAIRMAN, in reply, stated that, as regards the issue of debentures bearing interest at the rate of 4 per cent., a committee of the Board was now sitting to discuss that particular point.

The motion was then agreed to unanimously.

The CHAIRMAN then proposed a dividend at the rate of 5 per cent. per annum on the Ordinary shares for the half-years ended June 30 and and December 31, 1894, to be payable on and after March 1st. This was agreed to.

Mr. R. W. Wallace, Sir Frederick Bramwell, and Mr. G. H. Hopkinson were re-elected Directors, and a short discussion arose on the re-appointment of the auditors, Mr. Wallace referring to the proceedings at the meeting of the shareholders of the Westminster Electric Supply Corporation (reported elsewhere) as to the advisability of approaching the Board of Trade with a view to obviating the necessity of a double audit, one by the Company and another by the Board of Trade. The re-appointment of the auditors was finally agreed to, on the understanding that should it be decided by other metropolitan electric lighting companies to approach the Board of Trade on the subject, the Kensington and Knightsbridge Company should join in the application.

A vote of thanks was then passed to the Directors, and the sum of £500 voted for their services during the past year.

The proceedings then terminated.

Westminster Electric Supply Corporation (Limited).

The ordinary general meeting of the shareholders in this Corporation was held at the offices, Eccleston-place, Belgravia, on Wednesday, under the presidency of Mr. James Heslop Powell.

The SECRETARY (Mr. Frank Iago) read the notice calling the meeting and the minutes of the last general meeting, and the report of the Directors and statement of accounts were taken as read.

The CHAIRMAN: Gentlemen, it is a matter of very great regret to the Board—and I am sure it will be to all of you—to know that Lord Suffield is suffering from very severe illness, and is unable to attend to-day; but we have had news from him this morning informing us that he is better. He regrets very much his absence from us, but I have every hope that the next time we meet he will be with us. When the Westminster Electric Supply Corporation was started, the chief aim of the Directors was to give the public a constant, safe, and bright light without danger to any one. Having decided on the system to be adopted—for there are many systems—we had the advantage of very eminent advice from our engineer, and we also had the advantage of an able architect to erect this and other buildings, and to fit them with machinery, which has admirably answered its purposes. So successful have we been that in the very short space of five years we have reached a gross revenue of £52,646, and this not by any sudden turn of the tide. Every year there has been a constant increase, and the increase last year, I am happy to say, was larger than the increase of any previous year—that is to say, that last year the increase was very little less than £9,000, whereas two or three years ago it was much less than £7,000. The diagram on the wall here shows you how steadily our revenue has increased. The upper or blue line shows the applications made to us, and the yellow line just following it shows the number of lamps installed. You will see that the applications are always, of course, rather more than the lamps installed; but you see it goes on steadily, and when it goes up to the highest point, the advance seems to be faster than it did below. Now this very large income, and the increase every year which we have, prove, I think, that the public have increasingly appreciated our light; but, as one of my friends said to me who believed in electric light, "You have a further problem to solve—that is, to make your undertaking pay." I think we have undoubtedly solved this, for we have now arrived at the time when we are able to declare a dividend for the half-year at the rate of 6 per cent. per annum. The ratio of costs to revenue has been constantly decreasing. In 1892 it was as much as 59·4 per cent., and now we have reduced it to 45·5 per cent. in 1894, and this notwithstanding the diminution of our charge for current from 8d. to 6d. We believe this reduction in price for current has been a very wise stroke of policy, because it has induced many more to come on our circuits, and where there were originally waverers they have become our best friends, and, of course, have induced others to come in, partly on account of the cheapness of our price. Thus far for our gross revenue. I will now make a few remarks on our expenditure. In 1892 our capital expenditure per lamp installed was £3·56 per lamp, and it has now been reduced to £2·45—that is, from 3·56 to 2·45; and we believe this figure will be further reduced in consequence of the Board having already laid distributing mains very widely in excess of immediate demands. It will occur to all of you, without my explanation, that it is absolutely necessary for us to keep far in advance of the demands laid upon us. Perhaps, I may except electric supply companies, but in most supply companies you will seldom find the increase go on at so great a rate; and where this Company is supplying at so great a rate, it is absolutely necessary that we should be in advance, so that we may be able to take on any number of lamps offered to us at any particular time. We believe that no metropolitan company has spent less than we have per lamp, and we also believe that, taking the country as a whole, our expenditure will bear favourable comparison with that of any other company. So much for capital. Now let me say a few words as to the ratio of the cost of working. Not only has the ratio decreased; but the actual cost of generating and distribution has not increased, even with our considerably increased outlay—that is to say, that, although our revenue, as I previously explained to you, has increased in the year by as much almost as £9,000, yet, nevertheless, the actual amount of our expenses has decreased, being last year £500 less than they were in the previous year. In other words, with an increase of revenue of about £9,000, we have had a decrease in our expenditure of £500. You will naturally ask what is the reason for this. Condensation of water here may account for much; but I think the explanation is chiefly due to the uniform skill, care, and attention which our engineers, staff, and workmen have given to the business they are conducting. I particularly wish to add the workmen, because we have instituted a new system of bonus to our engineers and workmen, which seems to have acted well, both as regards the engineers and workmen and as regards, we believe, the shareholders and the consumers. If you will kindly turn to the revenue account —No. 4 statement—you will find that our gross revenue for 1894 is stated at £52,646. The cost of generating and distribution is £24,812, to which we must add depreciation on machinery; for, as I told you when I had the honour of addressing you once before, machinery wears out, and it would be perfect folly of us not to allow a fair sum for depreciation. Then there are insurance and the Board of Trade audit £279, making, according to my reckoning, £27,591, as the cost of working. This gives a net revenue of £25,055, which is more than 6¼ per cent. upon the whole of the capital which we have engaged in this business. When I speak of the whole of the capital I include, of course, the debenture capital as well as the share capital. From this amount, however, as prudent men, we must make some deduction. First of all we have done away with the item of cost of patents. That was a very proper charge to put to capital at the inception of our business; but, as you are all aware, the cost of patents is not an asset, and we thought on this occasion, as we had been so successful, we had better wipe that out altogether. Then again, with respect to preliminary expenses—expenses incurred before several members of the Board took office here—we have thought it wise to write £2,000 off that item. We have also written off £2,500 for sinking fund, a matter respecting which I desire to make a few remarks. It is, no doubt, within the knowledge of the shareholders that the concession for electric lighting does not extend beyond 42 years from the time of the grant. Few of us will probably live to see the time when our concession fails; but, nevertheless, although we shall not see that time, I do not think we ought to avoid the responsibility of providing for our successors. As in the case of tramways, we are not likely to obtain compensation for the value of our business, which I have no doubt will be very valuable then, but only for the value of our buildings and plant taken at their worn-out price. To make provision for so serious a loss we propose to create a reserve fund—a real reserve fund, which we hope to invest outside our own business, and we calculate that if we invest the premium we recently received from you on the shares we issued and £2,000 a year with the interest and the compound interest on those sums, we shall have by the end of the 42 years a very substantial sum to divide among our shareholders. I should like you to look at this matter from another point of view. It must not be forgotten that if we do not have a reserve fund, and a large or considerable alteration is made in the machinery, or some new principle is evolved of making electric light, we shall have nothing to dispose of at the end of our term, and it is very likely that we should not be able to raise sufficient money to carry on our business. Our engineer, in a report which he has made to us, says—and I wish strongly to impress upon you these words: "If everything went well with the Corporation the reserve might simply accumulate and finally remain in hand to safeguard the shareholders at the time of transfer. But if in 20 years—as is always possible—a new method of electric lighting may have been discovered which necessitates radical changes in the Corporation's system, they will be in a position to deal with the changes, by using their reserve for the purpose. Thus the Corporation would be able virtually to stand in the position of a new company, with plant and system modified to suit the new discoveries, without calling up new capital, and so reducing the value of the old. Without an invested and available reserve of this kind it is difficult to avoid some anxiety as to the effect upon the Company of such new discoveries as may fairly be looked upon as not improbable within the period of our parliamentary powers." Therefore it really comes to this—that by laying by this reserve we are strengthening the Company at all points. If we do not want a reserve, then there will be the money to divide among you at some time or other. If we do want the reserve to make the radical alterations which become necessary in applying a new science for mercantile purposes, there will be the money ready for that object: and we believe that, having done this, and having also done what we have accomplished before, we have safeguarded your interests in every possible way—first, by having chosen what we believe is the best system for our purpose, second, by having erected suitable buildings and plant to make the working of it sufficient, by working it with economy, and last, but not least, by making ample provision for old age and the end of life of work. With these remarks, I beg to move the adoption of the report.

The motion was seconded by Mr. EDMUND BOULNOIS, M.P.

In reply to remarks from shareholders, the CHAIRMAN stated that the term of their grant was for 42 years, and the sum they were setting aside would not be sufficient to return all the capital to the shareholders out of the reserve, but the Directors reckoned that the sum they would get for their undertaking would be quite sufficient to do that when supplemented by the probable sum they would receive for their buildings and plant. As to the question of the payment of the auditors, as had been pointed out the auditor of the Company received £52. 10s., while the auditor appointed by the Board of Trade received £60. 0s. 10d. Personally, he considered the cost of the double audit was unnecessarily large, in fact, unnecessary altogether, and he thought it would be much better to have the Government audit only, as they were obliged to submit to this audit. It was, however, not the Directors' wish to dictate to the shareholders, or to express any strong opinion on the matter one way or the other.

The adoption of the report was carried unanimously.

A dividend of 6 per cent. per annum, less income-tax, payable on March 1st, was then declared.

Mr. Boulnois, M.P., and Sir Douglas Galton, K.C.B., F.R.S., were re-elected as Directors.

Sir MARK J. STEWART, Bart., M.P., on the question of the reappointment of the auditor, proposed that the Government audit be considered sufficient. After some discussion, this was agreed to.

A proposal, made by Mr. S. R. SCOTT, to increase the Directors' remuneration from £800 to £1,500 was then unanimously agreed to.

A cordial vote of thanks to the Chairman was, on the motion of Sir MARK STEWART, seconded by Mr. SCOTT, unanimously approved, and the proceedings terminated.

Charing Cross and Strand Electricity Supply Corporation (Limited).

The annual ordinary general meeting of this Company was held on Thursday, at 2, Craig's-court, Charing Cross, Mr. G. H. Brougham Glasier (Chairman) presiding.

The General Manager and Secretary (Mr. E. Wilmot Seale) read the notice convening the meeting.

The CHAIRMAN: Gentlemen, as you will have noticed by the third paragraph in the report, we were on December 31st last supplying energy to 41,216 8-c.p. lamps, which was an increase of 19·7, or nearly 20 per cent. on the number supplied at the end of the year 1893. That shows a very important advance in the business of the Corporation. There are now upwards of 22 miles of mains laid, and in connection with these mains there has been a considerable additional capital outlay during the period under review. I wish the shareholders to understand that, although we have charged to capital account the sum expended for the laying of extra mains, they were not necessitated for the purposes of the new lamps hung during the year; but they were really laid with the object of strengthening the position of the system generally, and enabling us to meet any growing demand for current which may be made upon us in the course of time. It will be seen that the past year has been of a very satisfactory character, and I am glad to be able to say the same of the seven weeks that have expired of the current year. During January and the current month of this year, we have added 2,721 lamps to the number being supplied at the end of December, and we have increased our weekly average supply of electricity to the extent of 25·21 per cent. as compared with the corresponding weeks of the preceding year. That is an indication of the continued progress of our business, and I am pleased to say that applications are still coming in. The Board have written £485 off preliminary expenses, leaving only £700 more to be dealt with. We have also carried £1,600 to depreciation account. That is rather a large sum to apply to such a purpose. In 1897 we wrote off £700, but this year the sum proposed is £900 more, an amount equal to more than ½ per cent. on the entire share capital. We have not appropriated this £1,600 for depreciation because there are any faults either in the machinery or the mains. These have all given the greatest satisfaction, and are always kept in a high state of efficiency, so that they may be considered as good as new. The Directors feel, however, that the establishment of a fund for depreciation is a very important thing in a Company which is going to exist, one might say, for all time, and that it is a wise step to carry to depreciation account a substantial sum. Provision for bad debts has been made to the extent of £150, not because there are bad debts to that amount, but to meet the requirements of the Board of Trade. Our net earnings have amounted to £10,395. We have paid in respect of interest on Debentures £3,117; we have distributed £2,906 in payment of an interim dividend for the half-year ended June 30th last; and we have now to deal with £3,929. We propose to pay a final dividend, making 4½ per cent. for the whole year, leaving £304 to be carried forward to our next accounts. In 1893 our net earnings were £8,654 as against £10,395 for 1894, being an increase of £1,740, and this result has been obtained in spite of the fact that the average price per unit was more than a farthing less during the past year than in the preceding one. The balance carried forward in 1893 was only £43 compared with £304 on this occasion. When we met during last autumn some of the shareholders then present complained that the working expenses were rather high. Since then I have had the opportunity of comparing our expenses with those of other companies, and I can assure you that our total costs are considerably less than those of most other similar companies, and my statement on this matter is borne out by statistics which have recently been published in the technical press. At the meeting held last autumn a shareholder called attention to the following paragraph, which appeared in the prospectus issued in 1892:—"All preliminary difficulties have been overcome. The Company is now in full working order, and the Directors believe from the continually increasing demands they are receiving for energy that the earnings will within 18 months be sufficient to pay a dividend of not less than 10 per cent. upon the present share capital, which dividend can be considerably increased by a comparatively small outlay." Now, I want to call your attention to certain facts bearing upon this statement. It was made on the authority of the auditors, but with the full concurrence of the Board, who fully considered it to be correct. At the time that paragraph was published the charge made for current by us and other companies was 7¼d. per unit, and the difference between that price and the price obtained during 1894 represented a sum of £10,028. If, therefore, we had been able during 1894 to get the price per unit which was being paid at the time the prospectus in question was prepared we should have been able to pay a dividend for the past year of 11¼ per cent. I think you will agree with me that at the time the Board were amply justified in holding out the prospect of being able in a short period to pay 10 per cent. The cause of the reduction in the price per unit is, of course, competition. The Board has had to face competition, and I believe we have done right in facing it in the way we have done; that is to say, by reducing the price of the current. Other companies took that course, and we were bound to do the same. We are, however, getting a very good dividend, the Company is in a capital position, and we are getting increased applications for energy, applications to such an extent as enables me to state that we are obtaining our full share of business. There is just the possibility that in future competition will be less keen, and if so we will take full advantage of such a condition of things. We have taken steps to obtain a Provisional Order for enabling us to supply a further district of the Strand, St. Ann's, Soho, and so on. The matter is at present undecided. We have not considered it expedient up to the present time to offer any of the authorised debentures or share capital for subscription, and we do not propose to do so until we get the Provisional Order. I now have to move—

"*That the report of the Directors and the statement of accounts to December 31, 1894, be received and adopted; and that a dividend for the past half year be paid at the rate of five per cent., making, with the interim distribution, 4½ per cent. for the whole year (less income tax), and that the balance of £340 be carried to the next account.*"

Mr. W. W. ROBERTSON seconded the resolution, and expressed himself convinced as to the economical management of the Company's business. He regretted to find their shares standing at such a low figure on the Stock Exchange, as compared with the shares of another company in no better position than themselves.

The resolution was carried unanimously.

Mr. ARTHUR TOOTH proposed:—

"*That the retiring Directors, Mr. G. H. Brougham Glasier and Mr. I. Percy Mendoza be re-elected.*"

Mr. ROBERTSON seconded, and it was agreed to.

The CHAIRMAN, in thanking the meeting for re-electing Mr. Mendoza and himself, said the cost of the Company's coal was being gradually reduced. There was not the slightest doubt in his own mind that on their merits their shares deserved to stand at a considerably higher figure, but whenever shares were held tightly, and there was no free market, jobbers were afraid to deal in case they should be cornered. That, no doubt, was the explanation of the low price of their shares. He believed, however, that before he next met them, dealings in their shares would be a little more frequent and the prices more varied. If any of the shareholders thought of increasing their holdings, he should advise them to do so without much delay.

On the motion of Mr. ROBERTSON, seconded by Mr. LEWCOCK, the auditors (Messrs. O. R. Johnson & Son) were re-appointed.

A formal resolution was also passed, on the proposition of Mr. ROBERTSON, seconded by Mr. MENDOZA, applying £150 to an account for provision against bad debts.

A vote of thanks to the Chairman terminated the proceedings.

City of Bath Electric Lighting and Engineering Company (Limited).

As briefly mentioned in our last issue, the annual meeting of this Company was held at the offices, Dorchester-street, Bath, on Wednesday, the 13th inst., Mr. T. O. Callender, the Chairman, presiding.

The CHAIRMAN, in moving the adoption of the annual report (which appeared in our issue of the 8th inst.), alluded to the great improvement which had been made on previous years, and the probability of still better results in that ensuing. They were always sorry not to recommend the payment of a dividend. They had a sufficient sum in hand to have done so to a small extent, but after careful consideration they came to the conclusion that it would be better for the Company in the end to carry the balance of £500 odd forward. They hoped, however, that this would be the last time they would meet without declaring a dividend. They had spent a good deal of money, first of all in keeping their plant in first-class condition, and also in putting down new plant, in rearranging the station, and in making alterations which they saw were necessary and which would be of great advantage to them in the future. One question which electrical engineers had been looking to was that of fuel, and some of their furnaces had been fitted up so that they could burn liquid fuel, which afforded them an additional means of generating steam. It was a matter of congratulation to the Directors that the citizens of Bath were adopting the light more than in the past, and they would very soon be in a position to have their working plant filled up. It would be quite easy for them then to extend it, for they had ample room. Whatever they did, however, they would never let their plant and machinery run down to such an extent that they would not have sufficient to meet any emergency to which they might be subjected. The Chairman then referred to the maintenance of the light during the flood, and paid a hearty tribute to the ability of the manager, Mr. Metzger. He thought it well to say nothing about the Provisional Order which the Company were applying for, as the matter was *sub judice*.

Mr. B. H. VAN TROMP seconded, and said two or three years ago, when he joined the Board he had little hope that they were in reasonable distance of seeing that they had turned the corner. This year they had not only wiped out the loss of last year, but had made a considerable profit. In the event of the Provisional Order being obtained for an extension of their powers there would be no difficulty whatever in obtaining sufficient capital to carry out any additional work which might be imposed on the Company.

Some discussion took place on the proposal by the Directors to appropriate out of the year's profits the sum of £175 as Directors' fees for 1894; but eventually the resolution adopting the report and accounts was carried, and the retiring Directors were re-elected.

Tramways Union Company (Limited).

The report presented at the annual general meeting of the above Company, held at Winchester House on Tuesday, stated that "The Directors have for some time been watching the progress of electrical traction, and have taken some preliminary steps towards obtaining permission for its gradual introduction on the Madrid Tramways."

The CHAIRMAN (Mr. E. G. Underdown, Q.C.) having alluded to the working of the Company for the year under review, said: In conclusion, I should like to say that it is now several years since I saw the first tramway working with overhead wires in Germany. Since then we have seen various styles of electrical traction, and we have examined into them, and in that time electricity has made enormous strides; and I think that I may now say that traction by means of electricity has reached a stage when all possibility of future progress is so little that it can be counted by fractions, if I may so express myself. Suppose you are now getting 90 or 95 per cent. of power, which you expect to get theoretically, you may get 95 or 97 per cent. by improvements; therefore you are, to use a well-known phrase, within measurable distance of being able to apply electrical traction to your tramways. There is no doubt, as you will have seen by the deputations before the County Council, that they very strongly object to overhead wires, but there are some systems promoted which can get rid of this. There is a gentleman who has a tramway in South Staffordshire who says that his rod will go round curves better than the general rod goes on straight lines. Then we hear from other parts of England—from Blackpool, I think—that a very eminent firm in London have been successful in solving the problem of underground traction. Of course, if that can be done, it would be preferable. Some of us have been to Paris, and there we have seen a tramway moved by accumulators, and so on, and, at all events, we seem to be nearer the question of solving electrical traction than we were. There are a very large number of important combinations quite ready to come in and help the tramway companies who are not themselves in the position to carry out this, whenever the tramway companies wish to do so.

Mr. CONCANON: With regard to the very great question of electricity, we have some of us been making a very close study of this matter for the last six months or so; the question of electricity by the overhead wires system is, so far as the Continent is concerned, and so far as America is concerned, making extraordinary strides, and it has been proved to be a very important factor. In the first place, it is true that electrical traction can be worked at double the speed of horse traction without risk to the passers by. I have examined with great care into this question, and Mr. Richardson will bear me out, that we have recently seen a system at work at Havre where we saw the cars running at an extraordinary rate of speed, working through crowded streets and narrow streets on a Sunday, and people took very good care to get out of the way. Increased speed upon your tramway means increased receipts, and the result of experience up to the present has been that a minimum increase of receipts from this electrical traction through an increase of speed when once your cars are properly working, has been at least 30 per cent. As I have said, this electrical system is now well known on the Continent, but it has not grown so well in this country, where we are slow in adopting innovations—still it is making progress now, and I have not the least doubt in my own mind that five years hence there will not be a horse tramway to be seen in this country.

Mr. PRINGLE said he was interested in the Birmingham Central Tramways Company, and knew that in that Company they have a cable tramway that is a splendid success, they have a steam tramway which pays well, and they have a horse tramway which pays something, but they also have an utter failure in an electrical tramway—the electrical tramway pays nothing.

The CHAIRMAN: I have been watching the subject for years, and going into all the questions of accumulators and three or four other systems of electrical traction, and I do not believe that anything is better than the overhead wire, so long as we are allowed to put it up. I can only assure you that we shall carefully consider the whole matter, and that we shall carefully study everything connected with it.

The report was adopted.

Isle of Man Tramways and Electric Power Company (Limited).

The first annual meeting of this Company was held on Wednesday at Douglas.

Mr. A. BRUCE, the Chairman, in proposing the adoption of the report, congratulated the shareholders on the magnificent position of the Company, and pointed out that with the interim dividend already paid and that proposed the shareholders were paid the handsome dividend of 12 per cent. on the Preference and 15 on the Ordinary shares. They proposed to carry forward £2,000 to reserve, and £1,672 to profit and loss. He alluded to the prospective public improvements, which would increase the number of visitors and add to the revenue of the Company. The Company had ordered new motor cars from Messrs. Milnes and Co., of Birkenhead, and additional electrical equipment from Messrs. Mather and Platt, of Salford.

The report was adopted, and Messrs. A. Bruce and F. G. Callow were re-elected Directors.

Mr. J. ALWORTH, the manager, said that during the eight months the system had been working a million and a quarter persons had been carried without injury to life or limb, showing the efficiency with which the line was worked.

City of London Electric Lighting Company (Limited).

The statement of accounts and report of the Directors of this Company are just issued. The report refers to the appointment of Mr. Frank Bailey to be engineer to the Company in the place of Mr. D. Cook, resigned, and the appointment of Mr. J. Cecil Bull, who has been secretary of the Company from the commencement, to be also commercial manager. Mr. E. Lucas and Col. B. H. Martindale retire, and offer themselves for re-election as Directors, and Messrs. W. H. Pannell and Co., the auditors, also seek re-election. The total paid-up share capital of the Company is £800,000 in 40,000 Ordinary shares and 40,000 Preference shares of £10 each. The amount of loan capital received is £172,960, making the total paid-up capital £972,960. The meeting of shareholders will be held at Winchester House, Old Broad-street, London, E.C., on Wednesday next, at 2:30 p.m., when the following report will be presented to the shareholders:—

Capital.—The expenditure on capital account during the year ended December 31, 1894, amounted to £280,532. 9s., of which details are given in the accounts submitted. During the year Five per Cent. Debenture stock to the extent of £300,000 has been issued at premiums amounting to £71,000. The first issue of £100,000 is already quoted in the Stock Exchange official list, and application has been made for a quotation for the second issue of £200,000. The Directors have been advised that owing to the Debenture stock having been made redeemable at £125 per centum after December 31, 1910, the sanction of the shareholders is necessary to the issue of the further stock required to complete the £400,000 mentioned in the original prospectus, and a resolution for this purpose is to be submitted to the shareholders.

Revenue.—The net revenue for the year was £34,865. 2s. 6d. Balance brought forward £3,041. 14s. 9d. Total available revenue £37,906. 17s. 3d. Of this sum £3,154. 3s. 4d. has been paid in interest on Debenture stock to December 31st last, £12,000 as interim dividend on Six per Cent. Preference shares to June 30th last, making £15,154. 3s. 4d., leaving for further distribution £22,752. 13s. 11d. The Directors now recommend that dividends be paid for the past half-year of 6s. per share on the Preference shares (6 per cent. per annum), and 5s. per share on the Ordinary shares (5 per cent. per annum). This will absorb £22,000, leaving a balance of £752. 13s. 11d. to be carried forward. Out of the premiums already received on the issues of debenture stock the Directors have decided to write off the whole of the expenses in connection with the issues of Ordinary and Preference shares, Debenture stock, and other preliminary matters, amounting in all to £19,064. 18s. 4d., and to transfer the sum of £1,585. 11s. to the reserve fund, leaving a balance of £44,923. 18s., which it is proposed for the present to carry forward. The necessary provision for depreciation in accordance with the City of London Electric Lighting Act, 1893, has been made.

Notwithstanding repeated applications the Corporation has not yet given consent, as required by the Telegraph Act, 1892, to the use of certain tubes for telephonic purposes, and negotiations are still proceeding.

The generation and distribution expenses for the year, including repairs and renewals, were 46 per cent. of the earnings, as compared with 54·2 for 1893. Revenue is now being earned at the estimated rate of over

£105,000 per annum gross. The rapid progress made in the Company's business will be seen by the following table:—

	Dec. 31, 1892.	Dec. 31, 1893.	Dec. 31, 1894.
Estimated gross revenue from private lighting	£16,193	£45,738	£88,000
Estimated gross revenue from public lighting	£11,259	£12,933	£13,600
No. of 8-c.p. lamps connected.	20,241	65,341	135,460
Number of customers	242	1,080	2,740

Lands and Buildings.—The main buildings now finished will accomodate plant of sufficient capacity for at least 300,000 8-c.p. lamps connected. Possession of Rose's wharf and premises adjoining the Bankside Station has just been obtained; this site will be utilised in due course for the business of the Company. The whole of the twenty-two transformer stations are now in operation. These will accommodate equipment for the service of at least 400,000 8-c.p. lamps connected.

Generating Plant.—The plant already in position is of a capacity of 150,000 8-c.p. lamps, and the further machinery in course of construction by the contractors will be erected during the current year. The arc lighting plant has worked satisfactorily throughout the year. The total number of units sold during the year was 2,602,217.

Street Work.—This work is now practically complete. Further expenditure for cables will be limited to primary mains, feeders, and service conductors, which will be provided as from time to time required.

Private Lighting.—Nearly 3,000 private consumers, representing a total of 142,500 8-c.p. lamps, are being supplied with current. Applications continue to come in satisfactorily, the total received to date being equal to the supply of current for 151,000 8-c.p. lamps.

Public Lighting.—The Company is still awaiting the order of the Commissioners of Sewers to proceed with the lighting of the lesser streets, for which the necessary plant was in position a year ago.

Notting Hill Electric Lighting Company (Limited).

The Directors' report and statement of accounts of this Company were issued on Tuesday, and show a total paid-up capital of £82,890. The whole of the Ordinary and Founders' shares have been issued, leaving 17,011 Ordinary Preference shares of £10 each remaining unissued. The quantity of electricity generated during the year ended December 31st last was 145,943 units, of which 130,266 units were sold to private consumers, 3,652 used on works for lighting and testing, and 12,030 lost in distribution and not accounted for. The total maximum supply demanded during the period was equivalent to 15,669 8-c.p. lamps. The meeting of shareholders is to take place at the registered offices, Bulmer-place, High-street, Notting Hill, London, W., on Tuesday next, at 5:30 p.m. The following is the Directors' statement:—

The expenditure on capital account at the date of the last balance-sheet amounted to £78,528. 19s. 10d. During the year a further sum of £5,032. 1s. 7d. was expended, bringing up the total to £83,561. 1s. 5d. The principal item of expenditure is £4,083. 4s. 7d. for mains, the greater part of which represents the cost of the extension to Melbury-road and Addison-road. Against this capital expenditure £4,410 of Preference shares were issued. The preliminary expenses, compensation and cost of administration during construction, amounting to a sum of £5,205. 5s. 4d., have been transferred to a suspense account, with a view to their being gradually written off out of revenue by means of a sinking fund. The total expenditure charged to capital account now stands, therefore, at £78,335. 16s. 1d. The revenue account shows a profit of £2,401. 17s. 8d., as compared with profits of £1,481. 7s. 1d. in 1893 and £112. 6s. 1d. in 1892, and a loss of £554. 18s. 6d. in 1891. The amount received from the sale of current shows an increase of £687. 4s., and expenditure a decrease of £127. 2s. 8d. The Directors, who are entitled to fees amounting to £1,000, propose to draw for their services for the year 1894 the sum of £300. After payment of this sum the revenue account shows an available profit amounting to £2,101. 17s. 8d. Out of this £600 has been set aside for depreciation, and £156. 3s. 2d. has been written off preliminary expenses, leaving £1,243. 14s. 7d. available for the following dividends: 6 per cent. per annum (less income tax) on the Ordinary Preference shares, taking £566. 6s. (an interim dividend on these shares was paid on July 31st), 2s. per share (free of income-tax) on the Ordinary shares, taking £645. 4s., and £32. 4s. 7d. carried forward.

The engineer (Mr. G. Schultz) reports that the machinery and plant at the central station, as well as the mains, are in good condition, and no accident of any kind has occurred during the year. In view of recent occurrences in other districts, the Directors are taking steps to ventilate the culverts in order to prevent any possible accumulation of gas. The number of houses on the circuit has increased from 173 to 234, and the number of lights from 12,153 to 15,669.

The House-to-House Company having decided to abandon their area in the northern part of Kensington, the Directors, after prolonged negotiations with the local authority, decided to apply to Parliament for powers to extend over the whole of the northern portion of Kensington, thereby more than doubling their present area. The Standing Orders having been complied with, and no notice of opposition having been given, the Directors anticipate that the necessary powers will be conferred upon them during the current session. If the extension powers are granted, the area of this Company will consist of almost the whole of that part of the parish of Kensington north of Kensington High-street.

The Directors express their appreciation of the services of Mr. George Schultz, their engineer and manager, whose zeal and energy has largely contributed to the progress of the Company.

The Directors who retire are Messrs. A. E. Franklin and Francis Radford, and they offer themselves for re-election. The shareholders' auditors, Messrs. Fox, Sissons and Co., also retire, and seek re-election.

Telegraph Construction and Maintenance Company (Limited).

The following report is issued by the Directors of this Company, and will be submitted to the members at the thirty-first ordinary meeting to be held at the offices, 38, Old Broad-street, London, E.C., on Tuesday next, the 26th next, at one o'clock:—

The Directors deeply regret the death of Mr. Philip Rawson, who had been a much valued member of the Board for a period extending over 26 years. The accounts for the year show a net profit of £91,921. 7s. 9d., after charging the interest on the debentures. To this sum must be added £51,228. 10s. 8d. brought forward from last year, making a total of £143,149. 18s. 5d. From this amount is deducted the interim dividend of 5 per cent. paid July 24, 1894, amounting to £24,410, leaving £120,739. 18s. 5d. to be dealt with. Of this sum the Directors propose to distribute a dividend of £1. 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2. 8s. per share, or 20 per cent., free of income tax, leaving £53,509. 18s. 5d. to be carried forward to the next account.

The operations carried out during the year comprise the laying of a cable for the Eastern Extension Telegraph Company, between Singapore, Labuan and Hong Kong; and the manufacture of a cable for the Anglo-American Telegraph Company, and its laying between Valentia and Newfoundland; several lengths of cables have also been manufactured for different telegraph administrations and companies. Repairs of cables have been carried out in the North Sea and English Channel for the German Government. The factories at East Greenwich and Wharf-road and the Company's steamships are in good and efficient condition.

The Directors have the pleasure to announce that they have elected Admiral Sir Anthony Hiley Hoskins, G.C.B., to a seat at the Board. The retiring Director, Mr. George W. Campbell, offers himself for re-election at the meeting, and the auditors, Mr. John Gane and Mr. Patrick A. Glegg, who retire, offer themselves for re-election.

Cambridge Electric Supply Company (Limited).

The following report of the Directors of this Company will be presented to the meeting of shareholders, to be held at the offices, Thompson's-lane, Cambridge, on Wednesday next, at 12 o'clock:—

The Directors consider the prospects of the Company to be very satisfactory. During the twelve months lamps equivalent to 3,644 8 c.p. have been connected to the Company's mains, making a total at the present time equal to 11,644 lamps of 8 c.p. The electric light has during the year been extended throughout Caius and Sidney Colleges; 3,688 yards of main conduit pipe has been laid in Newnham and other districts, making at the present time a total of 12,146 yards. Since October last the supply of current has been continuous day and night. In order to maintain the supply most economically as well as to meet the increasing demand for current, the Directors have decided to add a small day load generating plant and an additional boiler. The Company has made a profit on the year's working of £933. 1s. 1d., which, added to £268. 10s. 11d. brought forward, gives a balance of £1.201. 12s. The Directors advise the payment of a dividend of 2½ per cent., absorbing £575. 18s., which, with £350. 17s. 7d. debenture interest, leaves £274. 16s. 5d. for depreciation, &c. An increased dividend for the current year is anticipated. Sir B. C. Browne and Mr. D. Munsey seek re-election as Directors, and Mr. Arthur Rutter, the auditor, also offers himself.

NEW COMPANIES, STATUTORY RETURNS, &c.

ALLIANCE METER COMPANY (LIMITED).—This Company was registered on February 15th, with a capital of £5,000 in £1 shares, to manufacture or deal in gas meters, water meters, and electric light meters, and to carry on the business of mechanical and electrical engineers, etc.

AROSCOPIC LENS COMPANY (LIMITED). This Company was registered on February 18th, with a capital of £1,000 in £1 shares, to carry on business in any part of the world as manufacturers and vendors of, agents for and dealers in, electrical, medical or optical instruments, discoveries, inventions and devices.

BATTERY AND MOTOR COMPANY (LIMITED).—This Company was registered on February 16th with a capital of £12,000, divided into 800 £5 per Cent. Preference shares and 1,600 Ordinary shares of £5 each, to enter into an agreement between Harry T. Barnett and Francis J. Moffett (as the trustee for the Company) with reference to the sale to and purchase by the Company of certain patents for improvements in primary batteries and motors and other property therein mentioned, and to carry on the business of manufacturing, working, using, letting on hire, and selling electric batteries, machinery, boats or vessels, and apparatus, &c.; for the production, transmission, storage and use of electric, magnetic or other force, whether under the said patents or otherwise. The subscribers (with one share each) are:—J. T. Pitt, George Brown, Stephen B. Saunders, H. Newman Godward, Arthur J. Coole, Henry S. Bourke, and James R. Pike. The first Directors are: Harry T. Barnett, William R. Bourke, William J. Dawson, William A. Hill, and Stephen B. Saunders, the first and last of whom are to be the Managing Directors for at least three years, with a salary of £250 each per annum and a percentage of the profits.

ELECTRIC GUEST CALL COMPANY (LIMITED). This Company was registered on February 7th, with a capital of £5,000, divided into 1,500 "A" and 3,500 "B" shares of £1 each, to enter into and carry into effect an agreement made between Arthur J. Benedict and De La Montagnie Moore (as trustee for the Company), and to carry on the business of manufacturers of and dealers in electrical and mechanical machines and apparatus, particularly those connected with the production of calls and announcing clocks for use in hotels, clubs, and similar establishments. The subscribers (with one share each) are D. L. M. Moore, H. E. Gibbins, A. Watkins, A. A. Heron, J. P. Moore, E. H. Edwards, and W. C. Greenop, Jun.

EMPIRE ECONOMIC STEAM PRODUCER (LIMITED).—This Company was registered on February 18th, with a capital of £80,000, divided into 50,000 Preferred and 30.000 Deferred shares of £1 each, to enter into an agreement between Rudolph Klostermann and Otto Friederici, and Charles H. Williams (as the trustee for the Company), for the purchase by the Company of certain letters patent relating to improvements in grates for use in boiler furnaces, and to improvements in boiler fires, and to carry on the business of mechanical engineers, boiler makers, &c.

JOHN CROSSLEY AND CO. (LIMITED).—This Company was registered on February 18th, with a capital of £5,000 divided into 500 Preference and 500 Ordinary shares of £5 each, to acquire the business of engineers, ironfounders, and machine makers carried on at Halifax, by John Crossley and Co.

PEARSON'S AUTOMATIC FIRE INDICATOR COMPANY (LIMITED).—This Company was registered on February 6th, with a capital of £5,000, in £1 shares, to acquire the inventions of Richard Pearson for the manufacture of a thermometric circuit closer used as a fire alarm and indicator, and to carry on the business of an electric instrument and apparatus company, of electricians, electrical contractors, mechanical and electrical engineers, suppliers of electricity, and electrical apparatus manufacturers and dealers. The subscribers (with one share each) are: Edward K. Burstal, Mark H. Winkley, Edwin H. Hubble, Edward Mann, C. E. Masterman, P. Greville, and J. Speer, the first four of whom and Edmund Stevenson are the first Directors.

WHEELER HILL (LIMITED).—This Company has been registered with a capital of £62,500, in £1 shares, to acquire a mining property in California, and to construct telegraphs, gas and electrical works, &c.

ELECTRICAL ADVERTISING SYNDICATE (LIMITED).—The annual return of this Company, made up to January 14th, has been filed. The nominal capital is £10,000, in £10 shares, of which 964 have been taken up and allotted. Of these 900 have had the full amount considered as fully paid. The full amount has been called and paid on the remainder.

ELECTRICAL PURIFICATION ASSOCIATION (LIMITED).—The annual return of this Company, made up to December 28th, has just been filed. 18,326 shares have been taken up out of a nominal capital of £25,000, in £1 shares. 5,000 of these have been issued as fully paid, and the full amount has been called on the remainder, resulting in the receipt of £13,226, and leaving £100 in arrears.

ELECTRO-ALKALI COMPANY (LIMITED).—The annual return of this Company, made up to January 3rd has just been filed. The nominal capital of £160,000 is divided into 10,000 Ordinary, 5,000 Preference, and 1,000 Deferred shares of £10 each, of which all the latter have been subscribed for and allotted. A call of £2 per share has been made, resulting in the payment of £1,990, leaving £10 still to come in.

ELECTROLYTIC CAUSTIC SODA AND CHLORINE TRUST (LIMITED).—The annual return of this Company, made up to December 27th, has recently been filed. The whole nominal capital of £20,000 in £10 shares has been taken up, and 500 shares have been issued as fully paid. The full amount has been called on the remainder, resulting in the payment of £15,000. A special resolution has since been filed for the voluntary winding-up of the Company, and Rendal Vogan, of Walton Lodge, Surbiton, Surrey, has been appointed liquidator.

ELMORE'S AMERICAN AND CANADIAN PATENT COPPER DEPOSITING COMPANY (LIMITED).—The annual return of this Company, made up to January 14th, has just been filed. Out of a nominal capital of £200,000 divided into 65,000 Priority and 35,000 Deferred shares of £2 each, 44,788 of the former and all the latter have been taken up, and the latter have been issued as fully paid. Resulting on a call of the full amount on the Priority shares, £86,044. 15s. has been received, leaving £3,531. 5s. as yet unpaid.

S. Z. DE FERRANTI (LIMITED).—The annual return of this Company, made up to January 14th, just filed, shows that the whole nominal capital of £100,000, divided into 2,000 Preference and 8,000 ordinary shares of £10 each, has been taken up, and of these 1,993 Preference and all the Ordinary have been issued as fully paid. The full amount has been called and paid on the remaining seven Preference shares.

OKONITE COMPANY (LIMITED).—The annual return of this Company, made up to January 10th, has just been filed. Out of a nominal capital of £340,000 divided into 17,000 Ordinary and a like number of Preference shares, all of £10 each, all the Ordinary and 16,995 Preference shares have been taken up. 5,666 of each class have been issued as fully-paid, and the full amount per share has been called on the remaining 11,334 Ordinary and 11,329 Preference shares, resulting in the receipt of £225,665, leaving a balance of £1,015 still to be paid. The sum of £5 has been paid on five forfeited Preference shares.

PACIFIC AND EUROPEAN TELEGRAPH COMPANY (LIMITED).—The annual return of this Company, made up to December 26th, has just been filed. The whole nominal capital of £100,000, in £10 shares, has been subscribed for and allotted. Upon each of these shares, £4 has been called, and the full amount has been received, with the exception that only £3 per share has been paid to date on 2,500 shares.

PIONEER ELECTRIC CARRIAGE COMPANY (LIMITED).—The annual return of this Company, made up to January 3rd, has just been filed. 52 shares have been taken up out of a nominal capital of £20,000, in £50 shares. The full amount has been called, of which £1,175 was not due till January 15th. £1,540 has been paid, and £1,060 is in arrears (of which £900 was not due till January 15th).

PYKE, HARRIS AND CO. (LIMITED).—The annual return of this Company, made up to January 11th, has been filed, The nominal capital is £30,000 divided into 1,400 "A" and 4,600 "B" shares of £5 each; 1,218 "A" and 3,600 "B" shares have been taken up, and all the latter have been issued as fully paid. The full amount has been called on the "A" shares, resulting in the receipt of £6,090.

QUEEN ANNE'S MANSIONS LIGHTING AND HEATING COMPANY (LIMITED).—The annual return of this Company, made up to January 11th and just filed, shows that the whole nominal capital of £60,000 divided into 3,000 Preference shares of £10 each, and a like number of Ordinary shares of similar value have been issued as fully paid.

RAILWAY AUTOMATIC ELECTRIC LIGHT SYNDICATE (LIMITED).—The annual return of this Company, made up to December 31st, has just been filed. The nominal capital is £25,000, divided into 400 Ordinary and 600 Preference shares of £25 each. All the Preference and 396 of the Ordinary are now taken up, and 200 of the latter class have been issued as fully paid. The full amount has been called on 200 Ordinary and 550 Preference, and £20 per share on the remaining 50 Preference, resulting in the payment of £18,103, leaving £1,592 still unpaid. The sum of £45 has been received in respect of 4 forfeited Ordinary shares.

READING ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to December 31st, has just been filed. A note states "that the company was in abeyance until July 1, 1894, and by an inadvertence no general meeting was held between that date and the close of the year." The nominal capital is £75,000 in £5 shares, and 2,719 of these have been taken up. Calls amounting to £4 per share have been made on 2,712 shares, and the full amount has been called on the remainder. The calls paid amount to £10,481, leaving £402 in arrears.

ROLLASON'S WIND MOTOR COMPANY (LIMITED).—The annual return of this Company, made up to January 4th, was recently filed. Out of a nominal capital of £35,000 divided into 350 Founders' and 34,650 Ordinary Shares of £1 each, all the Founders' and 24,133 Ordinary have been taken up. Of these the Founders' and 22,350 Ordinary have been issued as fully paid. The full amount has been called on 717 shares, and 5s. per share on the remainder, and in consequence £701. 12s. 6d. has been received, leaving £281. 17s. 6d. in arrears.

CITY NOTES.

ABERDARE.—It is said that a satisfactory response has been made to the invitation to provide capital for a local electric lighting company, and that a strong Board of Directors has been obtained for the venture.

BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED).—The debenture stock transfer books of this Company are closed to the 2nd day of March, inclusive.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended February 17th, were £998, as against £938 in the corresponding period of 1894, being an increase of £60. The total receipts for the half-year amount to £7,039, as against £6,665 for the corresponding period of 1894, an increase of £374.

GREAT NORTHERN TELEGRAPH COMPANY.—The coupons falling due on March 1st next on the debentures of 1883 (series B) will be paid by Messrs. C. J. Hambro and Son, 70, Old Broad-street, London, E.C. Coupons must be left three days for examination.

GREAT WESTERN RAILWAY COMPANY.—At the half-yearly meeting of this Company, held last week, Viscount Emlyn, who presided, in the course of his remarks, said that the increase of £2,630 in the general charges during the period covered by the report and accounts were due to expenses incurred in connection with the telegraphs. The directors were increasing the means of communication upon the line by electric appliances and telephones, and they believed that by so doing they would add to the security of working the line, and also reduce the cost of working by having rapid means of communication between one point and another. He considered that the outlay would well repay the Company in the near future.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 17th inst. amounted to £843. The amount for the corresponding week last year was £671.

SANITAS COMPANY (LIMITED).—The Directors recommend a final dividend of 5 per cent. and a bonus of $3\frac{3}{4}$ per cent., bringing up the total distribution for the past year to $13\frac{3}{4}$ per cent.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—The transfer books of this Company are closed from the 18th to the 26th inst. inclusive, preparatory to the payment of dividend.

WEST AFRICAN TELEGRAPH COMPANY (LIMITED).—The half-yearly interest due March 1st, on the 5 per Cent. Mortgage Debentures of this Company, will be paid by the National Bank of Scotland, Nicholas-lane, London, E.C.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended February 15th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,388.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the two weeks ended February 15th were £2,821, as compared with £2,620 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Feb. 13.		Price Wednesday, Feb. 20.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 21.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	14 0	Anglo-American	40	41	40	41	4 17 7	Jan., Apr., July, Oct.	40½	40
£2,993,560	Stock	28 0	Do. Preferred	75½	76½	75½	76½	5 4 7	" "	76½	76
£2,993,560	Stock	5/0	Do. Deferred	6½	6¾	6½	6¾	..	..	6¾	6½
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 17 4	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	11½	12	11¾	12¼	5 6 1	Mar., June, Oct., Dec.	12	11¾
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	109	113	109	113	4 9 3	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	148	152	148	152	4 12 1	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6 000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	20	..
12,931	5	1/8	Direct Spanish (fully paid)	4	4½	4	4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9½	10	9½	10	5 0 0	" "	..	–
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 1 11	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8¼	9	8¼	9	5 0 0	Jan., Apr., July, Oct.	8¹¹⁄₁₆	..
400,000	10	2/6	Eastern	16¼	16½	16¼	16½	3 18 9	" "	17¼	16⁵⁄₁₆
70,000	10	6%	Do. 6 per Cent. Preference	17½	18	17½	18	3 6 8	" "	..	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	124	127	124	127	3 3 0	May and November	125½	125
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	108	105	108	4 13 0	February & August	..	..
250,000	10	2/6	Eastern Extension	17	17½	17½	17½	4 0 0	Jan., Apr., July, Oct.	17½	17½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	123	126	123	126	3 3 6	February & August	124	..
£62,700	100	5%	* Do. 5 p. c. (Anatlo. Gov. Sub.) Debs. 1900	102	106	104	107	4 13 11	January and July	103½	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	102	106	104	107	4 13 11	" "	105	–
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106	109	106	109	3 13 7	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 4	May and November	..	–
180,227	10	1/0	Globe Telegraph and Trust	9½	9¾	9⅝	9⅞	4 11 2	Jan., Apr., July, Oct.	9⅞	9½
180,042	10	6%	Do. 6 per Cent. Preference	16½	16¾	16⅝	16⅞	3 11 3	" "	16⅞	16⅝
160 000	10	5 0	Great Northern	21¾	22¼	22	22½	3 11 1	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 Issue	106	109	106	109	4 11 9	March & September	103½	–
17,000	25	12/6	Indo-European	52	54	53	55	4 10 11	May and November	54	53½
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	105	109	105	109	5 12 8	March & September	..	–
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	105	108	3 14 7	..	..	–
11,839	8	4/0	Reuter's	3	4	3	4	..	April and October	..	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	118	123	118	123	4 17 7	" "	121½	..
15,609	10	6/0	West African Telegraph	4	5	4	6	..	January and July	..	–
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	102	105	103	106	4 16 2	March & September	105	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	–
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	98	103	7 15 4	June and December	93	..
88,321	10	6d.	West India and Panama	1	1½	1	1½	..	..	1⅛	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	5 6 8	May and November	11⁵⁄₁₆	11³⁄₁₆
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 10 6	June and December	..	..
64,242	15	3/0	Western and Brazilian	10¼	10¾	10¼	10¾	3 5 1	May and November	10¼	–
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	–	6⅝	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	4	4½	4¼	4¾	..	..	..	–
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	100	104	101	105	5 14 3	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	100	104	101	105	5 14 3	" "	..	–
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115	120	115	120	5 18 5	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	104	106	104	106	5 16 6	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2½	3½	3	4	–	..	3½	..
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	¹⁄₁₆	³⁄₁₆	¹⁄₁₆	³⁄₁₆	..	May and November	..	–
171,504	£1	6d.	Oriental Telephone and Electric (fully paid)	³⁄₁₆	¹¹⁄₁₆	³⁄₁₆	¹¹⁄₁₆	..	Yearly	–	..
484,507	5	3/4	National	5¾	5⅞	5¾	6¼	4 6 11	June and December	5¹⁵⁄₁₆	5½
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	16	17	16	16	3 15 0	" "	15¾	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	" "	15¹¹⁄₁₆	..
119,234	5	3/4	Do. 5% Non-Cumulative 3rd Pref.	6	6½	6	6½	4 0 0	–	6⁵⁄₁₆	6⅛
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	104	106	3 0 0	January and July	106	105½
68,000	5	1/0	United River Plate	1	2	1	2	..	" "	..	–
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	86	91	86	91	5 9 11	" "	..	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	13½	14½	13½	14½	..	–	14¾	14
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15½	16¾	15½	16¾	3 16 2	..	16½	15¾
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	5	5½	5	5½	3 12 0	–	–	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	..	–
8,322	£5	..	House-to-House Electric	..		..		–	–	..	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		–	..	..	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		–	January and July	–	–
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7½	7⅝	7½	7½	–	–	..	–
111,000	5	..	London Electric Supply	¼	½	..		..	..	..	–
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	9¾	10¼	9¾	10¼	2 8 9	..	10¼	9¹¹⁄₁₆
£160,000	Stock	4½%	* Do. 4½% Debs.	118	120	118	120	3 15 6	June and December	..	..
6,452	£10	..	Notting Hill Electric	7	7½	7	7½	..	..	..	..
19,980	£5	4 6	St. James and Pall Mall xd	7¾	8¼	7½	8	..	..	7¾	7¾
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9¼	8½	9	3 17 9	..	8¾	8⅝
59,900	5	2/0	Westminster Electric Supply (fully paid)	..		..		2 16 3	..	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	8	1/6	Brush Electrical Engineering	2⅝	2⅞	2⅝	2⅞	5 6 3	–	2⅞	2¹³⁄₁₆
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¾	2⅞	2¾	2⅞	4 11 5	–	2¹³⁄₁₆	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	115	118	115	118	3 17 9	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	3	3½	3	3½	–	January and July	..	..
12,139	5	..	Edison and Swan United	–		–		–	–	–	..
£26,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	–		–		..	–	–	..
120,000	2	..	Electric Construction	¼	½	¼	½	–	–	..	..
12,845	2	2/0¾	Do. 7 per Cent. Cumulative Pref.	1¼	2	1½	1¾	..	–	–	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1½	1⅝	1½	1⅝	–	–	1⅝	1⁹⁄₁₆
20,000	5	..	Fowler-Waring Cables (fully paid)	⅜	1½	½	1½		–	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	22½	23½	23	24	6 4 2	February & August	23¾	22¾
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 8 3	March & September	..	–
15,995	£10	0/4	International Okonite Ordinary	..		..		–	–	..	–
16,000	£10	..	Do. 8 per Cent. Preference	–		–		–	December and June	..	–
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	¼	–	–	¼		..	..	
37,350	12	12/0	Telegraph Construction and Maintenance	43	44	43	45	5 11 6	March and July ..	45	43½
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 13 6	January and July	..	..
37,514	£5	–	Woodhouse and Rawson Ordinary (£3 15s. paid)	–		–		..	–	..	..
41,098	£5	..	Do. Preference (fully paid)	–		–		..	–	..	..
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	9½	10½	9½	10½	4 15 3	..	–	..
£30,000	10	..	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1½%	City and South London Railway xd	48	50	46	48	2 12 1	May and November	48¾	47½
7,000	10	5%	Do. 5% Perpetual Preference xd	14	15	14	15	3 6 8	..	14¾	14½
£67,130	Stock	4%	Do. 4% Perpetual Debenture	128	130	130	133	3 0 2	May and November	132	130½
87,600	£10	2%	Liverpool Overhead Railway	8½	8¾	8³⁄₁₆	8¹¹⁄₁₆	2 9 8	..	–	..
6,295	10	5%	Do. 5% Preference	13	13½	13	13½	3 15 6	..	–	–
125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July ..	–	–

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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NOTES.

That the recent street explosions are due to leakage of gas from the mains and service pipes into electric supply conduits, or any other channels, such as sewer gullies, has been clearly established; but it has been difficult to account for the spark or flame which has fired the explosive mixture. A remarkable explanation has been found for the presence of the spark in St. Pancras and in other districts in which stoneware insulators are used. Incrustations have been found upon the copper mains and upon the insulators. In the former case the copper is being corroded, and green salts sufficiently described by the term verdigris have been produced. In the latter a whitish salt has been found, and analysis has shown that it consists of nearly pure caustic soda. So far, the damage would seem likely to result either in breaking of the copper main or collapse of the insulator; either of these occurrences would probably be accompanied by a spark. But no such failures have been discovered.

An entirely new light, however, has been thrown upon the matter by further examination of the white incrustation. We saw a specimen of this yesterday, excrescent on a fragment of stoneware insulator. A spoonful of cold water was thrown on it, and flames shot out. The experiment had been already repeated many times on this same specimen. It is clear that the caustic soda is only a secondary product, and that pure metallic sodium is electrolytically produced. The presence of water is, of course, necessary for the decomposition of the stoneware, and so long as the moisture is limited, the action goes on so slowly that the sodium turns into caustic soda as quickly as it is liberated. But if, under conditions which may easily and which do arise, particles of metallic sodium remain, mere contact with a drop of water will, as every schoolboy knows, produce active combustion. The Board of Trade, as soon as this was discovered, lost no time in seeking the advice of the Councils of the Royal Society and of the Institution of Electrical Engineers, and measures have already been taken to fill up the boxes in the St. Pancras district, and so to displace the explosive mixture. We understand that the Board of Trade has no intention of interfering with the electrical supply, and that an official communication is being sent to the Vestry, who are naturally anxious to remove the danger, so far as the electrical part is concerned.

It is not necessary to look to the salting of the streets for the source of sodium. This sufficiently reprehensible practice would, of course, give rise to sodium, and thus to gas explosions, even in conduits which are at present practically free from any such danger. The remedy appears to us to be to abandon the ginger-beer-bottle material, which is but a poor insulator, since when moist it actually becomes an electrolyte, and to adopt glass, as is done in other places in which plenty of gas is found, but where no explosions have occurred. Glass insulators for telegraph work are said to be hygroscopic. A film of moisture becomes condensed on its surface, and for this reason porcelain insulators are preferred for telegraph work in damp climates. But the conditions underground are quite different. Even if a film of moisture should be formed on a glass insulator in a conduit, it can do nothing but slightly and temporarily lower the insulation of the circuit. Glass being absolutely impervious, the moisture can be only superficial, and must soon be harmlessly dissipated by the current; it is impossible to conceive that a decently-designed insulator could hold enough water to allow the generation of what the Germans so expressively call "bang-gas." It is of the greatest importance that the whole matter should be thoroughly sifted; skilled electricians alone cannot cover the whole ground, but the aid of experienced practical chemists should be called in. It is satisfactory that some, at least, of the St. Pancras explosions are thus accounted for, and that, thanks to the prompt action of the Board of Trade, steps are being taken to prevent their recurrence. But not a tithe of the recent explosions can be thus explained, and it is most unfortunate that no energetic and practical Government department exists which can bring the primary culprits—the gas companies—to their senses.

The energy and the thoroughness with which our English municipalities have assumed the function of supplying electric current to all who may desire and can pay for it, is at once an unique and an interesting phenomenon. Whether the venture will prove, firstly, a sound financial success, and, secondly, a subject for general congratulation, time alone, and in regard to the latter consideration only a very long time, can show. The financial and engineering success of our leading London low tension companies, the reports and accounts of which are now all to hand, are, however, beyond quibble. The territory of these five prosperous concerns includes the very cream of the residential districts of the metropolis. Roughly triangular in shape, the apex is at Waterloo Bridge, and the southern and northern sides are formed by the river and by Oxford-street and the Bayswater-road.

Taking the companies in the order of their capital expenditures, we find the Westminster Electric Supply Corporation at the head of the list, with a capital expenditure of some £411,000 and an output of some 2,173,000 units. This well-managed concern has actually decreased its expenses in face of a 27 per cent. increase in its output. The St. James and Pall Mall Electric Light Company has now a capital expenditure of some £227,000 and an output of 1,570,000 units. The legal expenses of this Company gave rise to some grumbling at the annual general meeting, and it is not perhaps altogether cheering to learn that more "nuisance" litigation is pending; such misfortunes can, however, be accepted with some equanimity in face of a 6½ per cent. dividend, and may be considered as disagreeable incidents in a not altogether unpleasant campaign. The Charing Cross and Strand Electricity Supply Corporation comes next, with a capital expenditure of some £212,000 and an estimated output of some 950,000 units. The Kensington and Knightsbridge Electric Lighting Company, which has not, by the way, overcome its early coyness in the matter of presenting accounts to the shareholders in Board of Trade form, follows next with a capital expenditure of something like £187,000 and an output of about 978,000 units. This concern has succeeded in augmenting its income by 33 per cent., with an increased expenditure of only 20 per cent. Lastly, we come to the Chelsea Electricity Supply Company, with its capital expenditure of £120,000 and its output of 469,000 units, and which has managed to bring down its sheer cost of production by one-third of a penny.

All these companies, therefore, tell the same tale of increased output and decrease in the ratio of working expenses to revenue. All of them are paying satisfactory dividends, the same as last year in some cases, more than last year in others. All of them are setting aside sums for depreciation, and some, we are particularly glad to note, have already started capital redemption funds against the day of municipal purchase. The sums set aside for depreciation are no doubt of modest dimensions when considered by themselves, but the large sums annually spent on maintenance must also be reckoned in. For instance, the St. James' Company devoted £3,700 to depreciation, or only about 3 per cent. on its total expenditure on buildings, plant, mains, &c., but it spent no less than £2,200 during 1894 on upkeep, bringing the total up to 4 per cent., a by no means bad figure when we remember the small depreciation undergone by buildings or by bare copper mains when properly laid.

The cause of the range of dividend from 6½ to 4½ per cent. is to some extent explained if we divide the capital outlay of each company by the number of units sold by it. Thus the St. James' Company, with its 6½ per cent. dividend, has expended less than 3s. worth of capital per unit sold in 1894. The Westminster and Kensington Companies, with their dividends of 5 per cent., have expended 4s. The Chelsea Company, with its dividend of 5 per cent., has spent 5s.; and the Charing Cross Company, with its dividend of 4½ per cent., has spent about 4s. 6d. worth of capital per unit sold in 1894. Economy in capital expenditure, like virtue, brings its own reward.

The *Art Journal* for March contains an illustrated article by Mr. C. R. Ashbee on electric light fittings. Those who know the severity of the author's taste will not be surprised to find suggestions for fittings which would harmonise excellently with a Norman castle or a Pompeian villa. The ordinary ironmonger would, probably, be disgusted with the outlines, and would think Mr. Ashbee's favourite material, pewter, distinctly unseemly in polite society. Mr. Ashbee prefers rest in a design, and feels disturbed when three naked bronze children come rushing over the table with 48-candle-power hands full. It may suggest electricity, he says, but it does not suggest repose, and it has to be done very well if it is to be done at all. This bronze children business is, we think, getting rather tedious. The realism of the designs was novel at first, and hardly, if at all, more artistic than modern Italian sculpture; but the affectation of a green patina, done apparently in flatted oil paint, is singularly incongruous. It is a curious feature of the electric glow lamp, that it adapts itself, with the utmost facility, to a fifty-guinea gaudy ormolu vulgarity or to a sixpenny silk handkerchief with a hole in the middle of it.

Inter-urban Telephonic Communication in Germany.—The telephone trunk line between Berlin and Bremerhaven was brought into operation a few days ago.

International Telephony.—The Rome-Vienna telephone trunk line is to be completed by the end of this year. It will consist merely of a connecting link between the already existing Vienna-Trieste and Rome-Milan lines.

Cavendish Laboratory.—The extension of the buildings of the Cavendish Laboratory is about to be undertaken, at an expense of over £4,000. About half the cost will be met from the accumulated fees of students working in the laboratory.

The Price of Bad Weather.—The *Electrical Review* of New York says that it costs the West End Street Railway Company of Boston between £40,000 and £50,000 a year to keep its tracks clear of snow. A heavy snowstorm costs the road about £10,000.

Electric Traction in Bucharest.—The electric tramway, on the overhead conductor system, along the principal boulevards in Bucharest has been completed, and was recently opened for public traffic. The line, which is a double one the greater part of the distance, is about three miles long.

Telephony in Austria.—During last year 24 towns in Austria were provided with telephone exchanges. As regards interurban communication, nine new lines were put in operation during the year. There are now altogether 47 interurban telephone lines in operation in Austria, having a total length of 4,230 kilometres.

Cable Interruptions :	Date of Interruption.
Latakia—Cyprus	Nov. 27, 1894.
Hongkong—Macao	Dec. 31, 1894.
Martinique—Paramaribo	Feb. 21, 1895.
Cadiz—Teneriffe	Feb. 23, 1895.
Constantinople—Odessa	Feb. 25, 1895.

The Halifax and Bermudas Cable.—An official notice has been given in the Private Bill Office of the House of Lords that the Halifax and Bermudas Cable Company do not intend to proceed any further with their Bill deposited for this session. Under this Bill it was proposed to make further provision with reference to the investment of the subsidy, payable to the Company by Her Majesty's Government.

Municipal Telephony.—In answer to a question in the House of Commons, on Friday last, the Postmaster-General stated that he had consulted the Solicitor to the Post Office, and was advised by him that even if a corporation obtained a licence to transmit telegrams by telephone, it could not erect and maintain telephonic apparatus and manage what was generally understood by exchange business at the expense or risk of the corporate funds or rates without the express sanction of Parliament.

Protection from Lightning.—The Admiralty have directed that, in order that men working under a ship in dry dock may be secure against danger from lightning, a thorough metallic connection by wire, rope, or otherwise, is to be effected between several points of the ship's iron, such as ring bolts, &c., and iron pipes leading to the water outside the dry dock, there being no danger to anyone or anything inside the ship. Similar precautions are to be taken in respect to the frames of ships on the stocks in the course of building.

The Draft Telephone Agreement.—The following is the text of Mr. Benn's motion respecting telephone licences, which has the first place at the evening sitting to-day: "That a Select Committee be appointed to consider the proposed draft agreement between the Postmaster-General and the National Telephone Company, and report with reference to the monopoly which may thereby be created; the granting of telephone licences to municipalities; and generally on the future policy of the Post Office with reference to the extension of the telephone service."

The Flash Point of Petroleum Oils.—We have received from Mr. T. Graham Young, of Glasgow, a pamphlet containing his reply to an article in *The Times*, in which the substitution of a close test at 73°F., in place of the 100°F. open test, is advocated. Mr. Young gives his reasons for believing that this substitution would be a danger to the public, as, in his opinion, the two tests are not equivalent. It would certainly be a matter for regret if any new provisions should enable the oil distillers to leave a dangerous amount of light oil in the commercial burning oils.

The Electrical Utilisation of Water Power in Scotland.—At a recent meeting of the Inverness District Committee application was made on behalf of the British Aluminium Company, for authority to divert certain roads in the neighbourhood of Foyers, so as to allow of Lochs Forraline, Garth, &c., to be raised from 10 to 20ft. to provide water for turbines for the generation of electricity. It was agreed to sanction the diversion of the roads on condition *inter alia* that the Company pay the District Committee a sum of money, in respect of the value of the concession, for the making of new roads and the maintenance of existing roads in the district.

Municipal Tramways.—On Friday last a deputation from the Leeds Corporation waited upon the President of the Board of Trade with respect to the suspension of standing orders which prohibit corporations obtaining powers to work tramways. Mr. Bryce said the matter was one of great importance, but he could not act without consulting his colleagues. He suggested that, as the London County Council had a Bill to obtain powers to work their tramways before the House of Commons, they should wait till that Bill had been dealt with in Committee before further action was taken; but ultimately it was arranged that an endeavour should be made to get the Chairmen of Committees in both Houses to consider the matter with a view to arriving at a joint decision on the point.

French Submarine Cable Enterprise.—The following telegrams have appeared in the French papers:—

The Madagascar Cable.

Marseilles, February 16.

The Madagascar cable, the construction of which was entrusted by the Government to the Grammont Works at Pont-de-Chéruy (Isère), was delivered complete this morning at St. Tropez (Var), and will be put on board immediately. The rapidity with which this important work has been accomplished shows the superiority of French manufacturers over the English, to whom we were even recently tributary.

The Madagascar Expedition.

Toulon, February 24.

The steamer "François Arago," whose departure from St. Tropez was at first fixed for the 16th inst., and, after several successive postponements, definitely for to-day, has not yet got under weigh. These delays are owing to the difficulty of getting the Majunga-Mozambique cable on board, for the laying of which this steamer was specially chartered.

Fatal Accident at Bristol.—We have received the following letter from Mr. H. Faraday Proctor:

Sir: A most deplorable accident occurred at one of the sub-stations of the Bristol Corporation Electric Light Works on Monday afternoon, February 25th, resulting in the death of a linesman. The deceased, Robert Coleman, had been engaged by the Corporation as a linesman for twelve months, prior to which he had been employed by Messrs. Siemens Bros., National Telephone Company, &c., and was a thoroughly sound and good man in every respect. Coleman had been entrusted with the keeping in order of the sub stations for some months past, and at the time of the accident was wiping down the high-tension board with a cloth, and was wearing an india-rubber glove on his right hand for the purpose. While so working he looked away to speak to another person present, and the back of his left hand accidentally came in contact with a fuse terminal, he thus making contact to earth with the 2,000-volt mains. Every effort to restore him was without avail. A medical man was on the scene within two minutes.

On Wednesday evening an inquest was held, and a verdict of accidental death from electric shock was returned. Some jurymen thought it advisable that two gloves should be used by the workmen, and another suggested that a book of rules be handed to each man. Mr. Faraday Proctor remarked that they made a rule that one gloved hand should be used, and to instruct the men to wear two gloves would be like an invitation to them to break the rule.

Professorial Appointments.—At a meeting of the electors to the Sadlerian Professorship of Pure Mathematics, held at Gonville and Caius College Lodge on Monday afternoon, Dr. Andrew Russell Forsyth, F.R.S., Fellow of Trinity College, was elected professor in the place of the late Prof. Cayley. The new professor is a native of Glasgow, and was born in 1858. He was educated at Liverpool College, and proceeded to Trinity College in 1877, obtaining a scholarship. He graduated in the Mathematical Tripos of 1881 as Senior Wrangler, was subsequently awarded the first Smith's Prize, and in October of the same year was elected to a Fellowship at Trinity. He proceeded to the degree of Doctor in Science, and has for some time been a Fellow of the Royal Society. He is the author of a "Treatise on Differential Equations," first published in 1885. He also published, in 1890, "The Theory of Differential Equations," and, in 1893, "The Theory of functions of a Complete Variable."——Prof. Warburg, at present at Freiburg University, has been called to succeed the late Prof. Kundt as Professor of Experimental Physics at Berlin University. Dr. Johann Sahulka has been appointed head of the recently organised electrical department of the Austria Standards Bureau.

Recent Explosions.—On Friday last three junction-box explosions occurred at Huddersfield, and in the case of two of them several persons had narrow escapes of being injured. The first explosion occurred at a quarter past two in the morning. The other two boxes exploded simultaneously about half-past five o'clock yesterday afternoon. Mr. Mountain, the electrical engineer to the Corporation, is of opinion that the explosions were caused by gas getting into the junction boxes and being ignited by an electric spark.——On Saturday, about 7·50 p.m., an explosion in connection with the St. Pancras Vestry-mains took place opposite 10, Gee-street, Seymour-street, Euston-road, a few hundred yards from Endsleigh-gardens, where a similar explosion took place last December. As in the previous instance, the explosion was preceded by a low rumbling sound, and directly afterwards the covers of two manholes, one in the roadway and the other on the pavement, were blown into the air, while the paving stones were dislodged for a space of four or five yards. The manholes are about ten yards apart and are connected by culverts. The electric department of the Vestry and the Gas Light and Coke Company sent experts to make an examination. It is supposed that gas had accumulated in the manholes. No inquiry will be held into the matter. The probable cause of this explosion is discussed in another column.——With regard to the recent transformer chamber explosion in Leicester, Mr. Colson, the gas and electric lighting engineer has submitted his official report. In his judgment the explosion was caused by an electric arc being formed between the high tension terminals and the consequent gasifying of the oil used in the box as the insulating medium. Owing to the explosion it has been decided to substitute specially prepared wax for the oil at present in use in the various transformer chambers in the town.

MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 331.)

Surface Condensers.—Where the cooling water is too saline or too dirty to be used as feed water, and at the same time it is desired to feed the boilers with warm water from the condenser, some form of surface condenser must be used. A surface condenser, strictly speaking, is one in which the exhaust steam is separated from the cooling water by a partition of cooling surfaces, formed by metal tubes or other means; and in this sense it includes the evaporative condenser. We shall restrict the term to such condensers in which the cooling water is not evaporated at the cooling surface. The principal parts of a surface condenser plant comprise: a number of metal tubes fixed parallel to one another between two tube plates within a closed chest or chamber; a circulating pump, for causing a circulation of cold water through the condenser; and an air-pump, for drawing out the air and condensed steam. The condensed steam is passed into the hot-well, from which it is pumped into the feed-heaters and thence to the boilers. The circulating water is either returned to the cooling pond or rejected into the drain. Usually the plan of causing the circulating water to pass through the metal tubes, and the exhaust steam to flow into their containing chest or chamber, is followed; but in some surface condensers the reverse practice is followed. According to Mr. D. K. Clark the former practice is more efficacious than the latter.

As it is impossible to raise the temperature of the cooling water to the same point as that to which the steam is cooled, a difference of from 15°F. to 25°F. between the surfaces of the tubes being necessary, it will be seen that a surface condenser must be supplied with a greater weight of water than a jet condenser, for equal weights of steam condensed. Usually, in temperate climates, about 10lb. to 15lb. weight of cooling water per pound of steam is necessary. The condensed steam is pumped out of the condenser at from 110°F. to 130°F., and the cooling water is raised from about 60°F. to about 90°F. to 100°F.

In designing or selecting a surface condenser for an electric power station, it is well to ensure ample condensing surface, and to estimate the extent of this surface upon a rational basis. Old-fashioned engineers used to make the condenser surface bear a fixed relation to the boiler heating surface, which is all very well where the type of boiler and the class of work to be done are always the same. Nowadays, the boiler heating surface bears no fixed relation to the duty which will be imposed on the condenser, and the best plan is to design the extent of condenser surface to suit the number of heat units which will have to be abstracted from the exhaust steam in any given time, when the engines are working at their highest loads. From some experiments made by Mr. B. G. Nichol, it would seem that when cold water flows through clean brass tubes set horizontally, the velocity of the water being 78ft. per minute, a heat transference of 533 B.T.U. per square foot of tube surface per minute, per 1°F. of temperature difference can be obtained. Dirt on the tube surfaces, or oiliness caused by lubrication carried over with the steam, will very much reduce this efficiency; and it does not seem that it is wise to allow more than 200 B.T.U. per square foot of tube surface per minute. From this datum the total extent of surface for any given case can be calculated. It will be found to average about 2 square feet per I.H.P.

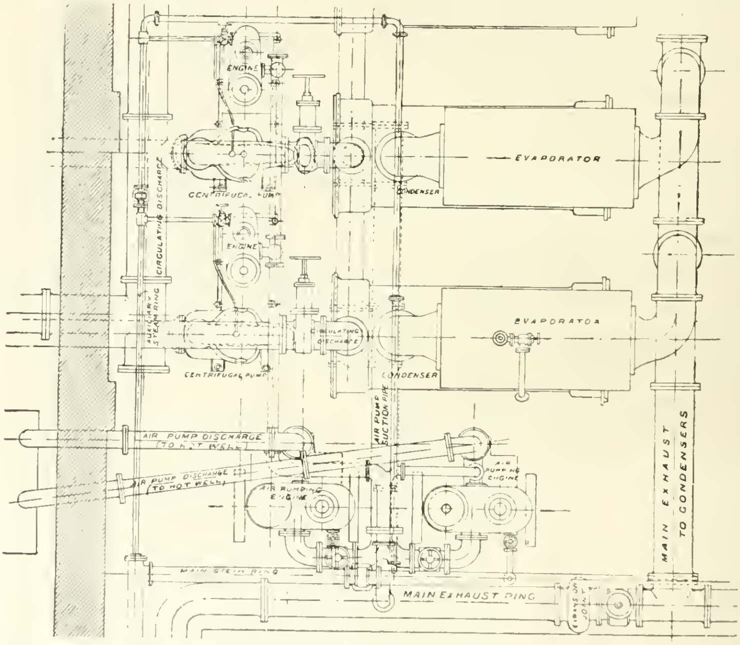

Fig. 47.—Plan of Condensing Plant at the British Electric Power Station.

Surface condensers, designed by Mr. Kapp and manufactured by Messrs. W. H. Allen and Co., are used at the Bristol electric power station, owing to the corrosive chemicals contained in the river Avon at the point where the station is situated. A plan, drawn to scale, of the condensing plant at this station is shown in Fig. 47. Each condenser is surmounted by a closed drum containing a supply of water, which can be evaporated and distilled for making up the waste of feedwater. This apparatus is called a feed-make-up evaporator, and the water in it is evaporated by turning live steam into it, as desired. The circulating pumps are of the centrifugal type, and the air-pumps are of the vertical direct-thrust pattern.

Evaporative Condensers.—Where the supply of cold water is very limited, and at the same time extensive space for reservoirs and cooling ponds cannot be afforded, the evaporative type of condenser is occasionally used. The evaporative condenser is a form of surface condenser, consisting of a large number of pipes, usually of cast iron, through the inside of which the exhaust steam is passed, and over the exterior of which cold water is continually trickled. The outer surfaces of the tubes or pipes are kept merely wet, they are not immersed in water; and the heat of the steam is carried off by the evaporation of water from these surfaces. Sometimes there is a forced draught of cold air past the pipes to assist the evaporation; but more often the pipes are stacked on the roof of the engine house, where the draught of the wind is sufficient to maintain the cooling action. A vacuum of from 20in. to 25in. of mercury can be obtained with a supply of cold water, copious enough to limit the evaporation to from 0·75 to 1·00 times the weight of steam condensed; so that the actual draught of water from the supply mains may be much less than where non-condensing engines of equal power are used. It is sometimes objected that evaporative condensers, necessitating as they do that the vacuum shall be produced at some distance from the engines, are liable to cause a bad vacuum at the point where it is really wanted, owing to leakage at the main pipe joints. It would not seem, however, that such need be the case, as condensers of this type have been used with success at more than one electric supply station; and the author is informed that in one case there is only a rise of ⅜ths of an inch of mercury between the condenser and the engines, the length of connecting exhaust main being 140ft., and the total length of piping, including the condenser, being 350ft.

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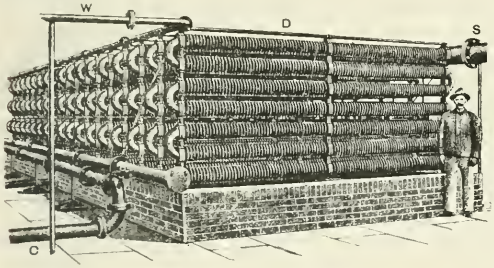

Fig. 48.—Ledward Evaporative Condenser

A large evaporative condenser, erected by Messrs. T. Ledward and Co., to work with a battery of Willans engines having a total capacity of 350 h.p., at Rixdorf, near Berlin, is shown in Fig. 48. The exhaust steam passes to the condenser through the main pipe S, and the supply of cooling water is conveyed by the water main W. The condensed steam is drawn off by the air pump through the pipe C, having previously passed through the system of condensing pipes forming the body of the stack. These pipes are corrugated with circular ribs, to increase the radiating surface; and they are bolted together with flanged-faced joints. Over each vertical set of pipes there is a branch water pipe, D, which is perforated to allow of a constant stream of cold water dripping on to the pipes and flanges. The surplus water drips into the tank at the base of the stack, and is conveyed back to the cooling tower, or pumped directly up again to the main W as may be desired. It may be mentioned that a very considerable vacuum can be obtained with a consumption of not more than half the weight of feed water, with the condenser fully loaded; while, when the condenser is at about 100 h.p. load a good working vacuum can be obtained without any water whatever, the dry cooling action of the pipes and radiators being sufficient.

Dry Air Condensers.—It has been proposed by some engineers to construct condensers after the pattern of Ledward's evaporative condenser, but to work them without cooling water. As has just been stated, the air will, to some extent, act as a cooling agent. The chief objection to this form of condenser is that it would necessitate the passage of very large volumes of cold air between and around the pipes, as the specific heat capacity of air is very much lower than that of evaporating water. Either an enormous extent of cooling surface would have to be provided, in which case the initial cost would be large, or artificial means would have to be adopted to force the air circulation, in which case the running cost would be high. Another objection to such a condenser is that it would be at the mercy of "the clerk of the weather."

Water Cooling Arrangements.—Where the condensing water is kept in circulation, and is not continuously rejected into the waste pipe, the provision of ample cooling plant is quite as important as the provision of the condenser itself. A considerable amount of heat has to be got rid of as fast as it is taken up by the cooling water, otherwise the water in the reservoir will rise in temperature, and the vacuum will fall. There are three methods, or combinations of these, which are used in practice; (1) the simple cooling pond or tank, (2) the spray or fountain, and (3) the cooling tower. In all three the action depends on the absorption of heat into the atmosphere, partly by direct heating of the air itself, but chiefly by evaporation of the warm water. The cooling pond or tank, without the aid of either fountain or tower, is the most expensive method, generally speaking; but it may be adopted where it is otherwise necessary to have a large quantity of water in reserve. The cooling action is practically independent of the depth of the water, and varies directly as the surface, so that an extensive, shallow pond is generally required. The amount of heat dissipated from each square foot of pond surface depends on the following conditions: (1) The temperature of the water, (2) the vapour pressure of the moisture already in the superincumbent air—in other words, the dew point—and (3) the condition of motion of the air over the surface of the water; *i.e.*, the wind. The following table, based upon the researches of Dr. Dalton, gives the weight of water evaporated from each square foot of pond surface, at any given temperature of the water and with the air quite dry and motionless. The number of units of heat dissipated is practically 1,000 times the weight of water evaporated. When the air is not perfectly dry—*i.e.*, in ordinary practice—the actual weight of water evaporated will be found by subtracting the weight corresponding to the temperature of the dew-point from the weight corresponding to the temperature of the water. Thus, in still air, if the dew-point is at 40°F. and the water is at 120°F., the actual evaporation per square foot of pond surface will be found by subtracting 0·0459 from 0·5815, or is equal to 0·5356lb.; and the number of heat units dissipated per hour from this surface is 535·6 B.T.U. When the air is not motionless the evaporation is increased; a light wind producing about 28 per cent. increase, and a brisk wind as much as 57 per cent. increase in evaporation.

Evaporation of Water into Perfectly Dry Still Air.

Temperature of water in degrees Fahr.	Lbs. of water evaporated per sq. ft. of water surface per hour.	Temperature of water in degrees Fahr	Lbs. of water evaporated per sq. ft. of water surface per hour.
32	0·0349	125	0·6619
35	0·0386	130	0·7580
40	0·0459	135	0·8730
45	0·0552	140	1·003
50	0·0655	145	1·140
55	0·0774	150	1·296
60	0·0917	155	1·467
65	0·1076	160	1·652
70	0·1257	165	1·865
75	0·1486	170	2·118
80	0·1746	175	2·378
85	0·2043	180	2·646
90	0·2375	185	2·969
95	0·2760	190	3·318
100	0·3248	195	3·706
105	0·3807	200	4·128
110	0·4418	205	4·563
115	0·5100	210	5·034
120	0·5815	212	5·239

(To be continued.)

LIGHTING PIT TOPS AND BOTTOMS.

BY ALBION T. SNELL.

In Mr. G. S. Corlett's Paper, which was read before the Northern Society of Electrical Engineers, attention is drawn to the difficulty of regulating pressure at the lamp terminals below ground, unless the shaft cables are of large section, compared with the load. But the question raised is not answered in a clear way, and as some confusion may arise with mining managers, I propose to add a few remarks.

Taking Mr. Corlett's figures as they stand, 1,300 yards of 19/11 cable is assumed to cost £310, and to have a line drop of 4 volts when carrying current for 50 incandescent lamps (25 amperes), the lamps to cost 30s. each erected, and the running and fixing of the conductor £40, making a total of £425 as the cost of lamps and wiring from pit bank. And a 19/15 cable costing £119 is said to give a line drop of 10 volts with the same load. The difference between the cost of the two cables is, therefore, at least £123, which is a considerable increase on the smaller sum, and the engineer who advised the colliery manager to spend it *merely* to lessen the regulation difficulties would not know his business.

Now, I have shown in "Electric Motive Power" that the size of the conductor as far as the pit bottom, which is the distributing centre, must be regulated simply with respect to the law of economy, always assuming that the cross section is not less than that of 19 strands of 16 S.W.G., which is, perhaps, the smallest cable worth running in deep shafts. The line drop is a secondary matter, and must be regulated as well as circumstances permit by one of the usual methods.

To take the case just referred to, when the smaller cable is employed. In the first place, I wish to point out that a fair approximation can be made by the use of 105-volt lamps on the surface and 100-volt lamps below ground, if the dynamo be suitably over-compounded, and the loads on the two circuits are approximately of the same magnitude. The feeder drop is by hypothesis 10 volts, and if this be compensated for by the shape of the characteristic curve, the mean variation of pressure under the worst conditions cannot exceed 5 per cent. at any part of the two circuits, as is easily seen to be the case. But in practice the matter would not be quite so bad, for it is not likely that the dynamo would at any time run with less than about 20 per cent. of the full load, at which the terminal pressure would be, say, 102 volts. And the characteristic curve could easily be flattened at from 75 per cent. to full load, so that the maximum terminal pressure would be 107·5 volts instead of 110 volts. The mean variation of pressure would then be about 3 per cent. With less than 20 per cent. load the pressure would diminish above ground, but below ground it would remain at approximately the proper value.

The preceding solution, however, is insufficient when the surface load is much larger than that at the end of the feeders in the pit. For example, with the assumed figures, the pressure at three-quarter load is 107·5 volts, and if the surface lighting *alone* absorbed this power then a few lamps run at the bottom of the pit would be overrun.

Next, I suggest that the regulation can *always* be made practically perfect by the use of a small series dynamo placed in series with the underground feeder circuit. This must be wound to carry the whole of the current in this part of the circuit, and to add volts in proportion to the fall of pressure at the feeder ends. The surface lighting would, of course, be run from the terminals of the main dynamo, which should be compounded, and the regulating dynamo should be coupled to it directly or by belting. The device is well known, and the cost very much less that that involved by the heavier cable, for the machine is of small size.

It will be evident from the above that there are simple ways of dealing with combined surface and underground lighting with even two-wire feeders. In some extreme cases three wires might be used with advantage. And there are special cases where a dynamotor at the pit bottom would give a neat solution; but in *no* case need an independent engine and dynamo be used at a pit bottom for lighting *merely* on account of pressure regulation, as suggested by Mr. Corlett in one of his alternative schemes.

CHEAP FUEL.

The processes of waste in Nature as well as in Art lead to the production of a great variety of combustible and semi-combustible materials—such as dust, sawdust, smudge, slack, breeze, &c. Many attempts to utilise these as fuel have been made, with more or less success, from time to time, and there exist no doubt many steam plants in which steam is cheaply raised by these low-grade fuels. But, apart altogether from the engineering side of the problem, to which we shall advert presently, there are important considerations to be made in estimating the merits of "cheap fuel" for steam plant. These low-grade fuels are only cheap when they lie right to hand, or, in other words, when little or no expense is involved in bringing them to the furnaces. Again, they are only "cheap" in the true sense where high-grade fuels cost many times as much per ton; for their tax on labour in stoking, &c., is as enormous as their yield in steam is paltry. Without further detail, then, we may assert that the use of low-grade fuels has only a local and restricted value. Even with an ideal furnace to consume them, these fuels could be used with advantage in only a very small percentage of existing stationary boilers.

During the past week the public has been invited to subscribe £25,000, out of a total capital of £80,000, for the purpose of exploiting a new system of low-grade fuel combustion. The patent rights are to be purchased for the sum of £40,000, of which one-quarter is payable in cash. Let us examine more closely what it is that the "Empire" Economic Steam Producer Company expects to do, and what it has to offer. As to the first matter, it makes the interesting estimate that there are about 300,000 stationary boilers now in use in the United Kingdom, and that "the reconstruction of only 1 per cent. of these, at a charge per boiler (to cover cost of reconstruction and royalty) of from £30 and upwards, according to size and nature of same, and a future minimum royalty of £10 per boiler per annum on such number of boilers, would produce a gross revenue of £30,000 per annum." No doubt: it is a matter of arithmetic. But it is a question whether this "reconstruction of only 1 per cent. of these" is ever likely to happen. The system proposed may or may not be as perfect as can be. That is not the point. Where the room for doubt lies is whether one in every 100 or even in every 1,000 factory boilers could advantageously be made to consume dust and low-grade fuel, in the first place, and by this particular patent process in the second place.

Next, what kind of an engineering article has this Company to offer? It intends to buy two patents and the rights to a third, which is still in embryo. Each of the complete patents relates to a form of grate, and the claims are for the grate alone though from the description it appears that a forced draught is intended to be used. The essential and common idea in these two grates seems to be to force a sufficiently strong draught through a number of perforations in the firebars or plates, so that "the fuel dust is kept floating above the plate in the currents of air rising through the perforations." By this truly original means it is sought to avoid clogging the perforations and to induce rapid combustion. We would like to know whether the engineering advisers of this Company have ever heard of clinker? And if so, what they think will become of it in their furnace? Will *it* "float above the perforations in the currents of air," or will it clog those same perforations? We should also like to know how they propose to prevent the dust fuel from making an excursion over the bridge and along the flues. Even in cases where the forced draught is not strong enough to make the fuel float above the grate, there is, we believe, no little trouble caused by the accumulations of ash and dust in the flues. What may be expected in a tornado such as is now proposed is too terrible to contemplate! Moreover many of our readers, and practically all of those who are directly interested in the subject, are well aware that the utilisation of dust and other forms of low-grade fuel is no new thing, and that the proposed system will find a number of competitors already in the field, among which we may mention the "Meldrum" system, recently described in our columns. It is due to the "Empire" system to state that it has been tried at several places, and that it seems to have given satisfaction where it has been used.

PROPAGATION OF MAGNETISATION OF IRON AS AFFECTED BY THE ELECTRIC CURRENTS IN THE IRON.*

BY J. HOPKINSON, F.R.S., AND E. WILSON.†

(Concluded from page 512.)

The alternate currents used have periodic times, varying from 4sec. to 80sec., and were obtained from a battery of 54 storage cells by means of a liquid reverser,§ shown in elevation and plan in Figs. 14 and 15. It consists of two upright curved plates of sheet copper, A A, between which were rotated two similar plates, B B, connected with collecting rings, D D, from which the current was led away by brushes to the primary circuit of the magnet. The copper plates are placed in a weak solution of copper sulphate in a porcelain jar. The inner copper plates, and the collecting rings, are fixed to a vertical shaft, S, which can be rotated at any desired speed by means of the gearing shown in the figure. The outer plates are connected to the terminals of the battery of storage cells, and the arrangement gives approximately a sine curve of current when working through a non-inductive resistance.

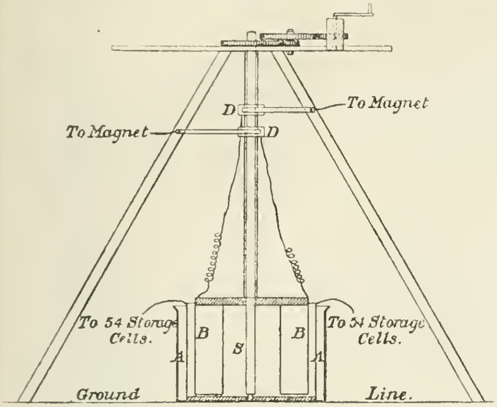

FIG. 14.

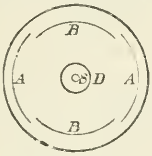

FIG. 15

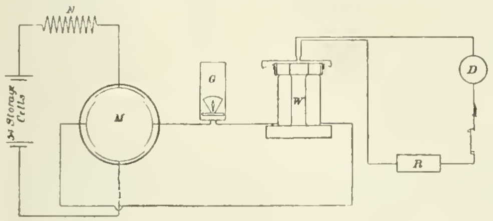

FIG. 16.

Fig. 16 gives a diagram of connections in which M is the current reverser, G is the Thomson graded current meter for measuring the maximum current in the copper coils, and W is the electromagnet.

A small, non-inductive resistance placed in the primary circuit served to give the curve of current by observations on the D'Arsonval galvanometer, D, of the time variation of the potential difference between its ends. The D'Arsonval galvonometer was also used for observing the electromotive forces of the exploring coils 1, 2, and 3 (*see* Fig. 8), R being an adjustable resistance in its circuit for the purpose of keeping the deflections on the scale.

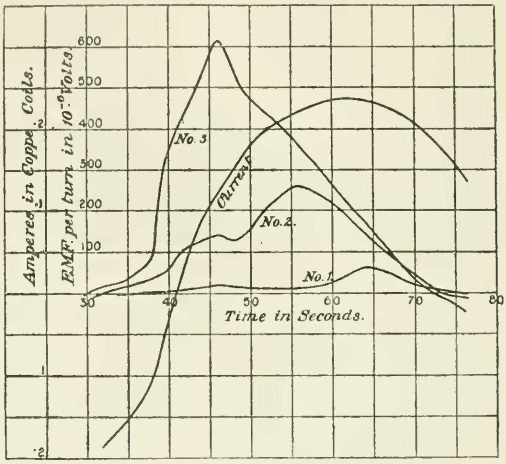

FIG. 19.

The method of experiment was as follows: The liquid reverser M was placed so as to give a maximum current on the meter G, which was adjusted by non-inductive resistance N to the desired value, and in all cases, when changing from higher to lower currents, a system of demagnetisation by reversals was adopted. Time was taken on a clock beating seconds, which could be heard distinctly.

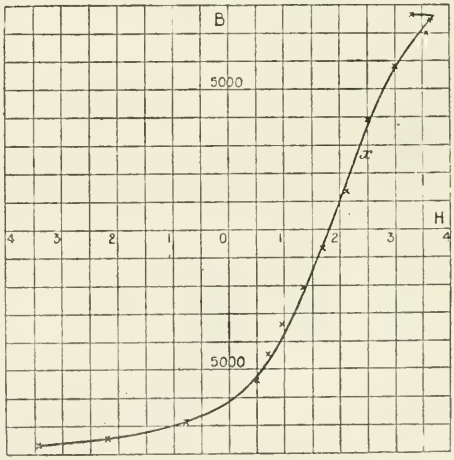

FIG. 19B.

As an example, take Fig. 19, in which the periodic time is 80 seconds, and the maximum current in the copper coils 0·23 ampere. The E.M.F. curves of the exploring coils are numbered 1, 2, and 3 respectively, and the curve of current in the copper coils is also given.

As in the case of simple reversals, we may from these curves attempt to obtain an approximation to the cyclic curve of induction of the iron. In all cases where this is done we have taken coil 1, and considered the area within it—that is to say, from a knowledge of the E M.F.'s at different depths of the iron, due to change of induction at any epoch, we have estimated the average magnetising force acting in this area, and this we call H_w. The

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* Abstract of a Paper read before the Royal Society.

† The experimental work of this Paper was in part carried out by three of the student demonstrators of the Siemens Laboratory, King's College, London, Messrs. Brazil, Atchison, and Greenham. We wish to express our thanks to them for their zealous co-operation.

‡ The figures marked with ‡ are not reproduced in this abstract. The reader is referred to the original Paper.

§ This form of reverser is due to Prof. Ewing.

Table II.

Time in seconds after reversal.	Curve I.			Curves II. and III.				Force due to current in magnet coils. H_1.	Radius 1·22cm.		Radius 3·18cm.		Radius 5·08cm.		Curve I.			Curve II.			Curve III.		
	Area in $\frac{4}{25}$ diagram squares of Curve 1. Fig. 12.	Change of induction per sq. cm. in C.G.S. units.	Induction per sq. cm. B.	Area in $\frac{4}{25}$ diagram squares of Curve 2. Fig. 12.	Area of Curve 2, minus Curve 1, in $\frac{4}{25}$ diagram squares.	Change of induction per sq. cm. in C.G.S. units.	Induction per sq. cm. B.		E.M.F. in volts in 10^{-6}.	Amperes per sq. cm.	E.M.F. in volts in 10^{-6}.	Amperes per sq. cm.	E.M.F. in volts in 10^{-6}.	Amperes per sq. cm.	Area in 2 diagram squares. Radii 1·22 to 5·08 of Curves in Fig. 12A.	Force due to induced currents. H_2.	Resultant force. H.	Area in 2 diagram squares. Radii 3·18 to 5·08 of curves in Fig. 12A.	Force due to induced currents. H_2.	Resultant force. H.	Area in 2 diagram squares. Radii 2·2 to 5·08 of curves in Fig. 12A.	Force due to induced currents. H_2.	Resultant force. H
0	0	0	−8,680	0	0	0	−7,720	−4·96	0	0	0	0	0	0	0	0	−4·96	0	0	−4·96	0	0	−4·96
2	1·5	...	...	13·7	12·2	1,842	−5.878	+4·86	36	0·377	268	1·06	888	2·14	21·4	−5·3	−0·44	15·0	−3·77	+1·09	19·1	−4·8	+0·06
3	2·7	2.130	−6.550	20·9	18·2	2.744	−4,976	+4·96	32	0·335	247	0·985	787	1·89	21·1	−5·28	−0·32	14·4	−3·62	+1·34	18·4	−4·6	+0·36
7	5·1	4.024	−4.656	47·1	42·0	6,315	−1,405	+4·96	20	0·200	310	1·23	437	1·05	18·9	−4·73	+0·23	11·6	−2·92	+2·04	17·0	−4·2	+0·76
11	7·1	5,604	−3 076	76·0	68·9	10,360	+2,460	+4·96	22	0·230	247	0·985	291	0·699	14·6	−3·6	+1·16	8·4	−2·11	+2·85	12·7	−3·2	+1·76
15	10·2	8,046	− 634	98·0	87·8	13,203	+5,483	+4·96	52	0·544	180	0·717	204	0·490	12·9	−3·2	+1·76	6·0	−1·51	+3·45	9·7	−2·4	+2·56
19	16·0	12,623	+3,943	111·5	95·5	14,360	+6,640	+4·96	52	0·544	113	0·450	144	0·346	8·56	−2·14	+2·82	4·0	−1·0	+3·96	6·4	−1·6	+3·36
23	19·7	15,540	+6,860	119·5	99·8	15,006	+7,286	+4·96	24	0·251	52	0·207	88	0·211	4·23	−1·05	+3·91	2·0	−0·50	+4·46	3·0	−0·75	+4·21
35	22·0	17,360	+8,680	124·7	102·7	15,440	+7,720	+4·96	0	0	0	0	0	0	0	0	+4·96	0	0	+4·96	0	0	+4·96

Table III.

Time in seconds after reversal.	Induction.			Radius 1·22cm.		Radius 3·18cm.		Radius 5·08cm.		Force due to current in magnet winding. H_1.	Force taken from the given cyclic curve. H.	Difference of forces. H_1 and H.	Area in four diagram squares corresponding to differences of forces. H_1 and H.	Area in four diagram squares of curves in Fig. 13A.
	Area in $\frac{4}{25}$ diagram squares of Curve 1, Fig. 13.	Change of induction per square cm. in C.G.S. units.	Induction per square cm. B.	E.M.F. in volts in 10^{-6}.	Amperes per square cm.	E.M.F. in volts in 10^{-6}.	Amperes per square cm.	E.M.F. in volts in 10^{-6}.	Amperes per square cm.					
0	0	0	−14,495	0	0	0	0	0	0	+16·02	16·0	0	0	0
1	0·92	1,814	−12,680	99·0	0·95	902·0	3·48	4,615	11·1	−14·09	3·0	17·0	6·7	7·9
2	1·9	3,747	−10,748	91·3	0·88	1,534·0	5·91	3,077	7·4	−14·83	0	14·8	5·9	7·8
3	2·5	4,930	− 9,565	79·9	0·77	1,804·0	6·95	2,460	5·9	−15·13	0·5	14·6	5·8	8·0
4	3·7	7,298	− 6,197	91·3	0·88	1,579·0	6·09	1,850	4·4	−15·28	1·0	14·3	5·7	8·8
5	4·8	9,467	− 5,028	205·0	1·98	1,331·0	5·13	1,540	3·7	−15·43	1·2	14·2	5·6	7·8
6	10·0	19,723	+ 5,228	647·0	5·87	902·0	3·48	1,080	2·6	−15·58	2·7	12·9	5·2	7·1
7	13·6	26,825	+12,330	152·0	1·47	541·0	2·09	810	1·9	−15·8	8·0	7·8	3·1	3·9
8	14·4	28,400	+13,905	26·6	0·26	158·0	0·61	310	0·7	−15·91	11·9	4·01	1·6	1·6
9	14·6	28,795	+14,300	3·8	0·04	22·6	0·09	77	0·2	−16·02	14·3	1·72	0·7	0·8
10	14·7	28,990	+14,495	0	0	0	0	0	0	−16·02	16·0	0	0	0

Table IV.

Time in seconds after reversal.	Induction, Fig. 9B.			Radius 1·22 cm.		Radins 3·18 cm.		Radius 5·08 cm.		Area in diagram squares of curves in Fig. 9A, radii 1·22 to 5·08.	Force due to induced currents. H_2.	Force due to current in magnet winding. H_1.	Resultant force. H.
	Area in $\frac{4}{25}$ diagram squares of Curve 1, Fig. 9.	Change of induction per square cm. in C.G.S. units.	Induction per sq. cm. B.	E.M.F. in volts in 10^{-6}.	Amperes per sq. cm.	E.M.F. in volts in 10^{-6}.	Amperes per sq. cm.	E.M.F. in volts in 10^{-6}.	Amperes per sq. cm.				
0	0	0	−15,480	0	0	0	0	0	0	...	0	−37·2	−37·2
1	0·9	1,775	−13,705	116	1·17	1,150	4·58	...	..	...	...	...	...
2	2·2	4,340	−11,140	116	1·17	3,775	15·0	4,595	11·05	22·2	−55·7	+34·1	−21·6
3	3·3	6,510	− 8,970	145	1·52	2,310	9·2	2,872	6·9	14·2	−35·6	+34·1	− 1·5
4	9·8	19,300	+ 3,820	1,160	11·7	1,569	6·25	1,436	3·45	14·2	−35·6	+36·4	+ 0·8
5	15·6	30,800	+15,320	0	0	524	2·09	718	1·72	3·2	− 8·0	+36·4	+28·4
6	15·7	30,960	+15,480	0	0	0	0	0	0	0	0	+37·2	+37·2

Table V.

Figures.	Tables.	Periodic time in seconds.	Force due to current in copper coils.		Max. resultant force. H.	Max. average induction per sq. cm. of Coil 1, in C.G.S. units. B.	Comparative area of curves Nos. 1, 2, 3, Figs. 19, 20, 21, 22.			$\frac{1}{4\pi}\int H dB$ taken from Ewing.	Ergs per cycle per cubic cm. dissipated by induced currents obtained from figs. 19D, 20D, 21D, 22D.
			Max. amperes.	Max. H_1.			No. 1.	No. 2.	No. 3.		
17		80	0·1	...	...	2,280	...	...	...	...	545
18		20	0·1	...	...	827	...	...	..	...	477
19, 19A, 19B, 19C, 19D,	VI.	80	0·23	4·87	3·67	7,690	9·7	62·5	139	3,000	3,820
20, 20A, 20B, 20C, 20D,	VII.	20	0·23	4·87	1·32	1,630	1·5	22·7	69·4	...	2,750
...	...	80	0·35	...	...	11,300	...	...	...	...	...
...	...	20	0·35	...	...	2,700	...	...	...	...	...
...	...	80	0·74	...	...	16,000	...	...	...	...	...
...	...	20	0.74	...	...	13,700	...	...	...	...	...
21, 21A, 21B, 21C, 21D,	VIII.	80	1·06	21·9	21·8	15,000	3·3	22·2	60·0	17,000	26,200
22, 22A, 22B, 22C, 22D,	IX.	20	1·06	21·9	13·0	15,500	2·1	18·5	43·4	...	54,500
23	...	4	0·24	...	...	...	...	...	...	...	...

Table VI.—*Periodic Time, 80 seconds. Maximum Current in Copper Coils, 0·23 ampere.*

	Coil 1.				Coil 2.				Coil 3.				Average induction per sq. cm. of Coil 1.			Current in copper coils.			Magnetising force due to induced currents.			Energy dissipated by induced currents.	
Time in seconds.	Deflection on D'Arsonval.	E.M.F. in 10^{-6} volts per turn.	Amperes per sq. cm.	Watts per sq. cm. in 10^{-6}.	Deflection on D'Arsonval.	E.M.F. in 10^{-6} volts per turn.	Amperes per sq. cm.	Watts per sq. cm. in 10^{-6}.	Deflection on D'Arsonval.	E.M.F. in 10^{-6} volts per turn.	Amperes per sq. cm.	Watts per sq. cm. in 10^{-6}.	Area of E.M.F. curve in $\frac{1}{25}$ diagram squares.	Half max. area + other areas in sq. cm.	Induction per sq. cm. in C.G.S. units.—B.	Deflection on D'Arsonval.	Amperes.	Force per cm. linear. H_1.	Area in diagram squares of curves in Fig. 19A, from rad. 1·27 to 5·08.	Force per cm. linear. H_2.	Resultant magnetising force per cm. linear. H.	Area in diagram squares of curves in Fig. 19C, from rad. 0 to 5·08.	Watts per cm. in 10^{-6}.
30	+ 0	...	...	...	+ 1·0	...	...	...	0	...	...	...	...	...	...	+ 67	+ ·204	...	...	...	...	...	...
32	+ 0	...	...	...	0	...	...	...	− 1·0	17·5	...	...	...	...	...	+ 61	+ ·186	...	...	...	...	..	...
34	+ 0	...	...	...	− 1·0	10·9	...	...	− 1·5	26·3	...	...	...	...	...	+ 53	+ ·162	+ 3·35	...	...	...	...	...
...	...	...	0	...	...	...	0·06	...	...	...	0·09	...	0	+ 19·5	7,690	...	..	+ 3·1	2·5	0·31	+ 3·41	...	...
36	− 0	...	...	...	− 2·0	21·8	0·08	1·74	− 3·0	52·6	0·13	6·84	...	...	...	+ 45	+ ·137	+ 2·85	...	...	...	...	...
38	− 0·5	2·13	...	...	− 3·0	32·7	...	...	− 5·0	87·7	...	...	...	...	...	+ 34	+ ·104	...	...	...	...	...	...
40	− 1·0	4·26	0·04	0·17	− 5·0	54·5	0·21	11·4	− 20·0	351·0	0·85	298·0	0·5	+ 19·0	7,496	+ 10	+ ·03	+ 0·63	12·5	1·57	+ 2·2	3·9	195
42	− 2·0	8·51	...	...	− 10·0	109·0	...	...	− 25·0	439·0	...	...	...	...	...	− 10	− ·03	...	...	...	...	...	...
44	− 3·5	14·9	0·14	2·09	− 11·0	120·0	0·46	55·2	− 30·0	527·0	1·27	669·0	2·15	+ 17·35	6,844	− 30	− ·091	− 1·90	22·0	2·77	+ 0·87	10·5	525
46	− 4·5	19·2	0·18	3·46	− 13·0	142·0	0·55	78·1	− 35·0	614·0	1·49	915·0	...	...	...	− 40	− ·122	...	...	...	...	16·4	820
48	− 3·5	14·9	0·14	2·09	− 11·5	125·0	0·48	60·0	− 30·0	527·0	1·27	669·0	5·8	+ 13·7	5,405	− 50	− ·152	− 3·16	21·0	2·64	− 0·52	10·5	525
50	− 3·0	12·8	...	...	− 14·0	153·0	...	...	− 25·0	439·0	...	...	...	...	...	− 59	− ·18	...	...	...	...	...	...
52	− 3·0	12·8	0·12	1·54	− 19·0	207·0	0·80	165·0	− 25·0	439·0	1·06	465·0	8·2	+ 11·3	4,460	− 66	− ·20	− 4·17	27·7	3·48	− 0·69	14·4	720
54	− 3·0	12·8	...	...	− 22·0	240·0	...	...	− 23·0	404·0	...	...	...	...	...	− 70	− ·21	...	...	..	...	...	...
56	− 3·0	12·8	0·12	1·54	− 23·0	251·0	0·97	243·0	− 20·0	351·0	0·85	298·0	10·9	+ 8·6	3,390	− 73	− ·22	− 4·62	29·0	3·65	− 0·97	15·0	750
58	− 4·0	17·0	0·16	2·72	− 22·0	240·0	0·93	223·0	− 18·0	316·0	0·76	240·0	12·2	+ 7·3	2,880	− 75	− ·229	− 4·74	27·7	3·48	− 1·26	12·8	640
60	− 6·0	25·5	0·25	6·37	− 20·0	218·0	0·84	183·0	− 15·0	263·0	0·63	166·0	14·0	+ 5·5	2,170	77	− ·235	− 4·87	28·0	3·52	− 1·35	11·5	575
62	− 10·0	42·6	0·41	17·5	− 17·0	185·0	0·71	131·0	− 12·0	211·0	0·51	108·0	17·7	+ 1·8	710	− 77	− ·235	− 4·87	24·9	3·13	− 1·74	7·5	375
64	− 15·0	63·8	0·62	39·6	− 13·0	142·0	0·55	78·0	− 10·0	175·0	0·42	73·5	23·0	− 3·5	1.380	− 77	− ·235	− 4·87	22·0	2·77	− 2·10	5·8	290
66	− 13·0	55·3	0·53	29·3	− 10·0	109·0	0·42	45·8	− 7·0	123·0	0·3	36·9	29·4	− 9·9	3,910	− 75	− ·229	− 4·74	17·5	2·20	− 2·54	...	...
68	− 10·0	42·6	0·41	17·5	− 7·0	76·3	0·29	22·1	− 4·0	70·2	0·17	11·9	34·1	− 14·6	5,760	− 73	− ·22	− 4·62	13·0	1·63	− 2·99	1·5	75
70	− 4·0	17·0	0·16	2·72	− 4·0	43·6	0·17	7·4	− 2·0	35·1	0·08	2·8	37·3	− 17·8	7,020	− 68	− ·207	− 4·30	6·0	0·75	− 3·55	..	...
72	− 2·0	8·5	0·08	0·68	− 1·0	10·9	0·04	0·45	0	0	0	0	38·5	− 19·0	7,500	− 63	− ·192	− 3·98	2·5	0·31	− 3·67	...	...
74	− 0·5	2·13	0·02	0·04	+ 0·5	5·4	0·02	0·11	1·0	17·5	0·04	0·7	...	...	...	− 55	− ·168	− 3·48	...	...	...	...	...
...	...	...	0	...	...	...	0·03	...	...	...	0·7	...	39·1	− 19·5	7,690	...	..	− 3·2	0·6	0·07	− 3·3	...	...
76	+ 0·5	2·13	0·02	0·04	+ 1·0	10·9	0·04	0·45	2·5	43·9	0·81	...	...	...	...	− 47	− ·143	− 2·97	...	...	...	...	...
78	+ 1·0	4·26	...	...	+ 2·0	21·8	...	...	5·5	87·7	...	...	...	...	...	− 35	...	...	...	...	...	...	...

Table VIII.—*Periodic Time, 80 seconds. Maximum Current in Copper Coils, 1·06 amperes.*

	Coil 1.				Coil 2.				Coil 3.				Average induction per sq. cm. of Coil 1.			Current in copper coils.			Magnetising force due to induced currents.			Energy dissipated by induced currents.	
Time in seconds.	Deflection on D'Arsonval.	E.M.F. in 10^{-6} volts per turn.	Amperes per sq. cm.	Watts per sq. cm. in 10^{-6}.	Deflection on D'Arsonval.	E.M.F. in 10^{-6} volts per turn.	Amperes per sq. cm.	Watts per sq. cm. in 10^{-6}.	Deflection on D'Arsonval.	E.M.F. in 10^{-6} volts per turn.	Amperes per sq. cm.	Watts per sq. cm. in 10^{-6}.	Area of E.M.F. curve in $\frac{1}{25}$ diagram squares.	Half max. area ± other areas in sq. cm.	Induction per sq. cm. in C.G.S. units.—B.	Deflection on D'Arsonval.	Amperes.	Force per cm. linear.—H_1.	Area in diagram squares of curves in Fig. 21A from rad. 1·27 to 5·08.	Force per cm. linear.—H_2.	Resultant magnetising force per cm. linear.—H.	Area in diagram squares of curves in Fig. 21C from rad. 0 to 5·08.	Watts per cm. in 10^{-6}.
12	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16	1·0	...	...	...	4	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...
18	0·5	...	...	...	1	...	...	...	1·5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
20	0	...	...	...	0	0	0	...	0·5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
22	0	...	...	...	0	0	0	..	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...
24	0	0	0	0	0	0	0	0	0	0	0	0	...	...	...	49	1·04	+ 21·5	0	0	− 21·5	0	0
26	0	0	0	...	0·5	8·78	0·0338	...	0·5	22·1	0·0532	...	...	...	...	45	0·95	+ 19·8	...	...	...	...	...
28	0	0	0	...	0·5	8·78	0·034	...	1	44·1	0·106	...	..	...	...	39	0·83	+ 17·1	...	...	...	...	...
30	0	0	0	...	1·0	17·6	0·068	...	2	88·3	0·213	...	0	...	...	35	0·74	+ 15·4	...	...	...	...	...
32	0	0	0	...	1·0	17·6	0·068	...	2	88·3	0·213	...	0	7·6	15,000	30	0·64	+ 13·2	...	...	...	...	...
34	0·5	4·12	0·0398	0·164	2	35·1	0·135	...	4	177	0·426	...	0	7·6	15,000	25	0·53	+ 11·0	...	...	...	...	...
36	0·5	4·12	0·0398	0·164	3	52·7	0·203	10·7	5	221	0·532	118	0·1	7·5	14,800	20	0·424	+ 8·78	5	+ 1·6	− 10·4	0·5	125
38	1·0	8·25	0·0795	...	4	70·2	0·271	...	8	353	0·851	...	0·2	7·4	14,600	12	0·254	+ 5·27	...	...	...	...	...
40	1·5	12·4	0·119	...	8	140	0·542	...	14	618	1·49	...	0·55	7·05	13,900	+ 2	0·042	+ 0·88	...	...	...	...	...
42	2·0	16·5	0·159	2·26	12	211	0·812	171	20	883	2·13	1,880	0·9	6·7	13,200	− 6	0·127	− 2·63	13·8	+ 4·34	− 1·71	6·4	1,600
44	4·0	33·0	0·318	10·5	15	263	1·02	268	30	1,320	3·19	4,210	1·3	6·3	12,400	14	0·297	− 6·15	...	...	...	12·8	3,200
46	5·0	41·2	0·398	16·4	15	263	1·02	268	40	1,770	4·26	7,540	2·1	5·5	10,800	20	0·424	− 8·78	23·5	+ 7·39	+ 1·39	20·3	5,070
48	4·0	33·0	0·318	10·5	45	790	3·05	2,410	38	1.680	4·04	6,790	2·8	4·8	9,470	26	0·55	− 11·4	...	...	...	41·5	10,400
50	4·5	37·1	0·358	13·3	51	896	3·45	3,090	33	1,460	3·51	5,120	3·5	4·1	8,090	30	0·64	− 13·2	...	...	...	42	10,500
52	10	82·5	0·795	65·6	45	790	3·05	2,410	28	1,240	2·98	3.690	4·6	+ 3·0	+ 5,920	35	0·74	− 15·4	42·0	+ 13·2	+ 2·2	35	8,750
54	47	388	3·74	1.451	35	615	2·37	1,460	20	883	2·13	1,880	9·65	− 2·05	− 4,040	39	0·33	− 17·1	43·0	+ 14·2	+ 2·9	31·5	7,880
56	5·0	41·2	0·398	16·4	10	176	0·677	119	14	618	1·49	921	14·8	7·2	14,200	44	0·93	− 19·3	10·0	+ 3·1	+ 17·2	2·5	625
58	0·5	4·12	0·0398	0·16	2	35·1	0·135	4·74	4	177	0·426	75	15·1	7·5	14,800	48	1·02	− 21·1	3·5	+ 1·1	+ 20·0	...	...
60	0·5	4·12	0·0398	0·16	1	17·6	0·068	1·20	2	88·3	0·213	18·8	15·18	7·58	14,950	49	1·04	− 21·5	1·6	+ 0·5	+ 21	...	...
62	0	0	0	...	0	0	0	...	0·5	22·1	0·053	0·12	15·2	7·6	15,000	50	1·06	− 21·9	0·15	+ 0·05	+ 21·8	...	...
64	0	0	0	0	0	0	0	0	0	0	0	0	15·2	7·6	15,000	49	1·02	− 21·1	0	0	...	0	0
66	0	0	0	...	0	0	0	...	0	0	0	..	...	...	...	43	0·91	− 18·9	...	...	...	...	...
68	0	0	0	...	1	17·6	0·068	...	0	0	0	..	...	...	...	40	...	...	...	...	...	...	...
70	...	...	...	...	...	...	...	...	1·5	...	...	...	...	...	..	35	...	...	...	...	...	...	...

Table VII.—*Periodic Time, 20 seconds. Maximum Current in Copper Coils, 0·23 ampere.*

Time in seconds	Coil 1				Coil 2.				Coil 3.				Average induction per sq. cm. of Coil 1.			Current in copper coils.			Resultant force, taken from the given cyclic curve.—H.	Magnetising force due to induced currents.			Energy dissipated by induced currents	
	Deflection on D'Arsonval.	E.M.F. in 10^{-6} volts per turn.	Amperes per sq. cm.	Watts per sq. cm. in 10^{-6}.	Deflection on D'Arsonval.	E.M.F. in 10^{-6} volts per turn.	Amperes per sq. cm.	Watts per sq. cm. in 10^{-6}.	Deflection on D'Arsonval.	E.M.F. in 10^{-6} volts per turn.	Amperes per sq. cm.	Watts per sq. cm. in 10^{-6}.	Area of E.M.F. curve, in $1\frac{2}{25}$ diagram squares.	Half max. area ± other areas, in sq. cm.	Induction per sq. cm. in C.G.S. units.—B.	Deflection on D'Arsonval.	Amperes.	Force per cm. linear.—H_1.		H_2.	Areas required from curves in Fig. 20A, in diagram squares.	Areas obtained from curves in Fig. 20A, as drawn, in diagram squares.	Areas in diagram squares of curves in Fig. 20C, from rad. 0 to 5·08.	Watts per cm. in 10^{-6}.
6	3	12·9	0·125	...	42	350	1·35	...	16	500	1·20	...	...	...	...	−39	·235	−4·86	...	...	...	...	...	...
8	4	17·2	0·166	2·86	30	250	0·965	241	− 8	250	0·602	150	...	...	...	−32	·193	−3·99	...	.	...	...	...	..
10	0	0	0	0	0	0	0	0	+10	312	0·752	235	0·0	+8·25	+1,630	−10	·060	−1·25	+1·32	0·07	0·22	0·4	0·3	30
11	...	...	...	...	...	...	...	...	...	...	...	...	0·8	+7·45	+1,470	...	...	...	+0·75	...	...	...	...	...
12	+5·5	23·7	0·229	5·43	+23	192	0·74	142	+42	1,310	3·16	4,140	2·8	+5·45	+1,075	+28	·169	+3·49	+0·20	3·69	11·7	12·5	14·2	1,420
13	...	...	...	...	...	...	...	...	...	...	...	...	5·0	+3·25	+ 641	...	...	..	−0·30	...	...	...	...	...
14	+4	17·2	0·166	2·86	+24	200	0·772	154	+28	874	2·11	1,840	6·9	+1·35	+ 266	+37	·223	+4·62	−0·45	4·17	13·3	13·0	15·0	1,500
15	...	...	...	...	...	...	...	...	..	...	...	...	8·5	−0·25	− 49	..	...	...	−0·60	...	...	...	...	...
16	+3·5	15·1	0·145	2·19	+42	350	1·35	472	+19	593	1·43	848	10·0	−1·75	− 345	+39	·235	+4·86	−0·90	3·96	12·6	14·9	16·8	1,680
17	...	...	...	...	...	...	...	...	...	...	..	...	11·7	−3·45	− 680	...	...	...	−0·95	...	...	...	...	...
18	+4	17·2	0·166	2·86	+35	292	1·13	330	+ 9	281	0·677	190	13·3	−5·05	− 996	+33	·199	+4·12	−1·10	3·02	9·6	11·0	8·2	820
19	...	...	...	...	...	...	...	...	..	...	...	...	15·0	−6·75	−1,330	...	...	...	−1·22	...	..	...	...	...
20	+2	8·6	0·083	0·714	+ 8	66·7	0·257	17·1	0	0	0	0	16·3	−8·05	−1,590	+10	·060	+1·25	−1·30	1·95	6·2	4·5	0·75	75
20·5	...	...	...	...	...	...	...	...	..	...	...	...	16·5	−8·25	−1,630	..	...	...	−1·32	...	...	...	...	..
22	−5	21·5	0·208	4·47	−24	200	0·772	154	42	1,310	3·16	4,140	...	...	...	−26	·157	−3·24	...	...	...	...	...	...
24	−4	17·2	0·166	...	25	209	0·804	...	30	937	2·26	...	...	...	...	−36	·217	−4·49	...	...	..	...	...	...
26	−3	...	0·125	...	41	...	1·32	...	22	...	1·65	...	...	...	...	−39	·235	+4·86	...	...	...	...	...	...

Table IX—*Periodic Time, 20 seconds. Maximum Current in Copper Coils, 1 06 amperes.*

Time in sec	Coil 1.				Coil 2.				Coil 3.				Average induction per sq. cm. of Coil 1.			Current in copper coils.			Magnetising force due to induced currents.		Resultant magnetising force per cm. linear.—H.	Energy dissipated by induced currents.	
	Deflection on D'Arsonval.	E.M.F. in 10^{-6} volts per turn.	Amperes per sq. cm.	Watts per sq. cm. in 10^{-6}.	Deflection on D'Arsonval.	E.M.F. in 10^{-6} volts per turn.	Amperes per sq. cm.	Watts per sq. cm. in 10^{-6}.	Deflection on D'Arsonval.	E.M.F. in 10^{-6} volts per turn.	Amperes per sq. cm.	Watts per sq. cm. in 10^{-6}.	Area of E.M.F. curve in $\frac{1}{4}$ diagram squares.	Half max. area ± other areas in sq. cm.	Induction per sq. cm. in C.G.S. units.—B.	Deflection on D'Arsonval.	Amperes.	Force per cm. linear. H_1.	Area in diagram squares of curves in Fig 22A from rad. 1·27 to 5·08.	Force per cm. linear. H_2.		Area in diagram squares of curves in Fig. 22C from rad. 0 to 5·08.	Watts per cm. in 10^{-6}.
26	10	109·0	1·05	...	23	1,630	6·28	...	14	1,920	4·63	...	...	...	...	39	...	..	...	...	...	...	...
28	50	545·0	5·25	...	+10	708	2·73	...	+ 3	412	0·992	...	...	...	...	30	0·86	17·8	...	...	..	...	...
30	0	0	0	0	− 2	142	0·546	77·5	− 8	1,098	2·64	2,900	0	+7·85	+15,500	+15	0·430	+ 8·91	6·5	4·09	13·0	0·5	1,250
31	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
32	5	54·5	0·525	28·6	7	495	1·91	945·0	30	4,120	9·92	40,900	0·5	+7·35	+14,500	− 5	0·143	− 2·97	22·0	13·8	10·0	8·0	20,000
33	...	...	...	...	..	...	...	...	...	...	...	...	..	...	...	..	...	...	..		...	...	...
34	4	43·6	0·420	18·3	25	1,770	6·82	12,100·0	24	3,290	7·93	26,100	1·5	+6·35	+12,500	25	0·716	14·8	38·0	23·9	9·1	17·6	44,000
35	...	...	...	...	..	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	..	...	...
36	10	109·0	1·05	114·0	25	1,770	6·82	12,100·0	15	2,060	4·96	10,200	2·8	+5·05	+ 9,960	37	1·06	22·0	41·0	25·8	+ 3·8	13·5	33,700
37	...	...	...	...	...	...	...	...	...	...	...	.	...	..	...	...	...	...	...	...	...	...	...
38	50	545·0	5·25	2,860·0	10	708	2·73	1,930·0	− 5	686	1·65	1,130	9·4	−1·55	− 3,060	30	0·86	17·8	+25·0	15·7	2·1	4·8	12,000
39	...	...	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
40	0	0	0	0	0	0	0	0	+ 5	686	1·65	1,130	15·7	−7·85	−15,500	−15	0·43	8·91	−1·5	0·94	9·8	0·07	175
42	5	54·5	0·525	...	5	354	1·36	...	30	4,120	9·92	...	...	...	...	+10	0·287	5·94	...	...	...	...	...
44	4	43·6	0·420	...	7	495	1·91	...	22	3,020	7·27	...	...	...	..	30	0·86	17·8	...	...	...	...	...

curves from which these forces have been obtained are given in Fig. 19A, and have been plotted from Table VI. The algebraic sum of this force, H_2, and the force H_1, given at the same epoch by the current in the copper coils, is taken to be the *then* resultant force magnetising this area. Also the integral of curve 1 (Fig. 19) gives the average induction over this area at the same epoch. Curve *x* (Fig. 19B) is the cyclic curve obtained by plotting the inductions in terms of the resultant force H.

The curves in Figs. 21, 22,‡ have been treated in a similar manner to that already described in connection with Fig. 19. But in Fig. 20 the procedure is a little different. In this case the periodic time is 20, and the maximum force per centimetre linear due to the current in the copper coils is 1·85. With this frequency and current the effects of induced currents in the iron are very marked; we have taken a given soft iron cyclic curve, of roughly the same maximum induction as given by the integral of curve No. 1 (Fig. 20), and have tabulated the forces obtained therefrom in Table VII. In Fig. 20A‡ we have plotted the amperes per square centimetre at the different radii, and for the several epochs, and in each case, by drawing a curve fairly through these points, as shown in the figure, we are able to produce areas in fair correspondence with the areas obtained by means of the given cyclic curve. The comparative areas are given in Table VII.

Referring now to the summary of results in Table V., we note the marked effect of change of frequency upon the average induction per unit area of the innermost coil No. 1, when dealing with comparatively small maximum inductions. Compare the results given in Figs. 19 and 20. The maximum force per centimetre linear due to the current in the copper coils is 4·8 in each case, but the average induction per square centimetre of coil No. 1 is reduced from 7,690 to 1,630 by a change of frequency from $\frac{1}{80}$ to $\frac{1}{20}$. This is, of course, not the case on the higher portion of the induction curve, as is shown by the results of Figs. 21 and 22, although the resultant force H is reduced by the induced currents.

We see further, from Fig. 20, that at 500 periods per second only the outside layers of our 1mm. wire are really useful.

In Fig. 21 the periodic time is 80, and the maximum average induction per square centimetre is 15,000.

The ergs dissipated per cycle per cubic centimetre are 26,000 by induced currents, and about 17,000 by magnetic hysteresis. This

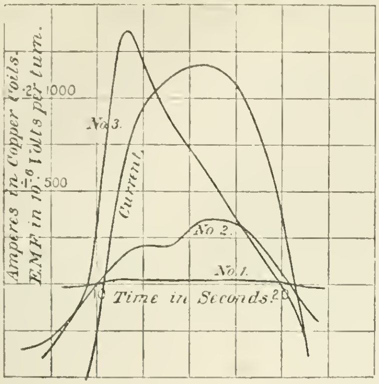

Fig. 20.

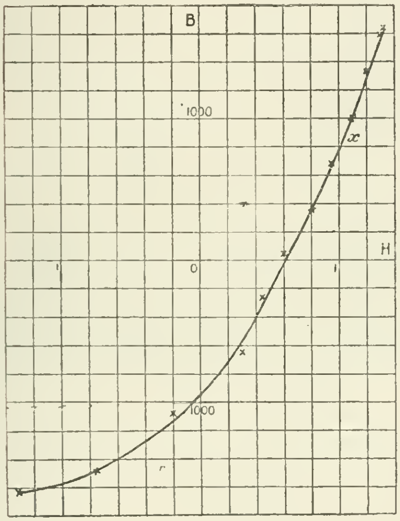

Fig. 20b.

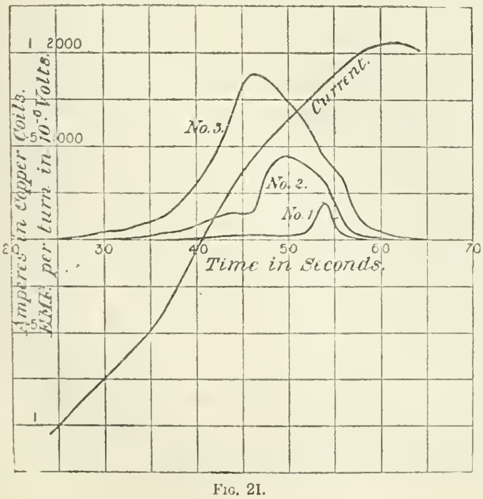

Fig. 21.

shows that, according to good practice, where the wires in armature cores are of an order of 1mm. or 2mm. diameter, the loss by induced currents would be but small as compared with the loss by magnetic hysteresis. This, of course, assumes the wires to be perfectly insulated from one another, which is not always realised in practice.

Both the armature cores of dynamos and the cores of transformers are now usually made of plates instead of wire; roughly speaking, a plate in regard to induced currents in its substance is comparable to a wire of a diameter double the thickness of the plate. We infer that the ordinary practice of making transformer plates about ½mm. thick, and plates of armature cores 1mm. thick, is not far wrong. Not much is lost by local currents in the iron, and the plates could not be much thicker without loss.*

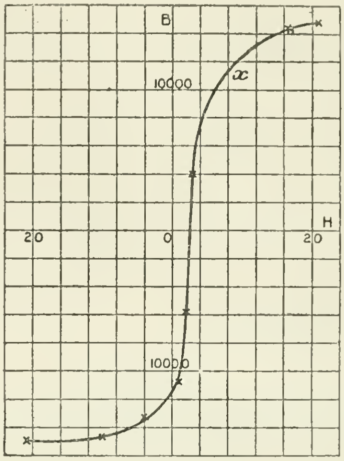

Fig. 21b.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, March 1st.

Institution of Junior Engineers.

8 p.m. Meeting at the Westminster Palace Hotel. The following Paper will be read: "Locomotive Repairing Work," by A. H. Newsom Smith.

SATURDAY, March 2nd.

Royal Institution.

3 p.m. Afternoon Lecture:—"Waves and Vibrations," by the Rt. Hon. Lord Rayleigh, F.R.S.,

MONDAY, March 4th.

Royal Institution.

5 p.m. General Monthly Meeting.

Society of Engineers.

7:30 p.m. Ordinary Meeting at the Westminster Palace Hotel. The following Paper will be read:—"Parliamentary Procedure as Affecting Light Railways and Tramways," by W. Worby Beaumont and Stephen Sellon.

TUESDAY, March 5th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. The following Paper will be read:—"Electricity Applied to River Gold Dredging," by Robert Hay, and a Discussion will take place on this Paper, and on that read last week by Mr. Robert Robertson on "Electrical Haulage at the Earnock Colliery."

FRIDAY, March 8th.

Physical Society.

5 p.m. Exhibitions of I, A Voltameter by Mr. Naber; II. The Focal Heliostat, by Dr. G. Johnstone Stoney; III. An Improvement in Siderostats, by Dr. G. Johnstone Stoney. The following Papers will be read:—"A New Harmonic Analyser," by G. U. Yule; "The Electromagnetic Field," by H. N. Allen.

Institution of Electrical Engineers.

8 p.m. Students' Meeting at 28 Victoria-street. The following Paper will be read:—"Incandescent Lamp Manufacture," by Leonard Johnson.

Royal Institution.

9 p.m. Evening Discourse:—"The Physical Work of von Helmholtz," by Prof. A. W. Rucker.

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* The question of dissipation of energy by local currents in iron has been discussed by Profs. J. J. Thomson and Ewing. See *The Electrician*, April 8 and 15, 1892

The Electrician.

(The Oldest Electrical Journal, 1861 1878).

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MAGNETISM AND MATHEMATICS.

In a leading article on the theory and practice of electrical engineering some years ago, we remarked that of all branches of engineering the electrical enjoys the greatest advantage in the facility with which the principles of pure science can be applied direct to the work. Electrical science started from the laboratory and found its way to the workshop; mechanical science was developed for centuries by the empirical engineer, feeling his way from one venture to another, and relying more upon the accumulated experience of his craft than upon any rationalised principles, uniformities, or inductions, which are called laws of science. But an exception must be made in problems connected with the magnetisation of iron. Science is correlated knowledge. The B-H curve was very useful knowledge, but as long as it defied the attempts of MÜLLER, LAMONT, FRÖLICH, and even MAXWELL to fit it with a formula it remained an item of knowledge. Even though EWING, in 1890, gave his theory of magnetisation, which was at once accepted because it explained, as did no previous theory, the well-known facts upon a simple basis, the magnetisation of iron still remained an empirical matter, to be found by separate experiment for each individual specimen. In his Royal Society Paper, Prof. EWING did not content himself with experiment and speculation, but threw in an equation or two (*The Electrician*, Vol. XXV., p. 541) giving the conditions of equilibrium of swinging magnets. Nobody seems to have followed up the mathematical treatment, but having at one end a group of molecular magnets possessing two degrees of freedom—simple intermolecular forces and an external force—and at the other end a smooth curve having several well-known characteristics, all of which are completely explained by the Ewing theory, the gap can be, and one day surely will be, filled up by a complete mathematical argument. Anyone who has seen Prof. Ewing's experimental demonstration will recognise that, not only in the initial configuration, but in the successive rearrangements after different groups have passed through an unstable stage, this problem, would, like that of the kinetic theory of gases, have to be dealt with in connection with the theory of probability. It may be that the number of constants would be enormous. Some of them would be physical and geometrical constants, and others would be merely due to the indirectness of the mathematical treatment. The complete mathematical work needed to bring the magnetisation of iron into the range of pure science would not, perhaps, be greater than that which has been expended on the theory of waves.

While the magnetisation of iron remains an empirical matter, attempts to treat by elaborate mathematics problems in which it is involved are to be regarded with suspicion. Academical theses on iron-less transformers have not, perhaps, been utterly useless, and clock-face diagrams, though not necessarily iron-less, ignore other practical considerations, and are of only limited application. The sooner this is recognised, the surer will be our progress, and the sounder will be our practice. In the discussion on Dr. J. Hopkinson's Paper at the recent meeting of the Institution of Electrical Engineers, allusion was made to the direct and practical way in which the author had attacked the propagation of magnetism in iron, and a just comparison was made with the author's Royal Society Paper of 1886, upon which all practical dynamo design is founded. In his reply, Dr. Hopkinson, referring to this allusion, said that the proper way to use mathematics was not to choose the facts so that the mathematics would easily deal with them; but to take the mathematics so far as they would go upon the facts as they actually are.

A little attention to this point of view, which Dr. Hopkinson so clearly indicates, is required both from mathematicians and from busy practical men—the one cannot make much progress without the other. "The philosopher," wrote Dr. Johnson, "may very justly be delighted with the extent of his views, and the artificer with the readiness of his hands; but let the one remember that without mechanical performances refined speculation is an empty dream; and the other, that without theoretical reasoning dexterity is little more than a brute instinct." If the artificer carefully plots his B H curve, or gets it from the iron or steel maker, designs his dynamo according to well-recognised principles, and builds conscientiously, he will succeed in doing good work. He ought to be delighted "with the readiness of his hands" if he gets high efficiency, no sparking, and cool bearings. Whether the job will pay, is another matter. But the speculations of the iron-less mathematicians not only result in an empty dream, but in tedious articles in technical journals or in Papers before scientific societies which may tempt unwary students to expend and waste much valuable time. The engineer, be he utterly devoid of mathematics, can, at all events, work upon his own experience, and, if he has only the intelligence to recognise his mistakes, may avoid their repetition. But the man of theory, choosing only such facts as are amenable to his mathematical methods, and even these facts often of the vaguest and most general character, will in general produce nothing more than a mathematical result, which may or may not be of interest to mathematicians. "For the wit and mind of man," wrote Bacon in his "Introduction to the Advancement of Learning," "if it work upon matter, which is the contemplation of the creatures of God, worketh according to the stuff, and is limited thereby; but if it work upon itself, as the spider worketh his web, then it is endless, and brings forth indeed cobwebs of learning, admirable for the fineness of thread and work, but of no substance or profit."

We wrote only a few weeks ago of the glorious uselessness of argon; need we justify an apparent inconsistency? The discovery of argon was an incident in a laborious research the object of which was merely to increase our knowledge of the physics of gases, and with no thought of practical utility. The space which we devote in these columns to pure scientific research may alone show the value which we attach to such additions to our knowledge. It is difficult to estimate the importance of a new truth; the best measure, perhaps, is its power of enabling collateral facts to be orderly connected, this being the real aim of all science. Workers in different branches of science have great difficulty in appreciating each others labours, and hence arises the absurd jealousies such as that between biologists and physicists: the one disparaging the tinkering with wires and magnets, and the other belittling the counting of hairs on a guinea pig's eyelids. How much more difficult must it be for a commercial man to appreciate the work of Faraday and Maxwell. So greatly do we value science for its own sake, that we have advocated without hesitation study of science as the foundation of an engineer's training, and cannot even regard the popular technological system as "a pleasant verbal equivalent for teaching a trade." On the other hand, we admire the firmness with which a man of Dr. Hopkinson's mathematical powers attacks a problem such as that of the predetermination of the characteristic of a dynamo, or of the behaviour of eddy currents in a magnet, without any elaboration of *a priori* equations. A research of this kind ought to provide plenty of material for those who only care to calculate. The common run of engineers, who have not even time to experiment, study the records of such work and, making no pretensions to science, apply them when and where they find them useful. Experimental facts and the experience of the profession are the foundation of their work, and theory is the scaffolding which surrounds it and rises far above it. By this scaffolding the advancing work is guided, and progress is greatly facilitated; but upon it no solid work can be built even when that stage has been reached by the main fabric.

THE ELECTRIC ARC.

BY HERTHA AYRTON.

(*Continued from page 475.*)

The curves in Fig. 21*a* are very distinctive in showing how completely and certainly the core of the positive carbon is responsible for a very low potential difference on starting the arc.

With the curve E E E, in which the potential difference started at about 27 volts, the positive carbon was solid, but drilled to the depth of one inch, and packed moderately tightly with the carbon from a soft core. For the first three minutes, therefore, it behaved exactly as if it were cored in the usual way, and after that it acted like a completely solid carbon. It is a little curious that the effect of a whole inch of soft core should apparently have exhausted itself in three minutes, and that from that time onwards the curve obtained with the drilled and packed positive carbon should be almost identical with that obtained with an ordinary solid positive carbon (*see* curve A A A, Fig. 21*a*). One would have expected the "hump" to be lower with the drilled and packed positive, on account of the loose soft carbon. Probably, however, the carbon was not as tightly packed as in a manufactured core, and, therefore, most of it was shot out during the first three minutes after starting the arc, only enough of it being left to keep the positive carbon from behaving as if it had merely a hole and no core at all.

Curve D D D, Fig. 21*a*, shows what that behaviour would have been. The positive carbon in this case had a hole two inches deep drilled in it, and left hollow, and this kept the potential difference higher throughout the whole variable period than when an ordinary solid positive carbon was used as in curve A A A, Fig. 21*a*

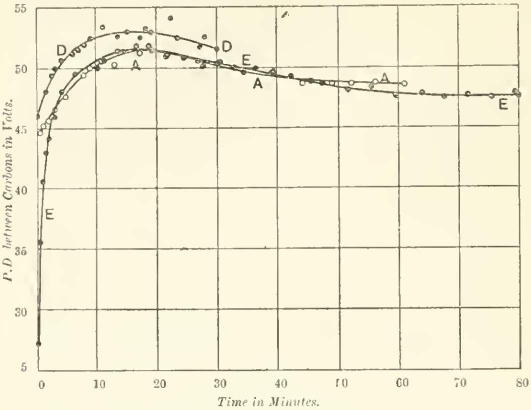

FIG. 21*a*.—Current suddenly started and kept at 10 amperes. Length of arc kept at 3mm. Carbons:—Positive, 18mm. solid; negative, 15mm. solid. Negative carbon in each case shaped by being previously used to form an arc 3mm. long, with a current of 10 amperes. A A A: End of solid positive carbon filed flat. D D D: Hole 2in. deep drilled in end of solid positive carbon. E E E: Hole 1in. deep drilled in end of solid positive carbon and packed tightly with soft carbon, end filed flat.

In order to find what influence, if any, a flat negative carbon would have in retarding the period at which the potential difference became constant, cored and uncored "normal" positive carbons were used, with flat uncored negatives. In Fig. 22, A A is the curve obtained with the uncored positive carbon, B B that obtained with the cored positive.

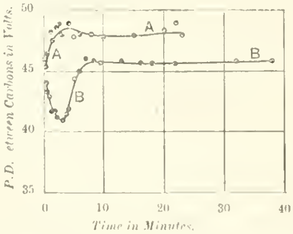

FIG. 22.—Current suddenly started and kept at 10 amperes. Length of arc kept at 3mm. A A Carbons: Positive, 18mm. solid; negative, 15mm. solid. B B Carbons: Positive, 18mm. cored; negative, 15mm. solid. Positive shaped by being previously used to give an arc 3mm. long with a current of 10 amperes. Negative filed flat.

Comparing these curves with those in Fig. 23, for which both carbons were filed flat, the positive carbon being solid with the curve A A A, and cored with B B B, we find that when a *normal* cored positive was used with a flat negative B B (Fig. 22) there was first a fall and then a rise of potential difference at starting, whereas when a *flat* cored positive was used with a flat negative, B B B (Fig. 23), there was only the usual rise that occurs whenever a flat cored positive carbon is used. But taking the solid positive carbons in each case, we find that the position is exactly reversed, for, whereas it was with the *flat* positive carbon A A A (Fig. 23) that the fall and subsequent rise of potential difference was obtained, on the contrary, with the *normal* positive A A (Fig. 22), the initial fall of potential difference was only about half a volt. On referring to other curves obtained with flat negative carbons and variously shaped positives, both cored and uncored, which it has not been thought necessary to publish, I find that in all cases the curve obtained is of the type of B B (Fig. 22) and A A A (Fig. 23). There is a fall of potential difference at starting, and then a rise, so that on the whole this shape for the beginning of the potential difference curve seems to be connected with the use of a *flat negative* carbon. The fact, however, of having the exceptions referred to above, and one other—Fig. 20, in which an initial fall of potential difference of about two volts was obtained with a *normal* negative carbon—make any explanation of this dip very difficult to arrive at. We may, however, gather one inference from all the curves, and that is that the shape of the negative carbon plays a very small part in the change of potential difference that takes place on starting the arc, for in every case in which a flat negative carbon was used with a "normal" positive, the potential difference had reached its steady value in about 8 minutes, and in no case did it deviate more than about 5 volts from that steady value, whereas, as has been shown, with a flat positive carbon, the potential difference took about 50 minutes to reach its steady value, and it deviated by from 7 to 33 volts from that steady value before reaching it.

Fig. 23 gives a sort of bird's-eye view of the differences caused in the change of potential difference after starting the arc by using

(1) A A A, both carbons solid and flat.
(2) B B B, positive carbon cored and both flat.
(3) B′ B′ B′, positive carbon cored, both normal, arc started with cold carbons.
(4) B″, positive carbon cored, both normal, arc started with hot carbons.

After three minutes from starting the arc the curve A A A (Fig. 23) differs very little from the curve A A A (Fig. 21), in which the negative carbon was "normal" instead of flat, and all the other conditions were the same. The reason there is so little appearance of "hump" has already been explained.

B B B (Fig. 23) also differs very slightly from B B B (Fig. 21) in which the negative was "normal" instead of flat, only B B B (Fig. 23) starts with rather a higher potential difference, 27 instead of 25 volts, and rises a little more slowly. Thus in both this and the preceding case it is evident that the difference made by using a flat or a "normal" negative is very small.

B′ B′ B′ and B″ (Fig. 23) show how slight is the change that takes place in the difference of potentials when the arc is started with both carbons "normal," whether hot or cold. Started cold the potential difference is about 1½ volts higher than started hot, which is what one might have expected. The whole change of potential difference, however, is very small, under both circumstances, not more than about 1½ volts altogether.

Thus we may gather from Figs. 20 to 23 that the changes that take place in the potential difference of an arc just after it is started are due in order of importance:—

(1) To the core of the positive carbon, if it has one—very low potential difference at starting.
(2) To the shape of the tip of the positive carbon—the "hump."
(3) To the shape of the tip of the negative carbon.
(4) Very slightly to the temperature of the carbons before starting the arc.

To try how changing the length of the arc affected the time during which the potential difference remained variable after the arc was started, an 18mm. cored positive carbon and a 15mm. solid negative were again used, the ends of both carbons were filed flat, and the current was again kept constant at 10 amperes; but the length of the arc was kept constant at 6mm. instead of at 3mm. as before.

It was found that in this case, as with the 3mm. arc, there was a very low potential difference at starting, a rise to a maximum, and then a slight fall, and finally the steady potential difference. But the whole series of changes, which extended, as we have seen, over a period of *55* minutes with the 3mm. arc, took only *20* minutes with the 6mm. arc.

Next, to see how varying the current affected the time during which the potential difference remained variable after the arc was started, an 18mm. cored positive carbon was again used with a 15mm. solid negative, the ends of both carbons were filed flat, the arc was kept at the constant length of 3mm.; but a constant current of 20 amperes was maintained, instead of one of 10 amperes, as in all the previous experiments on the variation of the potential difference with the time after starting the arc.

Again the curve obtained was found to be of the same character as curve B B B (Fig. 21), with which, also, both carbons were flat, and the positive cored; only, with the current of 20 amperes the changes were more rapid than with that of 10 amperes, and the potential difference became constant *38* minutes after starting the arc, instead of *55* minutes after.

We may gather from these last two experiments that the time during which the potential difference between the carbons remains variable after starting the arc with flat carbons is longer

(*a*) The shorter the arc,
(*b*) The smaller the current;

and thus question 4 (*The Electrician*, February 15th, p. 474) is answered.

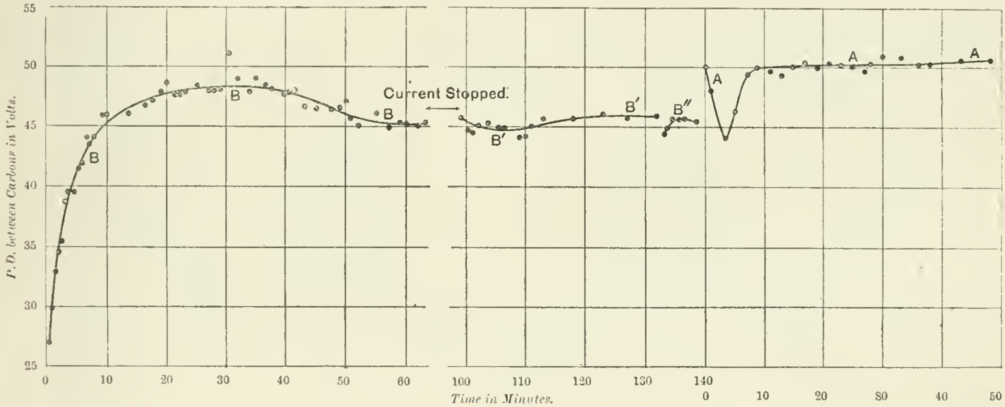

FIG. 23.—Current suddenly started and kept at 10 amperes. Length of arc kept at 3mm. Carbons :—Positive, 18mm. cored or solid, as stated ; negative, 15mm. solid.

Ends of both carbons filed flat. A A A : Positive carbon solid. B B B : Positive carbon, cored.

Both carbons shaped by being previously used for over one hour to give an arc 3mm. long with 10 amperes. Positive carbon cored. B′B′B′ : Arc started when carbons were cold. B″ : Arc started when carbons were hot.

The curves obtained from these two experiments were so like curve B B B (Fig. 21) in character that it was thought unnecessary to publish them.

The experiments, the results of which are noted in the curves in Figs. 24 and 25, were made to find what change took place in the potential difference between the ends of the carbons when the current was suddenly changed from a lower to a higher, and from a higher to a lower value, the length of arc being kept constant during each series of experiments.

These curves, as well as all the others published in this series of articles, are merely specimens of a number of sets of curves that have been obtained under similar conditions.

The instantaneous changes of potential difference in Figs. 24 and 25 are very striking. With wires one is accustomed to associate an increase of current with a *rise* of potential difference, and a diminution of current with a *fall*. But with the arc exactly the reverse takes place, and no experiments that I know of are better calculated to impress upon one the immense difference between the way in which a current flows through the arc and the way in which it flows through a wire than those from which these curves were taken.

With the arc, a sudden *rise* of current is in every case accompanied by a sudden *fall* of potential difference, and a sudden *fall* of current by a sudden *rise* of potential difference, even when, as in the case of an arc of 1mm. with a cored positive carbon (lower curves, Fig. 24), the final steady value of the potential difference is higher with the larger current than with the smaller.

Indeed, in nearly every case the potential difference overshoots the mark, as it were, and goes much lower with an increase of current, and much higher with a diminution, than its own final steady value. This exaggeration of the decrease and increase of potential difference, which is very marked when the currents are small, becomes less and less marked as the currents increase in value, until finally, with currents of 30 amperes and over, it ceases to exist with the carbons we have tried, and the potential difference remains practically constant, whether the current is changed suddenly or gradually. In fact, when we get on to the flat part of the curves in Figs. 4, 5, and 6, the potential difference is practically a constant, however quickly or slowly the current may be changed.

The curves in Fig. 24, the upper of which is for a solid positive carbon, and the lower for a cored positive, show that the excessive sudden rise and fall of potential difference with a sudden diminution and increase of current does not depend entirely upon the core, for it takes place in both sets of curves alike, although it is more marked in the lower.

The upper curves are a little deceptive, because the hissing, which took place in this particular experiment at 15 amperes, lowered the potential difference considerably, quite apart from the sudden change of current.

Some experiments I have recently made, as well as the above curves, amply verify the following deductions. With a sudden change of current :—

(1) The sudden change of potential difference is greater with a cored than with a solid positive carbon;

(2) The subsequent slow rise, or fall, of potential difference is greater with a cored than with a solid positive carbon;

(3) The time during which this slow change of potential difference takes place is greater with a cored than with a solid positive carbon.

The curves in Fig. 25 show, although not to a very marked extent, that the time the potential difference takes to reach its steady value after a sudden change of current is less with a longer than with a shorter arc. Experiments made within the last week, however, prove this point quite conclusively. For instance, with an 18mm. cored positive carbon and a 15mm. solid negative, arcs of 6mm. and 1mm., respectively, were maintained. The current was, in each case, kept first at 4 amperes, and when the potential difference had become steady for that current, it was suddenly changed to 9 amperes, and kept constant at that value till the potential difference had become steady. It was found that, after suddenly altering the current from 4 to 9 amperes, the time that elapsed before the potential difference assumed its steady value for 9 amperes was 9 minutes in the case of the 6mm. arc, and 16 minutes in that of the 1 mm. arc.

Many diagrams of the shapes of the carbons and visible arc were taken, some of which will be published later on, and these

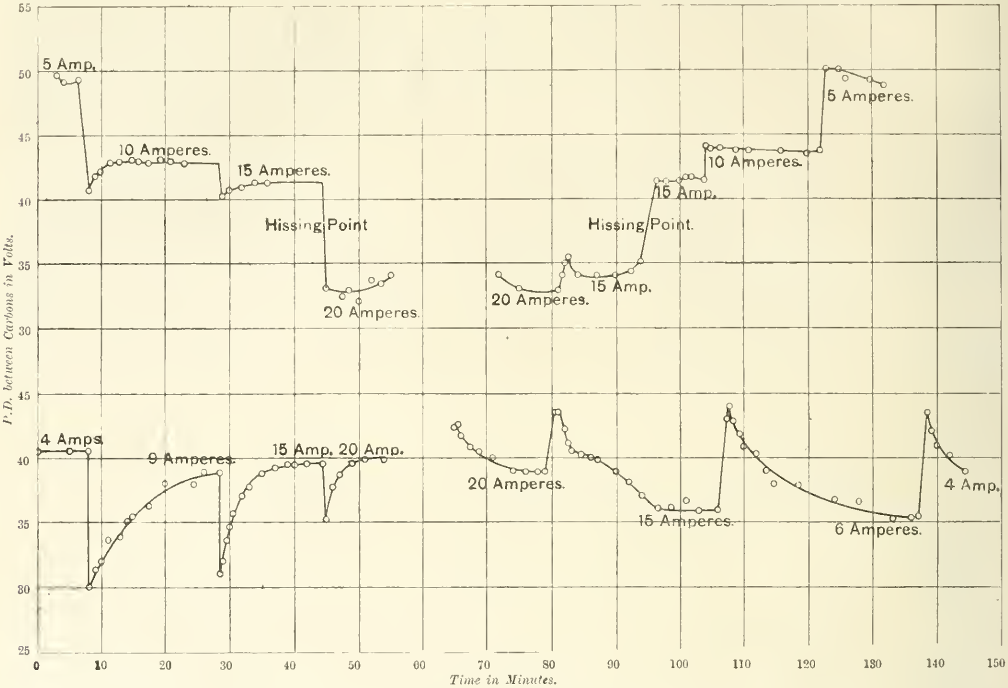

FIG. 24.—Change of P.D. with sudden change of current. Length of arc, 1mm. Carbons:—Positive, 18mm., solid in upper curves, cored in lower curves; negative, 15mm., solid in both.

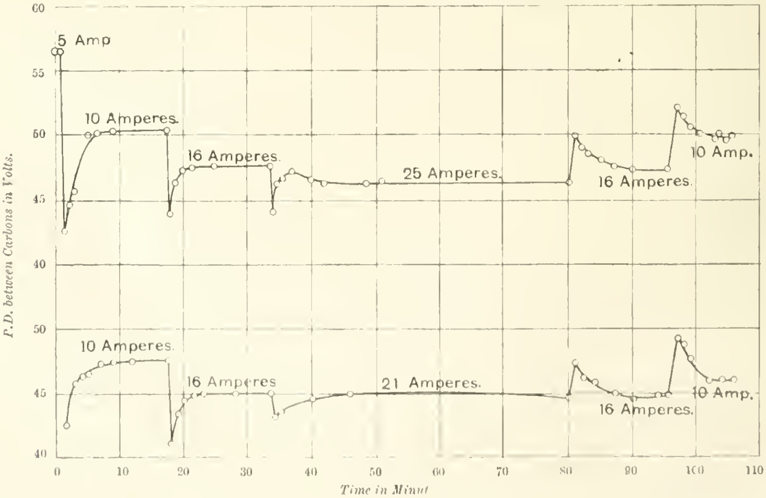

FIG. 25.—Change of P.D. with sudden change of current. Carbons:—Positive, 13mm. cored; negative, 11mm. solid. Length of arc in upper curves, 4mm.; in lower curves, 3mm.

These sudden exaggerated changes of potential difference probably depend upon the difference between the shapes of the carbons and craters with small and large currents, an idea which is strengthened by the fact that with very large currents the shapes of the carbons alter very slightly with a change of current, and, as we have just seen, the potential difference also scarcely alters. show that with a large current both carbons are burnt away much farther down than with a small current, thus making the lengths of the pointed parts of the carbons shorter the smaller the current. Hence, when a small current has been flowing through the arc for some little time, the carbons are very blunt, and the larger amount of volatile carbon sent off by the larger current when it is suddenly switched on will be squeezed out laterally, thus making the cross section of the arc abnormally great, and its resistance exceptionally small; therefore, the potential difference necessary to keep the current flowing will be below the steady value. Then as the points of the carbons burn away and become tapered under the influence of the larger current, the volatile carbon can stretch out more lengthwise, and gradually take its normal form for the larger current, and at the same time the potential difference *rises* to its final steady value.

Similarly, when a small current is turned on after a large current has been flowing for some time, the volatile carbon would at first be too much elongated owing to the ends of the carbons being much tapered, and as these burnt away and became blunter the volatile carbon would be squeezed out more laterally, the cross section of the arc would be increased, and the potential difference would *fall* to its final steady value.

Another reason for the exaggerated change of potential difference when the current is suddenly altered depends also on the tips of the carbons being blunter with small currents than with large ones, for it follows that the mean distance of the tips of the carbons from one another is less when they are "normal" for a small current than when they are "normal" for a large one, even although the length of the arc is maintained the same in both cases (*see* definition of length of arc, p. 335, *The Electrician*, January 18th), therefore the mean length of the arc must also be less in the first case than in the second. But if the mean length of the arc is less, the potential difference necessary to maintain a given current flowing through the arc will be less, all other conditions being the same. Therefore the potential difference necessary to maintain a large current flowing through an arc of given length will be less when the carbons are "normal" for a small current than when they are "normal" for a large one, and *vice versâ*.

(*To be continued.*)

DESCRIPTION OF A MOTOR-ALTERNATOR MADE FOR THE ELECTRICAL LABORATORIES AT UNIVERSITY COLLEGE.

In designing the internal arrangements of the new electrical engineering laboratories at University College, London, Dr. Fleming wished to make provision in the dynamo room for generating alternating currents for experimental purposes by some means which should provide, in the most simple manner possible, for producing alternating currents of various frequencies, and also for generating two-phase currents from the same plant. With this object he designed generally the machine shown in plan and elevation in Fig. 1, and Mr. Kapp worked out the full details and calculations of the machine, which was constructed to his drawings and to Dr. Fleming's specification by Messrs. Johnson and Phillips.

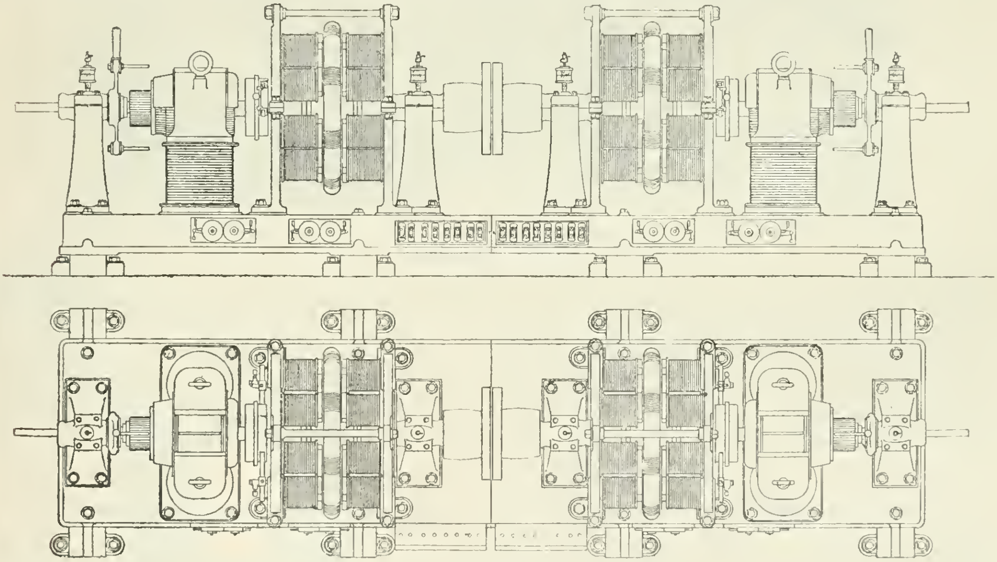

Fig. 1.—Johnson and Phillips' Motor-Alternator plant.

The machine consists of four separate machines bolted on to the same bed-plate, two Kapp alternators and two continuous-current motors. Each alternator is coupled direct to its own motor, the commutators of the continuous-current machines being on the outside end of the shaft. The shaft is cut in the middle and the inside ends carry a flange pulley. These pulleys can be coupled together through the flange by bolts, so as to drive the whole as one machine, or they can be separated for use as two machines. By coupling them together with the armatures in the proper relative position, two-phase currents can be got out of the united machine.

Each of the continuous-current motors is a 5-H.P. motor, designed to work at 100 volts. The armature is ring-wound, and there are 216 turns of wire on it, connected to a 72-part commutator. The magnets of the motors are of cast steel 6⅜in. in diameter. Each armature can carry 35 or 40 amperes comfortably.

The alternator armatures contain an iron core, and are each wound over with eight coils having 16 turns of wire. The field magnets have eight poles, and corresponding poles are opposite to one another. The alternators, when driven at a speed of 1,250 revolutions, give an electromotive force of 100 volts.

The four machines are carried on a cast-iron bed-plate 9ft. long and 2ft. wide, which is carried on slide rails in the usual manner. The ends of all the armature and field magnet circuits are brought to terminals fixed in a box on the front of the machine. In the field magnet circuit of each machine is an appropriate resistance, and in the armature circuits of the motors there are also resistances for starting the motors. Since the machine was delivered at the University College two very useful additions have been made to it by students working in the laboratory. One of these is a curve tracer, for tracing the form of alternating-current curves, which is fixed to one outside end of the right-hand machine, and the other a hydraulic speed indicator, which is fixed to the outside end of the shaft of the left-hand machine. This hydraulic speed indicator is of the form designed by Mr. Towers. A small centrifugal pump is driven by the shaft, and it pumps coloured water from a small reservoir placed over the pump through a pipe into two vertical glass tube pressure gauges, one of which is placed on the wall of the dynamo room, and the other of which is placed on the wall of the electrical laboratory thirty feet away. When the motor alternator is running, the centrifugal pump pumps the water up these tubes, until the hydrostatic pressure of the column of liquid supported in the tube balances the pressure due to the pump. The height of the column of liquid, therefore, can be made a measure of the speed of the machine, and these gauges have been carefully calibrated. The beauty of this hydraulic speed indicator is that it is so exceedingly responsive to changes in speed. A change in speed of less than one per cent. can be certainly detected, whilst the accuracy of the indication is independent of the density of the liquid used. The speed of the motor can therefore be regulated from the laboratory and kept exceedingly constant.

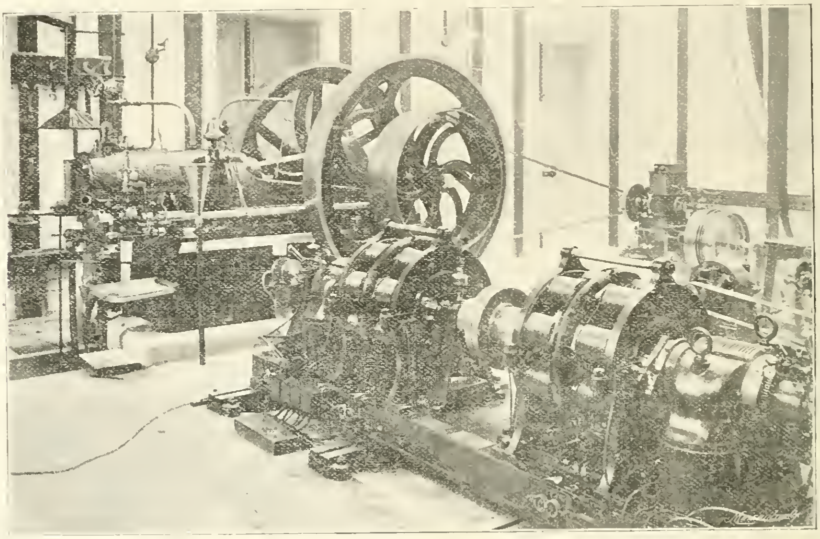

Fig. 2.—View of Part of the Dynamo Room in University College, London, showing the Motor-Alternator Plant.

It will be seen that such a double motor-alternator plant can be put to a great many uses. The alternators can be driven separately or together. The electromotive forces and currents of the alternators can be added together as required, or a two-phase alternating current can be obtained from the machine.

As usually used, the motors are driven off the St. Pancras electric lighting circuits, the speed being regulated by field resistances and the electromotive force of the alternator regulated by resistances in the alternator field-magnet circuits. The machine is exceedingly useful in investigations on alternating currents, and is a thoroughly excellent piece of work. It will be seen that the construction lends itself to many forms of experimental testing useful in a teaching laboratory. Fig. 2 (for the loan of which we are indebted to Messrs. Southam and Co.) gives a general view of the plant and of part of the dynamo room in which it stands.

THE MEASUREMENT OF INDUCTANCES, CAPACITIES, AND POLARISING RESISTANCES.

The secohmmeter designed several years ago by Profs. Ayrton and Perry has increased in simplicity and reliability since the day of its birth. In the latest pattern (shown in Fig. 1) the connections are all outside and visible, the brush-holders are easily set, and students, especially, will be glad to learn that the power previously required to turn the handle is now a mere fraction of its original value.

The principle of this instrument should, no doubt, be thoroughly well known; but a brief explanation of it may, nevertheless, prove useful, if only as a refresher of the memory. If a coil having self-induction be joined up in the usual manner to a Bridge, and a balance obtained, it is a common mistake on the part of the raw recruit to depress at the critical moment the battery and galvanometer keys in the wrong order, and as a meet reward to see the spot disappear. If, instead of merely making and breaking, the battery be reversed, the galvanometer receives a doubly-effective impulse. The Ayrton and Perry secohmmeter is simply an instrument which by the turning of a handle periodically reverses not only the battery connections, but also those of the galvanometer, so that a rapid succession of throws in the *same* direction is obtained, resulting in a steady deflection, depending on the self-induction of the coil and the number of impulses per second. The zero method is, however, more generally used. These reversals of connections are made by two rotary commutators, each with four stationary brushes. The two commutators are both on the same spindle, and in Fig. 1 the front commutator is seen. The group of brushes can be adjusted relatively to each other until both sets of reversals are simultaneous, or until they lag one behind the other by a given amount. The commutators may be driven at one or other of two speeds; one revolution of the handle may mean *four* reversals or *twenty-four* reversals of the connections; convenient speeds of the handle give a range of 200-6,000 reversals per minute of battery and galvanometer connections.

In Fig. 2 we show the necessary arrangements for a self-induction measurement with a P.O. or other pattern bridge.

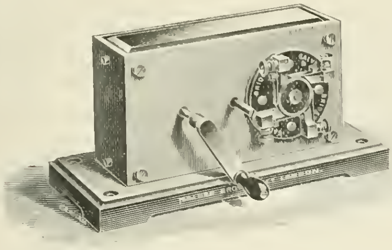

FIG. 1.—Secohmmeter (Latest Pattern).

Having selected two resistances in the ratio arms, balance is first obtained for steady currents by turning the secohmmeter handle slightly until contact is made by both commutators, and then altering the resistance in the bridge in the usual manner. The final adjustment is obtained by moving the sliding contact.

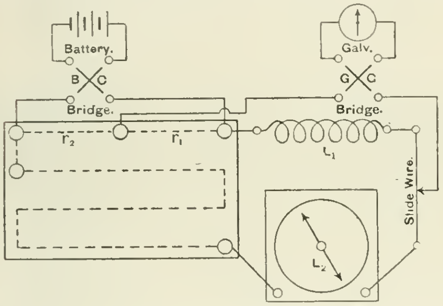

FIG. 2.—Diagram of Connections for Self-Induction Measurement.

When this has been done the secohmmeter handle is rotated, and balance is restored by turning the handle of the variable standard (*see* Fig. 3). When taking the final reading the secohmmeter should be run at a fairly high speed to gain sensitiveness. If r_1 and r_2 are the bridge resistances giving a balance with a steady current, then, on rotating the secohmmeter and restoring a balance by adjusting the variable standard inductance, we have $L_1/L_2=r_1/r_2$, where L_1 and L_2 are the coefficients of self-induction, one of which is the adjustable standard.

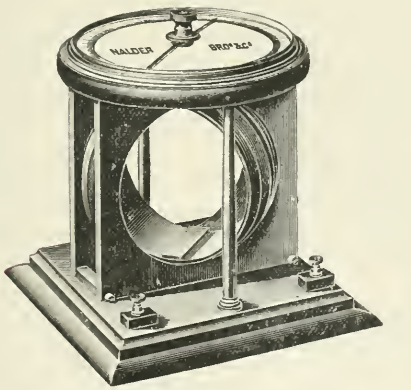

FIG. 3.—Variable Standard Inductance.

The variable standard (Fig. 3) consists of two coils connected in series. The smaller coil revolves inside the other so that it may be inclined at any angle with it, and by this means the self-induction may be varied continuously between a minimum and a maximum value. The range of the instrument is usually from about 0·004 to 0·040 henrys. In order to increase the range of the standard, single coils can be used which are made to any value from 10 to 1,000 millihenrys. Messrs. Nalder Bros. and Co., the makers of the secohmmeter and variable standard, have designed for this purpose a box of four coils, in which any coil can be used, or any, or all in series, by unplugging as in an ordinary resistance box, the coils being carefully arranged so as not to interfere with one another. The self-induction is simply the sum of that of the coils unplugged. The usual form has coils of 10, 20, 30, and 40 millihenrys, so that the range is from 10 to 100 millihenrys.

The secohmmeter also enables its owner to measure capacities, mutual inductions and polarising resistances with ease and accuracy.

ON SLOW CHANGES IN THE MAGNETIC PERMEABILITY OF IRON.*

BY WILLIAM M. MORDEY.

(*Concluded from page 502.*)

Condition not Changed by Repose.—Further, the iron of some transformers which showed this increase, but which for several months have not been used, show no return to their original condition. The author is therefore inclined to believe that if periods of repose in some cases prevent the rise, it is because the time of use is not long enough to allow of much increase of temperature.

This part of the subject is being pursued; but for the present the author will only say that, so long as iron is only slightly warmed (even when that warmth is caused by alternate-current magnetisation) its permeability remains unaffected.

It may be that repose at a temperature near or below zero Centigrade, or at a still lower temperature, would have some effect. It appears possible, since continued expansion due to moderate heat can bring about this permanent increase of hysteresis, that continued contraction by moderate cold may bring the iron back to its original condition, or even permanently increase its permeability. The author intends to investigate this point.

The slow increase of hysteresis,† which is the subject of this communication, must not be classed with the immediate effect produced by the moderate heating of iron. When the iron of transformers is heated, in working, it at first absorbs less energy than when cool, probably because the increase in its resistance lessens the eddies set up in it. This is the case whether the heating is by ordinary means or by magnetic reversals. It is a temporary effect—the loss goes up again on cooling. If it is kept heated a slow change takes place, the loss gradually increasing again, from the decrease of permeability caused by heat.‡ If the temporary reduction of the loss is entirely unaccounted for by the increased resistance reducing the eddies, it appears to afford a means of separating the losses caused by hysteresis proper and those caused by eddies. The ordinary measurement of magnetising loss of course gives the sum of these two.

The increase of hysteresis shown in the tests, and resulting from the heating, is somewhat greater than the author has observed in transformers where the heat has been caused by the magnetic and electric losses; possibly this is because in the latter cases the temperature has been somewhat lower.

All the tests show an increase of loss, the maximum apparently not yet having been reached. The tests are being continued.

Conclusions.—The conclusions to which these observations lead, so far as they have gone, are:—

1. The effect is not fatigue of the iron caused directly by repeated magnetic reversals—it is not "progressive magnetic fatigue."
2. Neither magnetic nor electric action is necessary to its production.
3. It is a physical change resulting from long-continued heating at a very moderate temperature.
4. It appears to be greater if pressure is applied during heating.
5. It is not produced when the iron is not allowed to rise more than a few degrees above the ordinary atmosphere.

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* Paper read before the Royal Society, December 19, 1894.

† This effect may have an important influence on the reliability of measuring instruments having iron portions magnetised by alternate currents. The constants of such instruments may gradually fall.

‡ See Appendix III.

6. It is similar to the effect produced by hammering, rolling, or by heating to redness and cooling quickly.
7. The iron returns to its original condition on re-annealing.
8. It does not return to its original condition if kept unused and at ordinary atmospheric temperatures, whether the periods of rest are short or long.

Appendix I.

Effect of Pressure without Heat.—The following test on the effect of pressure has been made without the application of heat. A transformer constructed in the manner of Fig. 1 was taken and tightened up by hand in the usual way, sufficient for ordinary purposes of construction. The loss, on magnetising to 2,180 B at 100 ∿ was found to be 59 8 watts.

It was then submitted to a pressure of 100 tons, or about 1,500lb. per sq. in. (10·57 kilos. per sq. cm.), in a direction to force the laminæ closer together, the tightening bolts then being screwed up with the pressure on. On magnetising again to 2,180 B the loss was found to be 72·5 watts, or an increase of 21 per cent.

It was kept bolted up in this way for 30 days, and readings taken occasionally as shown in Table IV., the loss remaining practically unchanged under this continued application of pressure.

The bolts were then slackened and the loss, on being again measured, was found to be the same as before the pressure was applied.

Thus, without heat, pressure (up to the limits of the test) produces no permanent effect. But that even a very small pressure will increase the permanent effect of heat is shown by the results given in Table VI.

It should, however, be remembered that Table VI. is the record of only a single set of tests, and that it is not known what the effect would have been if the iron had been heated without any application of pressure. It is, therefore, safe only to say that under considerable pressure, without the application of heat, there is a change of a definite amount which remains constant under constant pressure, and which disappears immediately on the removal of the pressure.[*]

It is, however, clear that the slow decrease in permeability under continued moderate heating is not to be accounted for by hardening produced by pressure.

The hardening, which takes place very slowly at these low temperatures, is similar, apparently, to the hardening which takes place when iron is heated to a high temperature and then suddenly cooled.

Table IV.

(Without application of heat; magnetised only for a few minutes occasionally for purpose of measuring loss.)

	Watts.
Before applying pressure	59·8.
During application of pressure of 1,500lb. per sq. in. (10·57 kilos. per sq. cm.)	72·5 on application. 70·2 after 9 days. 72·2 ,, 22 ,, 70·2 ,, 30 ,,
Without pressure	59·4 on 30th day.

The author has a test in hand to find the effect of heat combined with considerable pressure, but cannot yet give any results.

Appendix II.

The results obtained in this way, so far as the investigation has gone, are as follows:—

A ring was made up of iron ribbon, wound in a close volute, the convolutions separated from each other by paper. This was then wound with a magnetising winding of copper wire covering the whole ring. A test was taken on January 15, 1895, of the resistance of the iron, and of the energy spent in magnetising it to 2,500 B at 100 ∿. It was then kept in an oven at a temperature ranging between 60 C. and 75 C. It was taken out, cooled, and the tests repeated on January 25th and February 8th, as below:—

Date.	Temperature.	Watts at 100 ∿.	Power-factor.	Resistance of the iron.
	C.			
January 15	17·3	4·9	0·72	0·94^{10}
,, 25	17·0	5·4	0·73	0·96
February 8	17·3	6·7	0·8	1·07

Thus the hysteresis loss has gone up considerably as a result of continued heating, and the resistance has also risen. This result is in accordance with what is known as to the connection between the magnetic permeability and the electrical resistance of iron. Prof. Hughes showed many years ago[†] that the lower the resistance of iron the better its magnetic qualities.

As bearing on this point, the author has measured the resistance of some soft annealed iron strips, which were then hardened by being heated to redness and quenched in oil at 14°C. It was found that this hardening process increased the resistance 4 per cent. and 7 per cent. in different samples.

Appendix III.

This effect may be illustrated by an example. A transformer was kept in a tank of heated oil, the temperature of which was kept between 110° and 140°C. Readings of its loss were taken occasionally as below, the magnetisation being the same in all cases, the current being applied only at the time and for the purpose of the test.

This test has not yet been in progress long enough to show the slow rise very clearly.

	Watts.		Watts.
On immersion......	33·13 Jan. 1, '95.	After 3 days ...	30·67
After 20 minutes..	32·19	,, 4 ,, ...	31·5
,, 40 ,, ..	32·1	,, 6 ,, ...	36·0
,, 1 hour	32·0	,, 7 ,, ...	33·6
,, 1 ,, 20min.	32·0	,, 8 ,, ...	36·6
,, 2 ,, 30 ,,	31·54	,, 9 ,, ...	32·6
,, 24 ,, ...	28·88	,, 18 ,, ...	32·9
,, 2 days	29·6	,, 29 ,, ...	35·9 Jan. 29, '95.

CORRESPONDENCE.

DIRECT-READING INSTRUMENTS AND THE TEACHING OF PHYSICS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The interesting discussion that has been going on for several weeks in the pages of *The Electrician*, on the proper function of laboratory experiments in the systematic teaching of physics, and the kind of apparatus that ought to be employed in experiments carried out for the sake of the educational effect they produce on those who do them, has at least shown that it is very easy for those who take either side so to state the case of their opponents as to make it appear too absurd to need a serious answer. A very little exaggeration either way suffices for this result, but when it has been obtained we do not seem to be much nearer an intelligent conclusion than before. The moral I draw is that, if one hopes to add anything useful to the discussion, it is essential to try to understand the points of view of those to whom the matter presents itself under different lights.

A guiding distinction in the case seems to me to lie in the purpose with which an experiment is performed. It makes a great difference whether this purpose is to add to the general stock of existing scientific knowledge, or to increase the private stock of knowledge of the student by whom the experiment is made. In the first case we are dealing with a scientific research, and it is not only allowable but desirable that the researcher should avail himself of every help that is likely to add to the accuracy and value of his results. In the second case we are dealing with a laboratory exercise, where the only interest that attaches to the numerical result obtained is to see how near it comes to a value previously known.

If it be objected that this distinction is an unreal one, and that the performance of a "research" leading to some result not before known has an incomparably greater educative effect than the performance of any number of laboratory exercises, where the student can turn up in a book, before he begins, the result he ought to get, I am not disposed to deny that, in a sense, this is true; but I submit that to urge it in connection with the present discussion would be a mere attempt to confuse the issue. The discussion arose upon an experiment which was avowedly of the laboratory exercise type; there was no expectation or pretence that the result would add to the accuracy of our knowledge of the Mechanical Equivalent.

With regard to this particular experiment, it has already been pointed out by other correspondents that the chief ground for criticism was afforded by the title. If it had been called a "Verification of a direct-reading ammeter and voltmeter," I for one should not have had a word of fault to find. But when we hear of a "determination" of a fundamental physical constant, what we expect to find is a statement of how the values of the numerical factors in the formula connecting the magnitude in question with the fundamental units of length, time, and mass, have been ascertained.

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[*] Experiments on a solid bar under pressure have been made by Ewing and Low. "On the Influence of a Plane of Transverse Section on the Magnetic Permeability of an Iron Bar." *Phil. Mag.*, September, 1888.

[†] Royal Soc. *Proc.*, December, 1883.

In my laboratory we continually make, as laboratory exercises, what we call "absolute determinations" of **H**, of electrochemical equivalents, of differences of potential, of magnetic susceptibility, sometimes of resistance, in which the only measurements made are measurements of length, mass, and time. For this purpose we use commercially accessible standards. Our results may not always be very good—indeed, they are often very bad—but the problem put before the student is in every case to express the magnitude which he sets out to measure in terms of the fundamental physical units. Even a rough result obtained in this way is, I believe, of greater educational value than a far more accurate one got by help of a direct-reading contrivance, for the accuracy of whose indications the experimenter is not personally responsible.

My contention is very much that we ought to try to teach students of physics to rely as much as possible on themselves, and to depend as little as they can upon the accuracy of their instruments. With this object, I believe it is important to make them start as near the foundation as practicable, and to keep them on a very sparing allowance in the way of instrumental short cuts. Of course, this, like every other general statement that one can make in relation to the matter under discussion, requires to be applied with common sense, and can easily be made to appear absurd if used with too much "logical thoroughness." I do not admit that logic requires us to limit students to apparatus that they can make for themselves. In most cases I believe that setting them to make apparatus leads to nothing but waste of time and material. They must be supplied with apparatus, and with good apparatus, but it should involve as few arbitrary assumptions as possible. Resistance-coils are arbitrary assumptions which it is not reasonably possible for the average man to do without; Clark's cells border on the luxurious, but, as they have been specified in an Order in Council, they may be allowed without reproach. It is, no doubt, all a question of where to draw the line; I draw it somewhere about there.—Yours, &c.,

G. Carey Foster.

University College, London, February 25, 1895.

COATBRIDGE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I gathered from your reference to the gas engines at Coatbridge last week, that you were really interested in the question of the applicability of gas engines to the driving of alternators in parallel, but I now find from your article this week, and from your previous remarks which my assistant has shown me, that your real object was to attack the Mordey Victoria alternator. I do not intend to spend any time in defending the parallel working of that machine under cover of a discussion on gas engines, but I have pleasure in assuring you that I have not experienced the troubles which you ingeniously hint at.

At the present moment I am interested in one object only, and that is to prevent the £3,000 which has been spent on gas engines at Coatbridge from being altogether wasted by your apparent endeavour to pervert the lessons which may be deduced from a very mournful experience. As I have no commercial interest whatever in gas engines, your readers will not suspect me of attempting to suppress the truth.

From Coatbridge I have learned three things:

(1st.) That some gas engines are suitable for driving alternators in parallel. (2nd.) That some are not. (3rd.) That more honourable men of business than Messrs. Dick, Kerr and Co. I have never met, and I regret that success has eluded them by a mere accident.—Yours, &c.,

February 26, 1895. John S. Raworth.

P.S.—I shall be happy to enter on the subject of the parallel working of alternators with any responsible correspondent, if you will see fair play.

[It is distinctly comforting to find that Mr. Raworth still thinks us capable of fair play.—Ed. *E.*]

RUNNING ALTERNATORS IN PARALLEL.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am obliged by your printing my letter of the 19th inst. on this subject, but regret that in your Notes you insinuate that Mordey alternators run well in parallel at half or three-quarter load, but give trouble when run up to their full output. This may be the case with some alternators, and I have heard that it is so. It is not true as regards Mordey alternators, however, which run well in parallel from no load to full load. Even short circuits on the mains which pull down the station E.M.F. for a few seconds to a very low point do not cause the machines to get out of step. The synchronising currents are more noticeable at small loads than with large ones, which is probably due to less even turning of the engines when running at full speed with the steam very much throttled. In fact, the synchronising current is purely a matter of steady driving. The limit of safe load of these machines is imposed by the heating of the armature winding, and not by any difficulties in running parallel. It may interest you to know that last autumn, on one or two occasions of great pressure, we ran 75-kilowatt machines in parallel at 40 amperes × 2,200 volts each without trouble.

Another illustration may interest you. A few nights since, three 75-kilowatt and one 100-kilowatt machines were running in parallel on a load of 110 amperes. (It had been 134 amperes at 7 p.m., and our load often goes up and down a little between 7 and 7:30.) About 7:27 the eccentric strap on the engine of the 100-kilowatt machine broke, bending the eccentric rod, and entirely disarranging the steam distribution of the engine. Nevertheless, the machine ran on at its normal speed, keeping perfectly in step, and, taking a very few amperes, drove the engine until it was switched out, when the engine stopped in a few seconds. The voltmeter record for the time shows but an instantaneous kick of one volt (1 per cent.); and, as I was reading by the light at the moment, I can testify that, though I noticed the alteration, it was so slight and soon over that I did not think anything serious had happened. My belief is that nothing short of a mechanical obstruction which the machine cannot overcome (even utilising all the power of the others connected to it) as a motor will throw a Mordey alternator out of step, and, of course, the protecting fuses should cut it out before the motor current is dangerously heavy. Those who are a little behind the scenes know the origin, and can guess the purpose of the defamatory attack made on these alternators; but it is extremely regrettable that technical journals should give currency to these vague statements, calculated to do serious harm to the makers of a particular type of machine. It is not difficult to learn the truth as to the performance of these machines, and, if you are desirous to discover it, you are welcome to send a capable representative to watch the running of Mordey alternators at Bournemouth for one or two nights. I may say in conclusion that, while it is pretty clear what you mean by hinting at Mr. Raworth's unhappy experience of running in parallel, I believe that the facts do not support your inference, and that Coatbridge is the only place where I have heard of trouble of the kind, and certainly no one can maintain that gas engines are very well adapted to the work.

Finally, I find Dr. Fleming's Bankside curves very interesting, and worthy of study in this connection.—Yours, &c.,

Henry M. Sayers.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: We were very pleased to see in your last week's issue letters from engineers entirely disproving your conclusions *re* the parallel working of Mordey alternators, and were very much surprised on turning to your editorial notes to find that, in spite of these practical testimonies, you were still unconvinced. You suggest that these machines will only run satisfactorily in parallel at half or three-quarters load. In reply to this we have pleasure in stating that on several occasions during the past winter we have had alternators of this type working in parallel perfectly satisfactory on a load from 8 to 10 per cent. above the combined normal output of the two machines, often for an hour or two at a time.

We carry parallel running to the greatest possible extent in our station; we synchronise four or five times every evening, and never experience the slightest difficulty.

It must be remembered that we provincial engineers are entirely dependent upon our technical papers for information as to the successful working of any system other than our own, and we quite agree with Mr. Sayers in thinking that any journal making such a sweeping condemnation of a special type of plant should justify their remarks by getting some of the engineers in charge of stations to inform us what has been their cause for complaint. As we are probably amongst those —whom you are pleased to term the minority—who agree with Mr. Raworth in his ideas upon what constitutes satisfactory parallel running, we should like to know where are the vast majority? Why are they so silent?—Yours, &c.,

THE HASTINGS AND ST. LEONARDS-ON-SEA
ELECTRIC LIGHT COMPANY (LIMITED).
February 27, 1895. L. Andrews, Managing Engineer.

"KATHION"—A PROTEST.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you allow me to enter a protest against the use of the word ka*th*ion. As you very well know, the word is derived from κάτειμι, and should, therefore, be ka*t*ion, which is the form used in the older books on electricity.

It is not incumbent on electricians to be acquainted with the Greek language, but when one uses Greek words, one should endeavour to have them correct. Scientists are apt enough to criticise literateurs and others who adopt a scientific phraseology without scientific accuracy, and may expect to be taunted with lack of culture unless they avoid barbarisms, when making use of the classical languages.

It is quite evident, of course, how the error has slipped into use, a false analogy with *kathode* being responsible, but it is a pity that such mistakes should be perpetuated, and I trust that if you in your columns always adopt the correct form, it will again be established in the electric literature of our country.—Yours, &c., JOHN WADDELL, B.A, D.SC.

Royal Military College of Canada, Feb. 9, 1895.

THE INCANDESCENT GAS BURNER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Bernard Drake is quite correct in saying that electricians should welcome the Welsbach apparatus as a blessing in disguise; but I hardly think he has realised the direction from which ultimate salvation for the electric light is to come. There is no blinking the fact that the Welsbach burner possesses very many of the advantages of the electric incandescent lamp, and that it furnishes them at a very much lower cost. In most towns the cost of the electric light works out to nearly double the cost of gas when consumed in the ordinary burner, and as the Welsbach burner displaces at least three ordinary gas burners, while consuming less than one of those it displaces, the proportion between the cost of gas *à la* Welsbach and electricity *à la* glow lamp is certainly not less than as one to six, after making full allowance for the saving effected by convenient switches. Unfortunately, this is not the whole of the case against the electric lamp. Once the Welsbach or some similar burner is generally adopted, the gas supplied need only be such as can be used for heating purposes, and will be very much less expensive to produce than the present illuminating gas.

As Mr. Drake says, the use of the Welsbach burner will educate consumers up to the proper standard at which they will appreciate the electric light; but, in order that the latter may again go ahead, it will be necessary that the lamp itself shall be improved up to somewhere near the lines of the Welsbach burner. At present, as we know, the electric glow lamp is very wasteful. It demands far too much energy in proportion to the light it gives out. Surely, too, what has been done from outside, in the Welsbach burner, can be done from inside in the incandescent filament. Of course, it is knowing how to do it—that is the problem. And here, I think, is where the disguised blessing comes in. Great as have been the advances in the manufacture of glow lamps since that memorable evening when Mr. Swan first exhibited them at the Society's meeting, the lamp itself is to all intents the same as the one he then showed us.

If no rival such as the Welsbach had arisen, lamp makers would have gone peacefully on, hardly even increasing the efficiency of their lamps. Now, in pure self-defence, they will be obliged to be up and doing. Already there are rumours of discoveries of new substances that are likely to do for the glow lamp what the special compound in the mantle does for the Welsbach burner; and any day we may hear of someone having solved the problem. Fancy the enormous impetus that would be given to electric lighting by the advent of a glow lamp requiring only half a watt per candle-power.

Meanwhile there is a very large field where the Welsbach, at present, cannot enter, but where its educating influence will be felt.—Yours, &c., SYDNEY F. WALKER.

Cardiff Electrical Works.

THE BORCHERS BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the correspondence in your paper on Dr. Borcher's gas battery, I should like to make a few comments on the general nature of the battery, such as it presents itself to a student of physical chemistry. I have, to my astonishment, seen that some of your correspondents have made experiments with the object of proving that the E.M.F. of this battery was not due to the combination energy as represented by the formula—

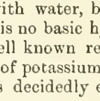
$$CO + O = CO_2. \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

That this is not the case and cannot be the case hardly needs any experimental proof, and, I doubt that Dr. Borchers ever entertained the idea. As a matter of fact, the positive or energy developing element of a voltaic combination must have the character of the cathion of an electrically decomposed electrolyte. Now, the most characteristic property of a cathion is that it is able to combine with hydroxyle to a basic hydrate or replace hydrogen in a negative hydrogen-combination forming a salt. This is universally true. Now CO does not enter directly in combination with water, but can be made to do so indirectly, and the result is no basic hydrate, but an acid *formic acid* HO COH.* The well known reaction set up when CO is passed over solid hydrate of potassium at a temperature higher than +100°C proves this decidedly electro-negative nature of CO. The reaction may be put:—

$$CO + KOH = KOH\ CO. \quad . \quad . \quad . \quad . \quad (2)$$

Another thing is also certain, *hoc est* a compound cathion must be of a chemically unstable character, and in most cases of only a hypothetical existence, although one of them, at least, the H_4N, may be easily isolated in the form of an amalgam. On the other hand, carbon monoxide has all the properties of an exceedingly well-balanced chemical compound—it is, in fact, the most stable of the oxides of carbon. Its tendency to combine with oxygen can be compared nearest with that of phosphorus trioxide (P_2O_3), which is so great that it lights itself in the air, and burns to P_2O_5. Yet nobody has ever proposed the use of P_2O_3 as an energy developing pole in a voltaic combination, and in all probability nobody is likely to do so. Thus, as we have seen, and as is well known, CO is the characteristic of negative radicles generally, and whenever it enters a positive radicle the properties of those radicles depend upon *another element* than carbon—generally nitrogen. The only other class of CO compounds known are non-electrolytes, specimens of which may be represented by the compounds—

$CO\ Cl_2$;



We have thus seen that CO has not at all the properties of a cathion, but those of the characteristic of an anion. From that reason it is obvious that it cannot be used *directly*, as current developer in a voltaic combination, deriving its E.M.F. from the combination energy, as represented by (1). This, of course, does not exclude the possibility of utilisation of the reducing power of the gas in question for reviving the cathode of a voltaic combination. According to my opinion, Dr. Borchers' cell derives its E.M.F. from the combination energy—

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* The hydroxyle compound of CO is the hypothetical hydrate of carbon binoxide, the carbonic acid $(HO)_2\ CO$.

$$Cu + O = CuO. \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The cathode is being constantly supplied with fresh copper by reduction of oxychloride of copper by means of the compound of cuprous chloride and carbon monoxide. The difference between the combination heats, as represented by following formula: $CO + O - Cu + O$, is spent as heat. Naturally, it is easy to understand that under these conditions the copper cathode may not only not diminish its weight, but we might even expect to hear of experiments showing an increase of the same. Eq: n (3), if calculated according to Thomson, gives an E.M.F. of 0·8055 volts, agreeing to within certain limits with what has been observed experimentally. The solubility of cupric oxide in chloride of ammonium and cuprous chloride and the solubility of CO in the same mixture no doubt have given a curious appearance to the phenomena connected with these experiments, and caused a deceptive complication; but it is to be hoped that the discussion of this voltaic combination will throw some light on the difference between reactions of ions and those of non-electrolytes.—Yours, &c., JOHN RHODIN.

C.E.S.S. Laboratory, Clifton Jn., near Manchester,
February 26, 1895.

LEGAL INTELLIGENCE.

Cassell Gold Extracting Company (Limited) v. Cyanide Gold Recovery Syndicate (Limited).

The further hearing of this case was resumed on Thursday last week, before Lord Halsbury and Lords Justices Lindley and Smith.

Mr. RALPH NEVILLE, Q.C., for the repondents, referred to the plaintiffs' Transvaal patent, and pointed out the difference between that and the English patent. It was frequently insisted on by the other side that although gold had been extracted by means of a solution containing cyanogen; yet no process had been marked with commercial success. He submitted that obtaining gold with solution was not and never could be a "commercial" success. What they got in solution was double cyanide of gold, and in that form it was not commercially useful. If a person tried to pay his debts with double cyanide of gold it would be refused, for double cyanide of gold was of no service until it was obtained in a metallic form.

Lord HALSBURY: The solution of the gold is an important step.

Mr. NEVILLE agreed; but there was nothing new in that. The utility of the plaintiffs' patent was not denied, and if the patent could be upheld on other grounds the plea of "want of utility" probably would not be fatal to it. When the state of knowledge for nearly a century before the date of MacArthur's patent was considered. the plaintiffs said, "Oh, yes; this method of bringing gold into solution was known, but it never had been done with commercial success"; but that argument did not carry any weight with it, because there could be no commercial success before the gold was extracted. The question was, had gold been brought into solution by a solution containing cyanogen before the date of the plaintiffs' patent? What the patentee was driving at was to get his gold into solution, and he did it; but he did not invent any new process for that. Really the only discovery made by the patentee was the alighting on an ore yielding the most valuable results when treated in this manner. To find out that gold in ore could be got in solution by a mixture containing cyanogen was one thing, and, if new and patentable, probably a very valuable invention; but the claim of the plaintiffs was quite different—namely, not that cyanide of potassium would dissolve the gold in the ore, but that a particular solution of cyanide of potassium would have the effect of dissolving the gold in the ore, and leaving the other things behind. No one could argue that these two inventions were the same, and, if they were not, then the patent was hopelessly bad for disconformity.

Lord Justice SMITH: I understood disconformity meant this—that you may not claim in your complete more than you have got in your provisional, but you may claim less.

Mr. NEVILLE: Of course you may; but that is not my point. You cannot get protection for one invention and good claim, because your complete means a different one. The point I am trying to make is, these are really two different inventions. If Mr. MacArthur stood on his first claim then he is in danger of having claimed too widely, having regard to the state of public knowledge and what had gone before. If he narrowed it and said it was only the second claim which he made then he was in the difficulty of having got one invention protected in his provisional and the other protected in his complete specification.

Sir RICHARD WEBSTER, replying on the whole case for the plaintiffs, said the case was one of very great importance and of extreme difficulty. Throughout the whole consideration of the case in the Court below, Mr. Justice Romer seemed to have been impressed with the view that there was nothing for his decision except the subject matter of the MacArthur patent as affected by the state of public knowledge before the date of his specification. The first and most important matter referred to again and again at every stage of the argument of respondents' counsel was that, in the court below, he (Sir Richard) either did abandon or led them to believe that he abandoned the claim for selective action. The second point was what was the proper construction of the plaintiffs' specifications. The third question with which he would deal with was that of "disconformity" between the provisional and complete specifications, but assuming that he could satisfy their lordships that he was right with regard to selective action, then the point of disconformity would not arise. The fourth point was want of novelty, and that would depend on the construction of the specifications and the subject matter of the patent. He would also deal with Rae and Simpson's patents. With regard to the first point (selective action), if there had been any misunderstanding about his position on behalf of the Cassell Company it was perhaps his own fault, but looking through the whole of the proceedings, he thought there was no trace of any statement by counsel which could have misled them. What he meant by selective action was that a dilute solution of cyanide of potassium within certain proportions did, in fact, have this selective action on ore, that it did extract the gold and silver and leave the other metals behind. He had never suggested that there was no solution of the other metals. A weak solution of cyanide of potassium had a "selective" action to this extent, that it solved the gold and silver and left behind the bulk of the iron and copper and whatever metallic substances there were in the ore.

Lord HALSBURY said he never understood that "selective" action had been abandoned by the plaintiff.

Sir RICHARD WEBSTER said that in the court below Mr. Justice Romer seemed to take the view that there was no subject matter for the patent. He (Sir Richard) agreed the strong solution would attack the baser metals, and so render it difficult to get the pure gold out of the solution. Having dealt with Rae and Simpson's specifications, as they, in his view, affected the case, the learned counsel said the action was not brought for damages, but simply for an injunction to restrain infringment, and he submitted that a case had been made for reversing the decision of the court below.

Their lordships took time to consider their judgment.

Heyl v. The Westphalite Syndicate (Limited).

This action was heard in the City of London Court, before the assistant Judge (Mr. Julian Robins). The plaintiff, an electrical engineer, of 134, Fenchurch-street, sued the defendant Company, carrying on business at 70, Gracechurch-street, to recover £12. 10s., the price of 500 electrical discharged sold and delivered. Mr. Osborn, for the plaintiff, in order to prove his case, read a number of letters which had passed between the parties. The goods, it appeared, had been sent to the defendants in September last, and were returned in October. Mr. Weigoll, for the defendants, contended that the plaintiff was prevented from recovering by the Statute of Frauds, as the contract, if any, was for a sum over £10, and there was no written memorandum. The Judge upheld the objection, and at once gave judgment for the defendants with costs.

National Telephone Company (Limited) v. Shand.

At the Greenwich County Court last week, before Judge Bristowe, an action was heard, in which the defendant, who was formerly general manager of the Victoria Steamboat Association, was summoned for the sum of £12, one year's rent of the telephone to his private house at Brockley, Kent. The plaintiffs relied upon an agreement, signed by the defendant, to sustain their case; but the defendant's contention was that he was merely acting in the capacity of a servant of the Association, and he denied personal liability. The order was produced, and it was found that it was not written on the official paper of the Association, but bore their name on the back. In evidence it appeared that the Association entered into an agreement with the plaintiffs for a set of telephones, including one at witness's house and one at defendant's. Capt. Shand had nothing to do with the matter beyond signing the order. For the plaintiffs it was urged that the defendant had used the telephone until the previous day, although the Association went into liquidation in July last.—The Judge said he must decide that the bargain was with the Association, and gave judgment for the defendant, with costs.

A Flywheel.—A 20ft. flywheel recently went to pieces at the Edgar-Thomson Steel Works, and did damage to the extent of £4,000. The engine was described by a local print as being "a model piece of machinery." Nevertheless it promptly ran away when something went wrong with its governor, and furnished material for the following graphics to a local reporter:—"The speed kept increasing, and it became evident to the engineer that the wheel could not hold together. He attempted to stop the engine, but failed, and soon the wheel with a terrific crash went to pieces, threshing the big engine into a thousand fragments and hurling tons of iron through the walls of the building like cannon balls. The entire end of the building and part of the roof was demolished."

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NOW READY.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Although about 100 pages are added to the book, no addition is made to the price, which is 7s. 6d., post free 8s. 3d., abroad 9s.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices :—*

THE LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, presented with our issue of January 4th, can be obtained mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s.—each post free. The Map showing positions of Supply Stations is mounted on the back of the Table. The Coloured Map issued with the Jan. 18th number and the Electricity Supply Statistics issued with the Feb. 1st number, are also mounted on some copies, and the price of these, complete, post free, is 5s.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

LABORATORY NOTES AND FORMS.—With the above title, we are publishing a set of Elementary (ready) and Advanced Exercises (portion now ready, remainder end of March) for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"ELECTRO-CHEMISTRY."—This useful work, by Dr. G. Gore, is still on sale, the price being 2s., post free.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. net., is now ready.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d (abroad 8s.). Prospectus on application.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and Wilkinson, price 6s. 6d., post free.

TENDERS INVITED.—Tenders are invited until the 18th inst. by the Ministry of Public Works, Madrid, for a concession for the establishment and working of a telephone exchange in the old town of Salamanca, Spain.

——— The Llanelly Borough District Council require tenders for providing and fixing electrical plant and machinery, including street lamps, and laying down mains for lighting portions of the town. Mr. Jennings is clerk, and tenders must be in by the 25th inst.

——— The General Direction of the French Posts and Telegraphs, Paris, invites tenders until the 7th inst. for 442 kilometres of telephone cables of different diameters.

TENDERS ACCEPTED.—The Norwich Town Council have accepted the tender of Messrs. Lawrence, Scott and Co. for the fittings for the lighting of St. Andrew's Hall for the sum of £458.

BUSINESS CHANGES.—It is reported that negotiations are in progress in reference to the formation of a company to acquire the electrical engineering branch of the business of Messrs. Ganz and Co., of Budapest. It is also stated that Messrs. Schuckert and Co., Limited, of Nuremberg, have entered into negotiations for the acquisition of the business and works of Messrs. Krizik, electrical engineers, of Prague.

APPOINTMENT VACANT.—The Walsall Corporation require an electrical engineer at a salary of £150 per annum. Applications must be sent in by Saturday, the 16th inst.

LIQUIDATIONS.—A petition has been presented for the winding up of the Ford-Lloyd Manufacturing Company (Limited), and is down for hearing at the Royal Courts of Justice, London, on Wednesday next, the 6th inst.

——— A meeting of Swan's Electric Company (Limited), is to be held at Messrs. Watson and Dendy's, 141, Pilgrim-street, Newcastle-on-Tyne, on March 23rd, at 10 a.m., to receive an account of the winding-up.

BANKRUPTCY.—The estate has been sequestrated of Messrs. Browning and Gardner, electrical engineers, of 122, George-street, Edinburgh. The election of trustee and commissioners will take place at Lyon and Turnbull's Rooms, Edinburgh, on March 6th, at 1 o'clock. Claims must be sent in by June 27th. Agents, Simpson and Marwick, Edinburgh.

PERSONAL.—Mr. M. G. Ross has resigned his position as Managing Director of the Hastings and St. Leonards-on-Sea Electric Light Company, and the Directors have appointed Mr. Leonard Andrews to take over the duties of the position. Mr. Andrews has had charge of the running of the station for the past 16 months.

IRON TRADE SYNDICATE.—Circulars have been issued, says the *Sheffield Telegraph*, to 200 iron firms in South Yorkshire, Lancashire, Derbyshire, Staffordshire, Worcestershire, and Shropshire, containing the draft scheme of a proposed new Midland Iron Trades Association. This is said to be the biggest combination ever attempted in the British iron trade, by which it is proposed to regulate the prices of all manufactured iron. The Committee of Management is to consist of 20 members, representing all the districts, and the operatives have consented to join the scheme.

BRITISH ALUMINIUM COMPANY.—Considerable interest is taken in the North of Scotland in the details of a scheme proposed by the British Aluminium Company to utilise the power at the Falls of Foyars on Loch Ness, which formed so great an attraction to visitors during the summer months. The Company propose to obtain motive power from the water at the Falls for the purpose of manufacturing aluminium by electricity, and it is estimated that this will give employment to about 100 men in a district where at present little population exists. Of course, there is no intention to do away with the Falls, and it is expected that the flow of waer will only be moderately affected in very dry seasons. The Secretary for Scotland has, it is said, ordered an official report to be made on the proposed operations of the Company.

ELECTRICAL TESTING INSTRUMENTS.—We have received the following letter from Mr. R. W. Paul :—

> Referring to your notice of recent catalogue of electrical testing instruments, my attention has been called to a description therein of a galvanometer, designed and patented by me in 1891 to 1892, and named by permission "The Ayrton-Mather Galvanometer." I note that the illustration and description in that catalogue correspond to my list No. 2 of 1892 (No. 76), and would point out that the details and arrangement of the instrument in question are covered by my patent No. 4,276 of that year. I regret that the firm issuing this list should copy the original designs of other makers.

CANADIAN MICA.—Dr. G. M. Dawson, the Director of the Geological Survey of Canada, has sent to the Imperial Institute a collection of some 50 samples of Canadian mica. The export of this article from Canada to the United States for electrical purposes has steadily increased, and Dr. Dawson calls the attention of persons interested in the trade in this country to the facilities which Canadian producers have for supplying this article.

A BATTERY INSPECTING LAMP.—The Electrical Power Storage Company are introducing a new lamp for putting into the electrolyte between the plates of our batteries. It is especially useful for inspecting the condition of the plates, that cannot otherwise be easily seen, in lead or lead-lined boxes. It has flexible connections, and is fitted with springs to grip on to the lead connecting bars of adjacent cells, a four-volt lamp being used.

COMBINED MACHINE TOOLS AND MOTORS.—Messrs. Greenwood and Batley (Limited), of Albion Works, Leeds, have just secured a large order from a foreign Government for machine tools with electric motors combined.

LIGHTING PLANT FOR H.M.S. "POWERFUL," "JUNO," AND "DORICE."—In a Trade Note in our issue of February 15th, dealing with work now being carried out by Messrs. Clarke, Chapman and Co., reference is made to the lighting plant for the above vessels. We are asked by Messrs. W. H. Allen, Son and Co. to point out that the permanent machinery for these three vessels is being manufactured by them at their Bedford works.

BATH.—In this city lighting troubles appear to be in connection with the gas. Many complaints are made of extinguished gas lamps, presumably owing to the frost. A meeting has been held of the Town Council, sitting as the Sanitary Authority, at which notice was given that it is the intention of the Authority to oppose the application of the Electric Lighting Committee of the Town Council for a Provisional Electric Lighting Order, it being the intention of the Authority to itself apply for an Order. It is probable that in the end the local electric lighting company will be left in full enjoyment of its Order.

Birmingham.—It was proposed by the Directors of the Birmingham Central Tramway Company to start a 5-car (15 minutes) electric service on their Bristol-road trams from the first Monday in March. This object has, however, been defeated by the prolonged frost, which has stopped the works, and has prevented the preparation of the necessary batteries. The Company hope, however, to commence the new service before the end of the current month.

On Tuesday next a further report is to be presented by the Technical School Committee on the question of lighting the school by electricity at an estimated cost of £6,271. 8s. This proposal wss adversely criticised at the last meeting of the administrative Council, and the Committee agree to provide details of the proposed expenditure. These details are included in the report to be presented on Tuesday next. Six firms have tendered for the equipment of the 116 rooms of which the new school will consist, the tenders varying from £20,510 to £13,226, the latter, that of Thomas Parker (Limited) being accepted. The work will require six months to execute. The Committee point out the reasons for recommending the lighting of the school by electricity were because of the greater conveniences afforded by electricity than by any other means of illumination. The Site and Building Sub-Committee, to whom the matter was referred, reported strongly in favour of the electric light on the grounds (1) of health and comfort of the students, most of whose work would be done in the evenings; (2) its great convenience and suitability for lighting the building; (3) because the provision of the necessary motive power required in the shops and laboratories could most conveniently be supplied by electricity, so that the plant required for both lighting the building and providing power could be combined in one installation; and (4) that under these conditions the annual cost of lighting by electricity would exceed by very little, if at all, that of gas. In addition, they considered the electric method of lighting is in itself a most valuable technical educational medium in the school, inasmuch as the machines will be available for demonstrative and other purposes by the students in engineering, electrical, and allied subjects. After full consideration, it was decided not to accept any of the tenders sent in, but to remodel the specifications and to advertise for tenders, omitting for the present the ornamental and other fittings required. To the revised specification 29 tenders were received, and, subject to the approval of the Council, the Committee propose accepting the tender of Messrs. D. and G. Graham of Glasgow, for the sum of £5,515 14s. 2d. For the ornamental and other fittings not included in the specification an estimated sum of £565 will be required, bringing the total expenditure to £6,080 14s. 2d.

Blyth.—It is stated that it has been decided by the newly-elected District Council to abolish the electric light at Waterloo and Cowpen Quay on the expiration of the existing contract, and to revert to the use of gas.

Bradford.—A proposal of the Electric Light Supply Committee of the Corporation to advertise for two powerful engines to supplement the plant at present working at the electric lighting station has been approved. The additional plant will fill up all available space, and it is therefore proposed to erect another station, probably on a site in the Canal road. The electric light enterprise of the Bradford Corporation is a remarkable instance of successful municipal trading. The supply was not established till 1890. In 1892 there was a net profit of £1,385, in 1893 of £1,623, and in 1894 of £2,138, or a return of 10 per cent. upon the capital expended.

Brighton.—The report of the Lighting Committee came before the Corporation at its last meeting. Councillor Dell took exception to the proposal to purchase the remaining portion of the block of buildings to complete the lighting station, and protested that the Council had gone mad on the electric lighting question. They were "piling on the agony," and the cost of the scheme would finally reach £500,000. He protested against the whole of the electric lighting works being placed in the centre of the town, as he was afraid that, if anything happened and the whole thing burst up, the inhabitants of his particular ward (St. Nicholas) might be sent where they would never be seen again. It was pointed out to Councillor Dell that it was his duty to inform the ratepayers that the Corporation's electric lighting scheme would have the effect of materially reducing the rates. The purchase was ultimately agreed to.

Bristol.—The Visiting Committee of the Bristol Lunatic Asylum are considering the advisability of introducing the electric light into their buildings at Stapleton, and have, in company with Mr. H. Faraday Proctor, the engineer to the Bristol Corporation, visited a similar institution at Exeter where the electric light has been adopted. Here the deputation were much impressed with the arrangements made, and were assured by the Town Clerk of Exeter and the medical superintendent of the institution that on no account would they return to gas lighting. From the points of health and cleanliness the electric light was a great advantage in such an institution, and it had encouraged a free use of ornamental plants all over the building, much to the enjoyment of the inmates It is understood that the only question remaining for serious consideration is whether a separate plant shall be put down, as at Exeter, or whether the current shall be taken from the Bristol Corporation mains.

Cardiff.—Mr. Sydney F. Walker returns to the charge and discusses, in a long letter to the *South Wales Daily News*, the system adopted for lighting this town. Mr. Walker concludes a lengthy epistle by a demand for a strict inquiry.

A meeting of the Glamorganshire Standing Joint Committee has been held at Cardiff, and a proposal to introduce the electric light into the county offices discussed. As several speakers described the electric light in the town as being "in a state of confusion," Mr. Rhys had no difficulty in carrying his proposal that the discussion be postponed for six months.

Chester.—A Mr. Preston has lectured the local Mutual Improvement Society on the subject of the electric light, and has seen fit to speak strongly against the Corporation's proposal to introduce the light into Chester, as, in Mr. Preston's views, local authorities have no business to risk the ratepayers' money on such a scheme. Mr. Preston is good enough to approve all other improvements proposed to be introduced into the town.

Church Lighting.—The church of St. Joseph, Preston, and the adjoining rectory, have been fitted for the electric light by Messrs. Bennett and Druce. Plant is provided for about 150 lights, and includes a Crossley engine and accumulators. The light will be taken solely from the accumulators, the generating plant being used only for charging purposes.

Conway.—The Town Council have received an application asking their sanction for the extension to Conway of the proposed Llandudno electric tramways. The application has been referred to the Estates Committee.

Coventry.—On the recommendation of the General Works Committee it has been decided by the Corporation to enter into an agreement with Mr. Graff Baker to withdraw the notice recently given with respect to the equipment of the electric tramways, and to grant a further extension of time, Mr. Graff Baker depositing with the City Treasurer the sum of £500, which is to be forfeited absolutely if the tramways are not completely equipped at the expiration of six months.

Ealing.—Messrs. Bramwell and Harris have, in compliance with the request of the Urban District Council, sent in a detailed report of the work done under the electric lighting scheme and a review of its present position. The report was discussed at the meeting of the Board.

Electricity in the Theatre.—In reference to a paragraph appearing in our last issue as to the application of electricity to the moving of stage scenery, it would appear that the English scene-shifter has no reason to take any alarm. The experience of men engaged in this country in stage work is to the effect that we are nearly a century ahead of continental practice, and that electricity has been used to some extent for some years past, several new departures having recently been introduced.

Hotel Lighting.—The new North British Railway Hotel, to be built from designs by Mr. W. Hamilton Beattie on the site between the North Bridge and Waverley Market, Edinburgh, at an estimated cost of £221,000, is, we understand, to be lighted throughout by electricity. The hotel will contain over 700 rooms.

Mr. B. H. Van Tromp presided at the annual meeting of shareholders of the Brighton Grand Hotel Company last week, and in the course of his remarks referred to the extensive electric light installation which the proprietors had worked for some time. Mr. Van Tromp stated that the Directors had now come to the conclusion that it was impossible to produce current by their own plant as cheaply as they could obtain it from the Corporation's mains. If the Directors had known seven years ago, when the plant was put in, that the Corporation would have taken advantage of their Provisional Order, they would have waited until the town scheme was worked by the Corporation. It was only after the Brighton and Hove Electric Lighting Company had tried to tie the hands of the Board by insisting upon a three years' agreement to take current at 10d. per unit that they felt compelled to seriously consider the question of putting down their own plant. Having decided to take current from the Corporation's mains, every effort would be made to dispose of their own plant at the greatest advantage. Some of it was valuable, and would be used for other purposes.

Huddersfield.—At the last meeting of the Town Council, in reference to the deficiency on the revenue account for electric lighting for the year ended December 31st last of £2,065, Mr. Calvert, Chairman of the Electric Lighting Committee, said the interest and sinking fund on the works amounted to nearly £3,400 for the year. If the scheme had been worked by a private company, instead of by a Corporation, a profit would have been shown of £1,400. As the money borrowed had to be repaid in 15 years' an abnormal amount was required to provide for the sinking fund. In 15 years' time, with the present output, he estimated they would make a profit of £3,000 a year.

Isle of Wight.—The contract for lighting by electricity the new County Asylum has been obtained by Mr. F. Shalders, of Southampton. Plant is to be put down for about 800 lights.

Killarney. The Governors of the Killarney District Lunatic Asylum have decided to invite tenders for lighting the institution by electricity.

Kingston-on-Thames.—It has been found that the gas-engine and dynamo recently put down at the electric light station are not of sufficient horse-power, and more powerful machinery has been ordered. A Local Government Board inquiry has been held on the request by the Town Council for powers to borrow an additional £10,000 for electric lighting purposes. This will bring up the total amount to £26,000. No opposition was offered to the application.

Liverpool.—The last weekly meeting of the Special Lighting Committee of the Corporation was strictly private. It has, however, transpired that an interview has taken place between the Committee and the Directors of the Liverpool Electric Supply Company, and the negotiations for the purchase of the undertaking are progressing, it is said, satisfactorily.

Maidstone.—At the District Council meeting last week Alderman Long said that the Electric Lighting Committee had as yet no report to present to the Council, as they had not come to any conclusion as to whether they should dispose of their Electric Lighting Order. A communication would probably be made at the next meeting of the Council.

Mill Lighting.—The mill owned by Mr. J. Pearce at Stanstead, Herts., has been fitted throughout for the electric light by Messrs. Crampton and Co., of Cambridge.

Moss Side.—The School Board for this district have discussed the question of lighting the schools by electricity, and tenders have been received. After some discussion it was decided not to accept any of the tenders sent in at present, but that the whole question should be considered at a special meeting of the Board, to be held this week after the receipt of a statement showing their financial position.

Newport (Mon.).—As in many other districts, the officials of the Newport Gas Company express their supreme contempt for the electric light so far as it is likely to affect the dividend-earning powers of the Company. The Directors in their report inform their shareholders that with gas at 3s. per thousand the electric light at 8d. per unit will be four times as costly. The Chairman of the Company does not anticipate that the electric light will in any way interfere with the gas company's profits. A subsequent speaker at the meeting of the shareholders, in alluding to the electric light, said he thought it might seriously affect the returns of the gas company in the days of their children or their grandchildren, but he did not think it would affect themselves. All seemed pleased with the outlook, and the meeting, therefore, passed off pleasantly.

Norwich.—At the last meeting of the Town Council Meeting Mr. Wild, in moving the acceptance of the tender of Messrs. Laurence, Scott and Co. for the fittings required in the lighting of St. Andrew's Hall, said that the Lighting Committee were unanimously of opinion that it would be better to have the lighting done by incandescent lamps. The lighting of the hall by electricity would not prove an altogether unproductive outlay, as they were informed by their engineer that the cost of the light would be considerably less than that of gas, and it was proposed to charge such a sum for the use of the hall as would pay a rental on the new fittings and meet the cost of the light. Complaints had been received from the organist that the organ was suffering from the use of gas, and that the pictures, which the citizens valued so much, were also depreciating in value from the same cause.

Paris. The lower *salons* of the Elysée were on Friday last, for the first time, illuminated by electricity, the occasion being the State ball given by the new President of the Republic and Madame Felix Faure. About 3,000 persons attended the function.

Sheffield.—An interesting exhibition at the Drill Hall closed on Saturday. A feature of the show has been the demonstration made by Mr. T. Scott Anderson of several electric welding systems, the particulars of which have, of course, much interested those engaged in the trades for which Sheffield is famous.

Ship Lighting.—Messrs. J. H. Holmes and Co. have just completed an important light and power installation on the s.s. "Habarofsk," built by Messrs. Hawthorn, Leslie and Co. for the Russian Volunteer Fleet. The lights in the different parts of the ship are controlled from the engine-room by an arrangement which admits of any of the lights being supplied from either of the two slow-speed dynamos which have been put down.

Southampton.—In reference to the electric organ blowing plant now used at the church of St. Laurence, Southampton, referred to in our last issue, we find this was put in by Mr. F. Shalders, of Southampton. The plant was designed and laid down by Mr. T. Davis.

St. Luke's (London).—At the last meeting of the Vestry it was stated that correspondence had taken place with the Board of Trade on the question of the transformer chambers. The late surveyor to the parish authorities pointed out some time ago that the gas mains in the City-road were so defective that gas was continually escaping, and that at any moment a serious explosion might occur. An offer had been made by the County of London Company to put clean shingle in the boxes in order to prevent any accumulation of gas, and this offer had been accepted by the Vestry on the further understanding that a good system of ventilation should be adopted throughout the footpath chambers.

Telegraphists' Grievances.—On Wednesday Sir Albert Rollit presided over a meeting of London and Provincial telegraph clerks, held at the Foresters' Hall, London. Complaint was made of the unsatisfactory replies recently given by the Postmaster-General to deputations from the telegraph staff which had discussed with him the grievances complained of. It was decided to again bring the matter of the inadequate scale of pay and the inequitable scheme of classification before Mr. Morley, and the meeting expressed the opinion that the present condition of the telegraph staff demanded inquiry by Royal Commission.

Telephone Agreements.—This evening Mr. J. W. Benn, M.P., will, in the House of Commons, move for the appointment of a select committee on the subject of Government concessions to Telephone Companies, with special reference to the memorandum signed on August 11, 1892, between the Government and the National Telephone Company. Mr. Benn has been promised the unanimous support of the Scotch members, and it is anticipated that an interesting debate will ensue, as the future policy of the Post Office with regard to the extension of the Telephone Service is also to be discussed.

Tramway Traction.—At the meetings of the London and Greenwich Tramways Company and of the North Staffordshire Tramways Company last week, Mr. Carruthers Wain, who presided at both meetings, referred to the attention given by the Directors to the question of the introduction of the lighting of the cars by electricity. In the case of the North Staffordshire Company it had been decided that this step should be adopted, and it was announced that the installation would be complete at the beginning of March. The London and Greenwich Company also expect that within a few weeks the cars belonging to the Company will be lighted electrically.

Wigan.—At the last meeting of the Gas and Electric Lighting Committee of the Town Council the further consideration of the schemes and tenders for electric lighting was adjourned.

Wolverhampton.—A meeting of the shareholders in the local gas company was held on Tuesday, at which it was carefully explained that the reduction of the price of gas by 3d. per thousand was brought about not by the competition of the electric light, but owing to a very considerable reduction in the price of coal. Notwithstanding the introduction of the electric light by the Corporation, the Chairman, Mr. Henry Ward, hoped that by economies the Company would be able to continue paying the regular dividends. The Manager of the Company said he did not see much advantage in the electric light for the use of shops, though it was a fairly good illuminant for the streets. The large demand for gas during the past few months had been quite surprising. There was, however, a tone of sadness about the meeting.

Worcester.—The electric light works at Powick were formally taken over by the Corporation on Monday last. Mr. E. T. Ruthven Murray, the newly-appointed electrical engineer to the Corporation, is now in charge.

Yeadon.—A special meeting of the District Council was called last week to discuss the electric lighting question, when Mr. J. Flaxington dealt fully with the advantages the electric light possesses over other forms of illumination, and proposed that the Council should call in an expert to examine and report upon the tenders which had been received. After an amendment, which found no seconder, had been rejected, Mr. Flaxington's proposal was adopted.

BOOK RECEIVED.

"The Engineer's Year-Book of Engineering Formulæ, Rules, Tables, Data, and Memoranda." By H. R. Kempe. Price 8s. (London: Crosby Lockwood and Son. 1895.)

"Street Railways Investments." By E. E. Higgins. Price $2. (New York: Street Railway Publishing Company. 1895.)

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

January 28, 1895.

1,931. W. H. Cohen. London. Making carbons, candles and pencils for electric lighting, and parts of electrical machines, or dynamos such as "brushes," out of plumbago, graphite or black lead in its natural state.

1,936. J. Graham and H. Chapman. London. Improvements in or connected with dynamos.

1,940. E. Hopkinson and A. P. Wood. London. An improvement in electrical controlling switches.

1,949. J. J. Pye. London. A combined mat and electric alarum contact.*

1,954. S. Allingham. London. Improvements in and relating to electrical devices, such as electromotors, generators and the like, for use in explosive atmospheres.

January 29, 1895.

1,970. J. de Galindez. London. A method of, and apparatus for, charging electrical accumulators from alternators, and changing into an alternating current the current given by the accumulator cells.

2,004. B. J. B. Mills. London. Improvements in electric recording meters and motors for operating same, and for operating the escapement mechanism of clocks or other apparatus requiring a chronometric movement. (C. Wirt, United States.)

2,009. W. McKenzie and J. A. Fleming. London. Improvements in holders for electric lamps.

2,025. R. W. Braham. London. Improvements relating to combined gas and electric light standards.*

2,030. G. Besozzi. London. Improved electrical apparatus for indicating and registering the arrivals in velocipede races.

2,031. Siemens Bros. and Co. (Limited). London. Improved automatic coupling for electro motors. (Messrs. Siemens and Halske, Germany.)*

2,064. J. Hopkinson. Westminster. Improvements in automatic switches and in their use for distribution of electricity.

January 30, 1895.

2,077. E. J. Paterson. London. Closed conduit electric railway. (F. F. Atkinson, U.S.A.)

2,100. G. Schultz. Liverpool. Improvements in the construction and method of arrangement and connection of cables and joints for electrical distribution.

2,133. J. Pogneaux. London. Improvements in or relating to electric batteries.

2,134. A. Basanta y Baqué. London. Improvements in or relating to electrical signalling apparatus for preventing collisions between trains.*

2,137. C. A. Beck and C. Rock. London. A permanently and automatically synchronised printing telegraph.

January 31, 1895.

2,182. G. F. Attree. Brighton. A duplex incandescent electric lamp.

2,218. G. Hummel. London. Improvements in or relating to "Watt hour" counter for alternating currents of electricity.

2,223. W. A. Clatworthy. London. An improved combined starting, reversing and controlling electric switch for operating electric motors.

2,237. J. F. Bachmann, J. Liebscher and A. Voot. London. Improvements in induction coils for use as resistances in electrical plant working with alternating current and with multiphase currents.

February 1, 1895.

2,250. F. H. Starling. Nottingham. Improvements in double and triple pole switches.

2,259. W. R. Hatton. London. A non-conducting sad iron stand.

2,277. G. Hirschmann. London. Improved method and means of connecting electrical accumulator plates with their conductors.*

2,280. W. O. Smith and G. R. B. Elphinstone. London. Improvements in galvanometers.

2,288. D. G. Fitz-Gerald. London. Improvements in voltaic batteries.

2,289. J. E. Kingsbury. London. Apparatus for counting or recording telephonic conversations. (The Western Electric Company, U.S.A.)

2,303. L. Hermand. London. Improvements in and relating to apparatus for lighting and extinguishing electric lamps.

February 2, 1895.

2,308. J. A. Ewing. Cambridge. Improvements in apparatus for testing magnetic quality in iron.

2,312. J. T. Niblett. London. Improvements in apparatus for regulating electrical pressure.

2,333. A. G. Adamson. Glasgow. Improvements in apparatus for the use of electric light for photographic purposes.*

2,341. W. H. Hallsworth. Dukinfield. Improvements in the driving of electrical or other machines on railway or other vehicles or engines.

2,343. A. E. Pope. Liverpool. Improvements in or relating to electric incandescent lamps. (F. R. Pope, Holland.)

2,355. W. E. Ayrton and T. Mather. London. Improvements in magnetic testing apparatus.

2,366. Siemens Bros. and Co. (Limited) and E. F. H. H. Lauckert. London. Improvements in electro dynamometers.

2,373. Bullers (Limited) and E. J. Chambers. London. Improvements in the socket joints of metallic telegraph poles.

February 4, 1895.

2,394. H. Levetus, E. M. Levetus, and W. Rowbotham. Birmingham. Improvements in primary batteries.

2,430. G. G. M. Hardingham. London. Improved means for insulating electric conductors. (The firm of Felten and Guilleaume, Germany.)

2,446. J. Boyes. London. Improvements in apparatus for the reflection of electric or other light applicable for use in connection with buoys at sea, signalling, advertising, and other purposes.

2,450. H. L. Fyfe. London. Improvements in the bulbs of incandescent lamps.

February 5, 1895.

2,492. W. S. Seaton. London. Improvements in submarine telegraph cables.

2,541. L. H. Hordern. London. Improvements in electric burglar alarms.

2,558. O. L. Peard and A. Essinger. London. Improvements in electric arc lamps.

2,561. J. Jeffryes and J. Lea. London. Improved means and appliances for regulating the feed of carbons in electric arc lamps.

February 6, 1895.

2,570. C. Meason and T. Ford. Birmingham. Improvements in chandeliers, electroliers, pendant hanging lamps, and brackets for gas, oil, or electric light.

2,604. R. E. B. Crompton. London. Improvements in electric arc lamps and their connections.

2,606. A. W. Gatfield and W. R. Clark. London. Electrical and pneumatic apparatus for scraping, cleaning, and lubricating the hulls of ships when afloat or in dock.

2,626. J. H. Cox. Greenock. Electro-copper sheathing.

2,650. S. Quincey. London. Improvements in electric bells or gongs.

2,659. Sir C. H. A. F. L. Ross, Bart. London. Improvements in electrical resistances.

February 7, 1895.

2,675. A. Wiglesworth. Liverpool. Improvements relating to insulators for overhead electrical conductors.

2,740. J. Fryer and A. E. Channon. London. Improvements in dynamo brushes.

February 8, 1895.

2,804. O. Imray. London. Metallic mixtures and alloys for effecting electro-chemical decompositions. (L. Diehl, Germany.)

2,805. R. J. Crowley, H. W. C. Cox, and C. F. Leighton. London. To regulate or assimilate the movements of electrically-connected mechanical instruments or machines, more particularly wheels or other bodies revolving upon axes, and to diminish variations in the movements or speed of the same by means of electrical impulses.

2,808. W. P. Thompson. London. Improvements in electric cables. (F. Clouth, Germany.)

2,816. F. King. London. Improvements in secondary batteries.

2,817. H. Edmunds. London. Improvements in or connected with electrical conductors for heating purposes.

2,827. C. L. Charlopin, V. M. Cornély, and L. C. Dautelf. London. Improvements in primary batteries.

February 9, 1895.

2,874. W. H. Buckley. Manchester. Improvements in or connected with electric lamps for surgical operations.

2,883. A. Lesquoy. London. A new or improved process to render the liquid of primary or secondary batteries motionless.

2,894. R. W. Hill. London. Improvements in the production of zinc chloride and in the generation of electricity.

2,913. J. Devonshire. London. Improvements in series parallel controllers. (E. D. Priest, United States.)*

2,914. J. Devonshire. London. Improvements in systems of electrica distribution. (C. P. Steinmetz, United States.)*

2,915. J. Devonshire. London. Improvements in systems of distribution by alternating currents. (C. P. Steinmetz, United States.)*

2,916. J. Devonshire. London. Improvements in systems of electrical distribution. (C. P. Steinmetz, United States.)*

2,917. J. Devonshire. London. Improvements in systems of electrical distribution. (C. P. Steinmetz, United States.)*

2,918. J. Devonshire. London. Improvements in windings for dynamo electric machines. (C. P. Steinmetz, United States.)*

February 11, 1895.

2,965. A. F. B. Gomess. London. An improved process for the electro-deposition of aluminium and aluminium alloys.

2,969. W. M. Grossett. London. Portable electric alarm, attachable to either lever or pendulum clock or timepiece.

2,971. A. W. Armstrong. London. Improvements in electrically-heated curling irons.

2,998. The Cowper-Coles Galvanising Syndicate (Limited) and S. O. Cowper-Coles. London. Improvements in and apparatus for the manufacture of copper, zinc, and other metal sheets, strips, or wires electrically.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

1,491. Barton (Jandus). Arc lamps.
2,105. Brown and Offord. Arc lamps.
2,274. Pringle. Supplying electricity to tramcars, vehicles, &c.
2,806. Kellner. Electrolytical decomposing apparatus.
3,079. Sanders. Electric bell indicator.
3,109. Imray (Rinecker). Electric locomotive.
3,294. Peterson. Electric lighting apparatus for gas burners.
3,725. Blackhurst. Galvanic elements.
4,142. Upward. Electrical letters and signs.
4,254. Andrews. Electric arc lamps.
4,366. Boult (Compagnie de l'Industrie Electrique). Dynamo-electric machines.
4,724. March. Secondary batteries.
5,026. Best. Chandeliers, electroliers, &c.
5,102. Gillmore. Telephonic relay.
5,314. Anderson. Magnetic separators.
5,509. Muirhead. Submarine cables.
5,647. Schneller and Wisse. Secondary coils for transformers.
5,721. Smith (Jorgensen). Electrolytic decomposition of common salt.
5,913. Raworth. Alternating-current generators.
6,089. Kingdon. Protecting electrical conductors.
6,554. Bullers (Limited) and Chambers. Telegraph poles, &c.
6,912. Hagen and Beyer. Electrical accumulators.
9,456. Russell. Junction or fuse-box for electric wires.
18,217. Blake. Transmitting telephonic messages between shore and lighthouse, &c.
19,924. Hoyland and Sturge. Combining electric light with metallic bedsteads.
21,629. Hanisch and others. Electric railways.
21,731. Day (Schoeffel). Arc lamps.
24,234. Körber. Electric lighting reflectors.
24,374. Clouth. Insulation of electric wires or cables.
24,431. Siemens Bros. and Co., and Perry. Telegraph, &c., posts.
24.630. Blackmore. Dissociating soluble salts by electrolysis.
25,030. Oliver. Separating metals by electric action.

COMPANIES' MEETINGS AND REPORTS.

City of London Electric Lighting Company (Limited).

The ordinary general meeting of this Company was held on Wednesday at Winchester House, Old Broad-street, under the presidency of Sir David L. Salomons, Bart.

Prior to the business of the meeting some photographs showing the whole of the developments of the Company's station from the outset were exhibited.

The MANAGER and SECRETARY (Mr. J. Cecil Bull) having read the notice calling the meeting, the report of the Directors was taken as read.

The CHAIRMAN: Gentlemen, when the days are dark and gloomy your Directors rejoice, for at such times not only are the shareholders' pockets benefited, but we also bring light, happiness, and health into many a home and into many an office, because the electric light does not vitiate the atmosphere; it is the best obtainable, and there is nothing about it to injure persons or things. Our customers must also be glad to have found out that in our mains there is no moisture to impede delivery of the electricity by condensation, freezing, or otherwise. Considering the absence of fogs that we have had this year, and especially at the end of the year, as we had to explain on the last occasion—and it is rather exceptional for London to be so clear for two years—we have done exceedingly well, and I think that if the affairs of the Company were to be reviewed by an impartial critic—which I will not consider myself—he could only come to the conclusion that we are giving a satisfactory supply, and that the organisation is good. You must remember that the electric light is comparatively a new illuminant, only introduced in a proper manner by us into the City of London as late as two or three years ago, and naturally a work of such magnitude requires time to carry out. When you remember that we are now raising a gross income of something like £114,000 a year, the view which I take, and which would be taken by an impartial critic, I think you will agree, is a fair one. On previous occasions it has been my necessity—I will not say duty—to make, not excuses to you for not giving dividends on the Ordinary shares, but to refer to the difficulty of teaching the public (for they require educating in that respect even now) that a new undertaking cannot pay on its Ordinary shares the moment the Company is started, and that it is necessary that the works should be completed, and that the Company should obtain its *clientèle* before the shareholders can receive anything in return. I do not think anyone here who has been present on previous occasions will say that I have made a number of promises which could not be fulfilled, as it is not my principle in life to make a promise unless I can see it can be carried out. You have shown up to the present time patience and indulgence to your Board of Directors, and at last the time for recompense has arrived. We have turned the corner—a corner I hope we shall never go back to. It makes it very easy to address you on an occasion of this kind, for the reception of a little money is such an agreeable thing to everyone, whether rich or poor, that only good temper can prevail. We have now begun to pay a dividend, and not a mean dividend, of 5 per cent. to the Ordinary shareholders, and I trust that we shall never meet here in the future without declaring a sum as large or larger as the years roll on. I might save your time by sitting down at this stage, but it is our wish—and it always has been—that what takes place in our Company should not be limited to our shareholders alone, but should be circulated outside, so that our friends and neighbours in the same business may learn a little from us as we have from them. It is a fair thing to do, and I believe that men of business with liberal views will always take this course. I will not attempt to run through the various figures in the report—having taken it as read, I presume that you have all read it—but I may have to refer to one or two items at a later stage. I may point out that the principal alteration in the staff since we last met is that of the appointment of Mr. Frank Bailey as our engineer, and I think we have to congratulate ourselves very greatly on this appointment. It was not without considerable difficulty that we secured his services; but the difficulties were overcome, he is with us, and we have greatly benefited already. He is too well known throughout the world for me to make any remarks as to his qualifications. The chief remark to be made on the report—and it is one that should not be overlooked—is that on page 3, showing the rapid growth of the Company. Taking simply the customers from the end of 1892, we find that at that period they numbered 242, while at the end of 1893 they numbered 1,080, and at the end of 1894, 2,740. You must not imagine that this increase will go on for ever, but it is satisfactory as showing that the citizens of London greatly appreciate our efforts to bring comfort and health into their offices. The accounts, if analysed by a man of the most severe mind, could not be seen to be other than honest. In the first place, the form in which they are rendered to you is one regarding which we do not exercise an option. It is the Board of Trade form, and the figures have to be filled in in accordance with their rules, subject to certain apportionments which naturally only the Directors can make, knowing the circumstances; and in order to check the Board the auditors go into every item with every care to be satisfied before they sign. The accounts show one or two very important points which may have escaped your attention. In the first place a lump sum of £19,064 in account No. 10, on the liability side, has been allocated in order to pay off all expenses connected with the issue of the various classes of shares and debentures. It is a very common practice to write this charge off by degrees, but the Board thought fit to take it out of the balance-sheet, and to do away with it, as we can afford to do so easily. The Ordinary shareholders have sacrificed a great deal in permitting the Board to issue Preference shares and debentures at a higher interest than the money might possibly have been obtained at. By doing this we were able to issue them at a premium, and this has enabled us to put by a very large sum for a reserve fund. Having made this sacrifice first, of writing off the whole of the expenses of the issue of capital at once, and, secondly, by having secured a reserve fund by the issue of shares, &c., at a premium, the Directors thought it was perfectly right and fitting that a sum of £1,585 in account No. 9 should be paid out of premiums, this being the 5 per cent. reserve fund, which it was necessary to put by apart from the depreciation fund. The auditors, I may say, fully concur in this view, and having given you this explanation, I am sure you will uphold us for having done quite right in this matter. This depreciation reserve fund—for there are really two, although they go under different names by Act of Parliament—is not idle, because the bulk of the money is invested and bears interest, which goes to assist the dividend of the ordinary shareholders. These combined funds consist of £40,000 odd invested in consols purchased at an average price of £98$\frac{7}{16}$; and also of a sum of £15,200 invested in Metropolitan Two and a-Half per Cent. Consolidated Stock, which was purchased at £94$\frac{7}{8}$. The actual value of these funds represents, in round figures, about £56,000 at cost, but owing to the rise in Consols the value if sold would be greater. To this has to be added the balance of premiums on the last issue of debenture stock, and other sums, which make a total of, altogether, about £90,000. I trust, therefore, that we are in a very safe position for the future, as our income is likely to be sufficient to meet all requirements without trenching on this fund, or only to a nominal extent from time to time. I think you will agree that the rapid extension of the Company's business shows that the public is satisfied with our efforts. We are now just over 3½ years old, of which 18 months were necessarily occupied in getting things ready. I think that the photographs which you have seen show the importance of the work with which we have had to deal. One trouble we have had to contend with has been the condensing plant. It should have been ready long ago, and was ready, but when the pumps were set to work it was found that the strainers choked very rapidly. This was due to the water in the Thames being full of leaves and straw. It was an unforeseen difficulty, but is now being met by special machinery, which will continue to clear the strainers so as take the leaves away and allow the water to pass. The detailed drawings are practically finished now, and in a very short time we trust to have it in position. This will be of great advantage in lightening the coal bill, and in decreasing the amount of steam that naturally comes from works when you have no condensing plant. I think that, as regards the public lighting, equal satisfaction must be felt, for the reason that the gas lampposts throughout the main thoroughfares were removed soon after our last meeting. I then told you that they were about to be removed, and that has been done, and no one has ever criticised the lighting of the City without an expression of opinion complimentary to us. It will give you a notion of how it has worked when I tell you that the total number of breakdowns has been only six. I do not mean throughout the City, but here and there a lamp at a time, no street having been thrown into darkness, and the total extinctions being under three hours. The number of lamp hours is considerably over 2,000,000, and the percentage of lamps extinguished has been 0·067. That is exceedingly nominal. The private lighting has also been very satisfactory, notwithstanding the number of difficulties with which we have had to contend, for the total extinction has been only 0·012 per cent. of lighting hours, which is very small indeed, Our engineer has suggested to the Board a method of giving discounts whereby the small consumer will be reached. The difficulty we have always had has been that the discounts have been given, as is done in commerce, to large people—the wealthy people—and the small people have got nothing or only a very little. We have now found a very easy, convenient, and fair method of giving discounts to everyone. It has been devised by Mr. Bailey, and I hope it will give satisfaction to every one in the City. We are still waiting, but we hope soon to receive an order from the City authorities to light the lesser streets. The delay in giving this order is due to many reasons—to no fault of this Company, but to various experiments which have been tried in order to obtain a satisfactory system. We are now, however, urging the authorities to settle on some principle for lighting the minor streets, and we hope that in a short time it will be a settled matter, and will no longer appear as a promised order in future reports. There is one point of great importance to us, although it may appear a very small matter. Next door to our works, in which a very large sum of money is sunk, there existed an enormous oil store. If this had caught fire no doubt our works would have been in jeopardy of being destroyed, and it was a serious danger not only to our own property, but also to the citizens at large, owing to the fact that at any moment the supply of electricity to the City might have been stopped. In face of this the Board decided that there was no other course open to them but to purchase these works if they could do so on reasonable terms. We have been enabled to do this, the price paid being a very fair one, and not at all unreasonable, as is so often the case, and the oil store has now disappeared. These works are not an imaginary advantage to us, for, apart from removing this great danger, the land running alongside of our own will enable us to put up such offices as may be required to supplement our present offices, stores, workshops, or anything that may be found desirable, and we shall thus save a considerable sum which we should otherwise have had to pay for renting places elsewhere. There is, therefore, that advantage, quite apart from the question of the safety of our concern. I daresay you are aware (although time moves so quickly now that one is apt to forget what took place a few months ago) that we gave a dinner to the Lord Mayor and a large number of gentlemen connected with the electrical science and industry. That dinner was cooked entirely by electricity, the intention being to show that cooking by electricity was quite practical. We showed that, and also drew great attention to this Company in this way, and I trust that the expenditure in connection with it has been successful, although you will understand that it is difficult to trace how many pounds have come to us owing to this dinner. On the whole, we feel convinced that it was a benefit to us. The whole of our boilers at the station, with one or two exceptions, are fitted with automatic stokers, which enables small coal to be used, and this is an economy in point of money, and also abates the smoke nuisance. Since this has been done we have not been troubled with complaints about the smoke nuisance. I think you will find that we are a pattern company as compared with many of the factories around which have not these various appliances. When you consider that we have running machinery there requiring thousands of horse-power, you will see that we have to consume an immense quantity of coal, but, nevertheless, the smoke from these chimneys is very small. I may tell you for your information that we have now plant in position for, in round numbers, 121,000 8-c.p. lamps, and on order 120,000 8-c.p. lamps. These figures may not seem to tally with other figures showing the number connected, but we have never had so many as 80 per cent. of our lamps lighted at any one time. We have got connected now 157,000 lamps, so that we have an ample margin. It is rather misleading, perhaps, to state the length of cables in one way, so my figures must be dissected. The total length of trenches now in use is 63·1 miles, and the total length of the cables laid 618·1 miles. The total length of high tension laid is 110½ miles, and the total length of low-tension distributors about 48 miles, which you might probably put into more ordinary language to the general public by saying 40 miles of house frontage. That gives you roughly an idea of the state of the Company as regards the mains at the present time. If you will allow me, I will give now a few technical figures, not so much for your interest here, but it may interest a great many who are working with us outside. We have metered to the 31st of December last for private lighting 1,532,396 units, and for public lighting very nearly 1,000,000 of units. There are over 73,000 units which have been used on the works in connection with private lighting, but this will be very much less in future, when all the testings are completed. Together these figures make a total of 2,602,217 units, against 1,741,099 units for 1893. The ratio of generation and distribution to receipts for 1894 was 46 per cent., but by estimation (for I cannot guarantee these figures to 1 per cent.), as compared with 54·2 per cent. for 1893. This shows conclusively how working expenses go down as the output becomes greater. On the other hand, as our machinery increases, the money put aside for depreciation and reserve must necessarily increase, and, therefore, you must not expect that if we keep on obtaining a larger output year after year it will be all profit. These figures show that we have improved every year, and I trust we shall continue to do so. By the revenue account on page 2 of the report you will see that 50·27 per cent. of the total revenue may be taken as profit for 1894, whereas in 1893 the figures were 40·11 per cent. These figures, again, are better for private lighting if taken by itself, and I thought it was fair that you should see the figures taken *en bloc*, and as years go on we shall be able to make a better comparison. This has been only two years' working. The proportion of profit for 1894 has been roughly a little over 10 per cent. more than in 1893. As for our coal consumption, it stands for the average of the year at 1⅓d. per unit, but if taken at the best of the year—which is about now and the last month—it is considerably under 1d., and it will be under 1d. for the whole year. That, however, is no great thing, for we ought to work at under 1d. per unit. I think that we are doing quite as well as others. Our statutory price is 8d. per unit, but this is reduced by discounts, &c., to 7·7d. per unit. The 8-c.p. lamp in 1893 earned somewhere between 13s. and 13s. 6d. per annum, but we calculated roughly from 12s. to 13s. to be on the safe side. The total number of lamps at the present moment being supplied are 144,086, we have still 7,157 to connect, and applications are coming in very satisfactorily, averaging, taking one month with another, practically 1,000 per week. I hope that may continue for many years, although no one can forecast the future. We have still the power to issue £100,000 of debenture stock, and this will be required to continue the extension of your works. We had the power to issue £400,000 of stock, but having issued £300,000, redeemable, at the option of the Company, after the year 1910, at £125 per cent., we have come to a standstill unless you sanction the issue of the £100,000 that remains, and I shall ask you by-and-by to do so. That will complete the £400,000. Two of my colleagues, Mr. Edward Lucas and Col. Martindale, retire by rotation, but being eligible, they offer themselves for re-election, and I trust that by-and-by you will do them the honour to re-appoint them to represent you. With regard to the staff, I can only say what I have said before—that in every way they have done their best to please the Board and to earn your gratitude, and our thanks are greatly due to their energies for the success we have had in the past. I now conclude by proposing the following resolution:—

"*That the Directors' report and statement of the accounts for the year ended December 31, 1894, with the appropriation of the reserve and depreciation funds as proposed, be and the same are hereby received and adopted.*"

Mr. JOSEPH BEVAN BRAITHWAITE, Jun.: I have great pleasure in seconding the report, because on this occasion we have come to the point which some of us have always been confident we should come to, and we are in a position to declare a dividend on the Ordinary shares of the Company. As some of you who are old shareholders of the Company may remember, those of us who put our money into this concern at the end of 1890 and the beginning of 1891 were rather laughed at, and were told that the idea of making electric lighting pay in the City of London was ridiculous, and that within two years—they were kind enough to give us as long as that—our cables would be pulled up, the whole of our capital would be gone, and that our Company would have to liquidate. Some of us, however, took a different view, and thought that the City of London presented exceptional advantages for a well-managed electric lighting company. Experience has shown us that so far from our light in the City earning less revenue per lamp than in other parts of the metropolis, it is a trifle ahead. In addition to that we have a field which is unique it its character, as the City may, I think, without egotism on our part who live in the City, be described as the wealthiest in the world. We, therefore, have a class of customers to deal with in the City to whom a question of a few pounds more or less in their lighting bills is of no moment whatever compared with the question of comfort and convenience. I think we may, therefore, fairly congratulate ourselves at this meeting, because, with the comparatively small number of lamps we had at the beginning of 1894 – about 65,000—we have not only earned our Debenture and Preference interest, but also a first dividend of 5 per cent. on our Ordinary shares. You will naturally ask, What are the prospects for the future? because you did not go into this thing for a return of 5 per cent. Well, I think I may say that the prospects for the future are very satisfactory. We have at this moment 144,000 lamps connected to our mains, as against 65,000 at this time last year. If 65,000 lamps will earn all our debenture and Preference interest I leave you to figure out what prospects there are for the Ordinary dividend when we commence this year with 144,000 lamps. That, however, would be unsatisfactory if the indications were that we had come to the end of our demands, because, as those who have been in the Company from the beginning are aware, we have always laid our plans with the idea of ultimately having a demand in the City of something like 400,000 8-c.p. lamps. You are entitled to ask if there is any prospect of those figures being realised. The region of prophecy is one into which it is not wise to enter, and all I can say is that up to the present time the applications for lamps continue to come in as well as ever in the history of the Company. Although we have applications now for over 150,000 lamps, we are still receiving them at the average rate of 1,000 lamps per week, which is about as rapid as we care to have them. If we add only 50,000 lamps a year to our mains, we shall be perfectly satisfied. As to the position of the Ordinary shareholders, I think that the Chairman has brought out two points exceedingly satisfactory to them. One is that the item of expenses for our issue of capital, amounting to £19,000, has been wiped out, and therefore no longer stands against the Ordinary shareholder in the balance-sheet. In the second place, owing to their forbearance and willingness to put this Company on a thoroughly sound financial basis—owing to their having allowed us to issue our Preference shares and Debenture Stock at rather a high rate of interest—we have been able to accumulate for the Ordinary shareholders, after wiping out this £19,000, a reserve fund of about £90,000. All that goes to strengthen the position of the Ordinary shareholders, and I think I may venture to say that, should nothing unforeseen occur to prevent it, that reserve fund is likely to remain intact. What I mean by that is that the revenue for the present year will enable us to pay a good dividend on the Ordinary shares, and at the same time to meet all proper charges in maintaining our plant, and provide for the statutory depreciation in our machinery all out of revenue. I look to seeing the reserve fund steadily increase, in fact. I do not think there is any other point on which I need detain the shareholders. Our undertaking has now got out of its infancy, and I hope has entered on a very healthy and vigorous youth, which I trust will be followed by a hale and hearty middle age. I congratulate those who put their money into it at a time when it seemed a risky and plucky thing to do, that they have conferred a great benefit on the City of London, and I hope with no ultimate injury to their own pockets.

A discussion followed, in the course of which

Mr. SYDNEY MORSE referred to the recent explosions, particularly the one on Southwark Bridge. Being interested in electric lighting generally, he found there was an idea prevailing that the explosions were solely caused by the electric light company's mains. He was informed that the Southwark Bridge explosion was caused by something other than electricity, and that it damaged the Company's work, and the question he desired to put was whether the Company had taken any step to bring home to the gas company their responsibility for these explosions

The CHAIRMAN, in reply, said: I have much pleasure in answering the questions I have been asked. In my opening remarks I did not put before you the position of the Company in quite as liberal a spirit as did my friend and colleague Mr. Braithwaite, because I did not feel that I was entitled to do so; but I may say that I fully share his views, although it is never wise to be too sanguine. He takes a very hopeful view, and he has been right so far in all his prophecies with respect to this Company, and I only trust that his predictions to-day may be similarly correct. A gentleman has asked a question with respect to the telephone tubes, but I can only refer him to the newspapers for an answer. From time to time the Commissioners consider the question, but the matter gets constantly shunted. I trust that it will be settled in course of time, but when you deal with public bodies, where people have so many interests, it is difficult to carry anything through with expedition. I hope that they will see the justice of our desire that these tubes, in which we have a certain sum invested, may be used for telephonic purposes. We are dealing with the Commissioners now, and we have made exceedingly liberal offers. In a private business, if I were the Commissioners, I should be only too pleased to accept the offer made by the Company. With reference to the question raised by Mr. Morse, the various explosions are still under discussion and consideration by the Board of Trade, and I do not think it would be right for us to analyse what may be done until we know what is to be done. As far as we are concerned, we are doing our best to avoid the possibility of such explosions occurring in the City. It is perfectly true that the gas company, in having been given a monopoly to put pipes down throughout London, have taken French licence and occupy the whole of the soil with their gas. Some suppose that in consequence of the wood pavement and the asphalt, the gas that used to escape and poison Londoners is now kept underground, and will naturally find its way into any empty space; but, whatever the cause, the gas companies have on all occasions met us very fairly, and I do not think that, under existing circumstances, it would be fair to say anything against them, although we are rivals. Before long the Board of Trade will probably issue rules, or some kind of report, which will place us right in regard to explosions in the future. It has been from time to time stated—I do not say by the gas companies—that where the conductors are insulated, electricity gives off certain gases which explode. This idea has been upset, however, on many occasions by explosions occurring in those conduits where no bitumen existed at all, and where the copper was naked. In regard to the Southwark Bridge explosion, I may say at once that it had nothing to do with the electric mains at all. With respect to the contract for the lesser streets, there is a certain annual sum provided in the contracts with the City authorities, and as soon as they make up their minds how they will light these streets it will be our business to carry out the work, and the sooner the better. We are urging them as far as possible to do so. The contract for the public lighting is all one contract, but it is divided into two parts, and the second part for the minor streets is to be done when the Commissioners of Sewers decide the method of electrical lighting. As regards the question of cost per unit, the gentleman who asked that question appears to have an idea that the fact of giving discounts shows that we are lowering the price per unit, but that does not follow. There are a large number of buildings we are lighting; for instance, the Inner and Middle Temples, where there are many thousand lamps, and places like Cannon-street Station, and there is a talk of other stations, and some other large buildings, where they would put up their own plant if we did not supply them at a reasonable price. As soon as you get a certain profit you can always do the remainder at a lower price. It is generally taken that we are not allowed to treat customers on different terms, so the only way in which we can treat them is by giving discounts. In this way we are enabled to take over a large number of these big customers, who otherwise would not come into this system, who give us a profit, and who, by employing our light, are enabled to use their basements for their own businesses. He then put the motion, and it was carried unanimously. He afterwards proposed—

"*That the following dividends for the half year ended December 31, 1894, be and are hereby declared:—On the Company's Preference shares the sum of 6s. per share, making, with the interim dividend of 6s. per share paid on July 19, 1894, the full dividend of 6 per cent. per annum for the year. On the Company's Ordinary shares the sum of 5s. per share. That the respective dividends be paid on February 28, 1895.*"

Mr. EDWARD LUCAS seconded the motion, which was unanimously carried.

The retiring Directors and auditors were afterwards re-elected.

The CHAIRMAN next proposed

"*That the Directors be and are hereby authorised to issue the remaining one hundred thousand pounds (£100,000) of the Company's Debenture Stock, subject to the terms and conditions of the Deed of Trust, dated February 26, 1894.*"

Mr. F. W. REYNOLDS seconded the resolution, and it was unanimously agreed to.

On the motion of Mr. WANCKE, seconded by Mr. J. REILLY, a vote of thanks was passed to the Chairman, Directors and staff.

The CHAIRMAN, in reply, expressed a hope that in the future they would meet on as amicable terms as on the present occasion, and that he might have as good news to lay before them.

The proceedings then terminated.

Notting Hill Electric Lighting Company (Limited).

The eighth ordinary general meeting of this Company was held on Tuesday, at the registered offices, Bulmer-place, High-street, Notting Hill, Prof. Wm. Crookes, F.R.S. (Chairman), presiding.

The SECRETARY (Mr. R. G. Rawkins) read the notice calling the meeting.

The CHAIRMAN: It gives me great pleasure to have this opportunity of congratulating you on the continued success of our Company. Although we are not making quite such rapid strides as are some of the electric lighting companies, there is satisfaction in knowing that our progress, though slow, is certainly sure. I think it will be best for me to follow my usual plan of going through the accounts which have been put before you for confirmation. *No. 1 Account.* The only alteration in this account since last year is that the issue of Preference shares has increased by 441. Since the end of the year, however, a further 450 of these shares have been allotted, leaving the unissued share capital at the present time at £12,610. *No. 2 Account.* This account shows that we have not yet commenced to exercise our powers of borrowing, which extend to £50,000. *No. 3 (Capital) Account.* The amount spent on this account during the year amounted to £5,032. 1s. 7d., but notwithstanding this fact the total expenditure shown is £193. 3s. 9d. less than that which appeared in the previous year's account. The explanation is that the sum of £5,205. 5s. 4d. in former accounts, representing the cost of opposing injunctions, compensations, general administration, and management expenses during construction and preliminary expenses to the first general allotment of shares, has been transferred under the advice of the auditor of the Board of Trade to a suspense account, and as it is not represented by any visible assets, it will be gradually written off out of revenue. *No. 4 (Revenue) Account.* I think you will agree with me that this account must be considered highly satisfactory. There has been an increase in the revenue of £793. 7s. 11d., and, although this has naturally entailed increased work, the expenses for the same period, as mentioned in the Directors' report, have decreased by £127. 2s. 8d. The staff deserve our best thanks for the manner they have carried out their duties in order to bring about this result. The working expenses have been now cut down to almost the lowest possible point, but the Company has an efficient and hard-working staff, and I think I may confidently assert that the business is now being worked on more economical lines than any similar undertaking in London. The gross profit has risen from £1,481 to £2,401, showing an increase of nearly 70 per cent. This, of course, is brought about principally by the additional number of lamps connected; these have increased to the extent of 3,500 during the year, or more than 800 above the additions for the previous year, being, in fact, a larger increase than during any 12 months since the commencement. As a large part of the additional lamps were connected towards the close of the year 1894, we shall only receive the full benefit of them during the current year. The amount of bad debts for the year was only £5. 16s. 6d.; this shows the wisdom of our policy in requiring deposits in doubtful cases. The Electrical Association, which was originally formed by the London companies with the view of taking up any important question seriously affecting the industry, has, I regret to say, been dissolved, and the amount of £43 odd appearing in the revenue account represents the Company's proportion of the surplus assets. *No. 5 (Net Revenue) Account.* This account requires little explanation from me. The account shows an available profit of £1,513. 14s. 7d., which is reduced to £1,243. 14s. 7d. after providing for the £300 the Directors propose to take for their services during the year, instead of the £1,000 to which they are entitled. I should like to take this opportunity of stating that the Directors have now surrendered fees amounting altogether to £2,510. I have a resolution to propose presently dealing with the balance of undivided profit; but before dismissing this account it may be well to mention that nearly £1,300 have been taken out of the year's revenue for repairs and depreciation, or 25 per cent. of the gross receipts. *No. 6 (Depreciation) Account* and *No. 7, General Balance Sheet.* These speak for themselves, and I do not think there is anything in either of them requiring comment. The certificate of the auditors appears at the end of pages 8 and 9. In addition to this I may mention that as they carry out their work every three months they also supply the Board with a quarterly report on the accounts. I regret to say that our lamp earnings are still very low, reaching only to about 6s. for each 8-c.p. lamp. This is much lower than any of the other London companies, and you will readily understand that very few customer have earned a discount, the lowest rate of 5 per cent. being allowed only when the earnings per lamp for the year reach 10s. Considering the smallness of the Company's output the sheer cost per unit reflects the greatest credit on the engineering staff, and it will compare favourably with other London companies, some of which are sending out nearly twenty times our number of units. Towards the end of the year an important extension of the mains was made from the Phillimore district, along Kensington-road, throughout Melbury-road, and a part of Addison-road. This work was carried out entirely by our own staff, thereby effecting a considerable saving in the expense. I am pleased to say that, although the extension cost about £3,400, it is already more than paying its way, besides satisfying several of the residents in the Melbury-road district who have been anxious to have the light for a long time past. Other small extensions have been made during the year to connect up houses requiring the light, and in every case a satisfactory return on the capital outlay has been obtained. The total capital spent on new mains during the year was £4,083. 4s. 7d. You will have learnt from the Directors' report that they have applied for powers to light the area adjoining the present one on the northern side, including Uxbridge-road, Ladbroke-grove, and many other streets of more or less importance. The Board of Trade has approved the draft Provisional Order, and the only thing now required is for Parliament to pass the Bill confirming the Order. The only streets in which the Company undertakes to lay mains within two years from the date of the Order are Archer-street, Ladbroke-gardens, Norland-square, and parts of Uxbridge-road, Ladbroke-grove, and Portobello-road. Before agreeing to this the Directors took the precaution of having these streets canvassed, and from the results obtained we felt justified in agreeing to this compulsory area. When these powers are obtained we shall have greater facilities for supplying current in the western or Addison-road district of our present area, where we have not yet been able to send current except to the Melbury-road end, owing mainly to the difficulty of obtaining the necessary site for a battery station and to the fact that Uxbridge-road, our only available approach to Addison-road on the north, is outside our present area. This was one of the chief reasons we had for applying for additional powers, and directly our new Order comes into force we propose constructing a main down the Uxbridge-road, continuing it along the Addison-road, and so connect it with the mains recently laid in that neighbourhood. By this means we hope to supply a large number of lights without going to the expense of erecting a battery station. It is a matter for regret that explosions of gas have recently taken place in electric lighting main culverts, but so far we are to be congratulated on nothing of the kind having occurred in our district. The Directors hope shortly to have all their culverts ventilated, thereby preventing, as far as possible, any accumulation of gas in them, and a plan for carrying this out is now having full consideration. No accident of any kind has occurred, and although the winter has been exceptionally severe everything has progressed satisfactorily, with the exception of a little water recently getting into our culverts through the bursting of a water-pipe. No stoppage whatever has occurred in the supply of current throughout the year; in fact, I believe the only stoppage we ever had was the one which occurred a year or two ago, when the current was turned off for two hours in the early morning. With this exception current has been supplied to our customers day and night uninterruptedly since it was first switched on on May 30, 1891. In conclusion I should like to say that the Directors' first consideration has been to give a return to the holders of the Ordinary share capital, and everything that could properly be done to bring about this result has been done. Although the dividend is not so large as could be wished, now that the dividend-earning point has been reached there is every reason to believe that it will go on increasing, and the future increased prosperity of the Company seems to me fully assured. I now beg formally to propose:—

"(1.) *That the report of the Directors and the accounts to December 31, 1894, submitted to this meeting, be, and the same are, hereby approved and adopted.* (2.) *That a dividend at the rate of 6 per cent. per annum for the half-year to December 31, 1894, be, and is hereby, declared on the Ordinary Preference shares, payable forthwith, making, with the interim dividend paid in July, 6 per cent. for the year.* (3.) *That a dividend of 2s. per share free of income tax be, and is hereby, declared on the Ordinary shares of the Company, payable forthwith.*"

Perhaps one of my co-Directors will second these resolutions, and I will put them to the meeting *seriatim*, unless any shareholder would like to make any remarks before I do so.

Mr. ALEXANDER HOWDEN seconded the resolutions, which were carried without discussion.

Mr. BURNESS, in proposing the re-election of the retiring Directors, Mr. A. E. Franklin and Mr. Francis Radford, said he begged to offer his hearty congratulations to the Board in being able to pay a dividend at that early stage of the Company's existence. He only hoped that this sign of prosperity would be an encouragement to the shopkeepers along the line of the Company's mains to use electric current instead of gas.

Col. BUTTANSHAW seconded the proposition, which was agreed to.

Mr. MATTERSON then moved the re-appointment of the shareholders' auditors, Messrs. Fox, Sissons and Co.

Mr. BRADFORD seconded, and the proposal was adopted.

Mr. MATTERSON, in proposing a vote of thanks to the Chairman, said the shareholders were fortunate in possessing such a gentleman as Prof. Crookes to look after their affairs. He felt thorough confidence in their Chairman and the other members of the Board, and he believed it was due to their great ability and attention to the interests of the Company that it was in such a satisfactory position.

Col. BUTTANSHAW seconded, and the proposition was unanimously carried.

The CHAIRMAN, in acknowledging the vote of thanks, said the Company owed a great deal of its success to Mr. Schultz (engineer and manager) and the other officials, all of whom worked hard for the benefit of the shareholders. He felt that he did not deserve all that had been said in his praise; but with the other Directors he would continue to do his best to promote the success of the Company. The frost had caused them considerable trouble, but they were now getting rid of that difficulty.

The proceedings then terminated.

Telegraph Construction and Maintenance Company (Limited).

The thirty-first ordinary general meeting of the members of this Company was held at the offices, 38, Old Broad-street, on Tuesday, under the presidency of Admiral Sir George H. Richards, K.C.B., F.R.S.

The SOLICITOR (Mr. Chapman) read the notice convening the meeting and the minutes of the two previous meetings.

The CHAIRMAN: I am sorry to see so small a meeting. I hope the influenza has not affected you as it has some of us on this side of the table; but I am very pleased to meet you. I daresay that, as you have had the report in your hands for some days, you will take it as read. My first duty is to inform you of the death of one of our Directors, Mr. Philip Rawson, which occurred on November 12th last. Mr. Rawson was one of our oldest Directors—I think he was 25 years on the Board of this Company, and he was held in high esteem by all of us. He was always in his place and invariably took a great interest in everything connected with your affairs. He is very much missed by us, and I feel sure that we shall have your sympathy with us at his death. As regards the question of filling up the vacancy, I think it right to say a word or two. We have always looked at it as one of the important duties of the Board, and in view of the nature of this Company it is a matter which we all think demands our deepest consideration. Of course, in every company of this kind, and in every mercantile company, the first duty is to get the best commercial assistance on its Board. It has always been our policy to do that, but on a Board of this kind we require a great deal more than that. We have, as you know, to carry out great operations between this country and our distant Colonies, and between all parts of the world and this country, and therefore it is very essential for us, we think, that we should have on our Board men who, I may say, are of world-wide reputation and influence—men whose names command confidence both at home and abroad. If you will look down our report you will see that we have lately placed two gentlemen on our Board who fulfil all these conditions in the very highest degree—I allude to Sir Robert Herbert and Admiral Sir Anthony Hoskins. As I said before, both of their names command great confidence, and we think ourselves very fortunate in having secured the assistance of these gentlemen in your interests, and in the interests of the Company generally. Now, gentlemen, I will proceed with the business of the meeting. I think I may fairly congratulate you on the result of last year's working. We carried out two rather large operations last year. We laid a cable for the Eastern Extension Company up the China Sea, between Singapore, Labuan, Borneo, and Hong Kong. This cable was something over 1,700 miles in length. It was all laid in the early part of the year, and its manufacture, of course, came into the accounts of the year before. After that we laid a cable for the Anglo-American Company across the Atlantic—a cable between Ireland and Newfoundland. That cable was something under 2,000 miles in length, and I believe it was a cable of the largest capacity that was ever made. Both these works were carried out with great success, and I may say that they were crowded into half the year. We cannot command times and seasons, but all our resources were taxed, and all the skill and ability of our staff were called into requisition. I think it reflects great credit on them that the work was done so well and without any hitch at all. Since then we have laid some smaller lengths of cable for various foreign Governments and companies. On the whole we are able to pay you a dividend of £2. 8s. a share, including the interim dividend paid last July. Although these were rather large works, they really do not take very long to describe, and I do not know that I have anything further to say on that part of the subject. The meeting, however, generally asks or wishes to know what our prospects are for the current year, and very naturally so, and I think I had better anticipate this question by telling you all I can about it. We have no contracts on hand, and, in fact, we meet this year with less work in progress than ever before. I think it right to tell you this squarely; but, at the same time, it not infrequently happens, as it did last year, that all our year's work comes into a half-year, and the year is early yet. We hope, of course, that we shall get better business, and you may, at all events, depend that all the exertions of the Directors and the executive will be devoted to that end. Our principal work at present is in manufacturing certain lengths of store cable ready for work; and, taking advantage of this lull, which has often occurred before, we are putting our machinery and appliances into such a state that we shall be enabled to do our work more efficiently and more economically when it comes. I do not know that I have anything more to say. I think it right to tell you exactly what our prospects are; but I think I should tell you at the same time that we have the most perfect confidence in the soundness and the healthy condition of the Company. I hope you will take that as our view. Before putting the resolution to you I shall be glad to answer any question; but I will now move—

"*Resolved that the report and accounts of the Directors to December 31, 1894, submitted to this meeting, be, and the same are hereby received and adopted, and that a dividend of 36s. per share, in addition to the 12s. per share interest, or interim dividend paid to June 30, 1894, be paid on all shares of the Company for the year ended December 31, 1894, and that such dividend be paid free of income tax.*"

Mr. GEORGE W. CAMPBELL: I have much pleasure in seconding that.

Mr. CROFT said he hoped that, as a very old member of the Company, he might be allowed to express on the part of the shareholders the regret which they felt at the loss sustained by the Company in the death of Mr.

Rawson. It was his (the speaker's) duty on the last occasion on which the shareholders saw Mr. Rawson on the other side of the table to put some questions to that gentleman with respect to his connection with another company, which was very notorious at that time. If, in putting those questions, he made use of any expression which the deceased might possibly have considered hard or painful, be could only express his very great regret. He felt it his duty, however, to ask these questions, which were answered by Mr. Rawson, whose connection with the company in question was, he believed, a subject of great regret and annoyance to that gentleman. He was sure that the shareholders would greatly regret his death. He was aware that it had always been the policy of the Directors of this Company to observe judicious reticence, and on the part of the shareholders he thought that this was very good policy. With respect to a commercial company such as theirs, where rivalry and competition were so great, it was very necessary that Directors should not disclose more information than they thought proper with respect to the operations of the Company. If he sat down without getting an answer to the question he was about to put he should rest quite satisfied, believing that the Directors, in their judgment, did not think it a question which it was in the interests of the Company should be answered. There were, however, some matters which were more or less common knowledge, and he alluded now to an article which appeared a few days ago in *The Times*. The Chairman had made no reference to the article, and he did not know whether it referred to their Company. He alluded to the Pacific cable. The article contained the following passage :—"Acting under the resolution of the Conference, which requested that the Canadian Government should take the necessary steps to promote the construction of the cable, the Dominion Government called for tenders under three forms. By the first of these, Form A, the cable is to be owned and controlled by Government, to be worked under Government authority, and to be kept in repair by the contractor for three years. The only actual offers received are, Mr. Sandford Fleming informs us, according to this form, and he proceeds to state that :—Among the tenders received is an offer from an old-established and reliable firm to lay the cable on Route No. 1, the all-British route by Fanning Island" for a certain sum. He might be quite wrong in asuming that the "old-established and reliable firm" did not relate to this Company, but he hoped it did. If the Chairman saw fit to make any observation with respect to the Pacific cable, he was sure they would receive it with great satisfaction ; but if he thought that it was not advisable to say anything, he was sure that the shareholders would rest contented.

The CHAIRMAN : We are very pleased at what you have said about Mr. Rawson. I can assure you that so far from that gentleman thinking anything of what you said, he was the first man to say that he expected it. You will remember that he regretted having had anything to do with the company alluded to, by which he was a great loser. Your words, however, have been very pleasing to us. You alluded to the Pacific cable. Well, you know, the Pacific cable has been written about for years. All I can say on the matter is that it will very likely be laid some day, but at present it is in the air. Some seven or eight routes have been proposed for this cable, which is to extend about 8.000 miles, and to do all kinds of things. But none of these routes have been examined, and there have been no specifications in regard to the cables. It is all of a vague kind. No doubt tenders have been asked for, and so far as this Company is concerned, we have said what we could do as far as possible ; but we cannot speak accurately. You spoke of a company that has tendered for a low sum. If a cable were advertised to be laid to the moon there would be contractors for it. Before, however, a contractor can give a real tender, he must have questions asked, routes must be examined, and specifications must be given for the cable. It makes a great difference whether a cable goes a short distance between two points or a long distance. You may rest assured that we are not the old-established firm spoken of in *The Times* article, but we are the oldest Company that exists, and the pioneer Company in connection with all such work as this. Whatever difficulties there may be, you may depend upon this that this Company will not shrink from any of them. I have no doubt that when the time comes for this cable to be laid we ought to stand as good a chance as anyone else, and nothing will be wanting on our part in the matter. He then put the motion, and it was carried unanimously. He afterwards proposed the re-election as a Director of Mr. George W. Campbell.

Mr. JAMES PENDER, J.P., seconded the resolution, which was carried unanimously.

On the motion of Mr. GIBSON, seconded by Mr. CROFT, Mr. John Gane and Mr. Patrick A. Glegg were re-elected auditors of the Company for the year 1895 at the usual remuneration, Mr. Gibson expressing a hope that they might have as good a balance-sheet to audit next time as they had had on the present occasion.

Mr. CROFT then proposed a vote of thanks to the Chairman and Directors for their exertions in the interests of the Company.

Mr. GIBSON, in seconding the motion, observed that the Directors were certainly entitled to the best confidence of the shareholders for having done so well as they had. He hoped that Mr. Shuter was not absent owing to ill health.

The motion was carried unanimously.

The CHAIRMAN : We thank you very heartily for your kind vote of thanks to us. Our great object is to do our best for you and to have your confidence. Before we separate I ought, perhaps, to say that our excellent Managing Director, Mr. Shuter, who has been here so many years, has had a very severe illness lately. He is in a fair way of recovery, and I had hoped he would be present to-day, but for the severity of the weather. I hope, however, that we shall have him here again in a few days. I thought that the shareholders, who have known Mr. Shuter so well, would feel an interest in being informed about this.

The proceedings then terminated.

Edison and Swan United Electric Light Company (Limited).

An extraordinary general meeting of this Company was held yesterday at the Cannon-street Hotel, and confirmed, as special resolutions, the resolutions passed at the extraordinary general meeting held on February 5th. The Earl of Lichfield presided.

The CHAIRMAN said : I think it is unnecessary for me to trouble you with many words to-day. As you are aware, this meeting is held to confirm certain resolutions which were passed at the last extraordinary general meeting, and I daresay that most of you present also know that the alterations we are proposing to make in the articles of association are in order to conform with the requirements of the Stock Exchange. We hope that when these alterations are effected the Stock Exchange will grant us a quotation on the partly-paid shares. Whereas at the last meeting it was necessary to put each resolution separately, I am informed by our solicitor, Mr. Crisp, that to-day the opposite has to take place, and that we must put the whole of them *en bloc*. He then submitted the resolution in the usual way, and expressed his readiness to answer any question.

A SHAREHOLDER inquired, with regard to the insertion at the end of Clause *f.* of Article 65, whether the £100,000 of debenture stock that had been issued would form part of the £200,000 mentioned in the words to be inserted.

The CHAIRMAN replied in the affirmative.

Major FLOOD PAGE then seconded the resolution, which was carried unanimously, and the proceedings terminated.

Chelsea Electricity Supply Company (Limited).

The following is the Directors' report, to be submitted to the annual ordinary general meeting, to be held at the Central Station, Draycott-place, Chelsea, London, S.W., on Tuesday next, the 5th inst., at noon :—

The 6,000 Six per Cent. Preference shares, of £5 each, issued in April last at a premium, have been fully subscribed. The balance of premiums on the Preference shares, after deducting the expenses of issue, amounts to £1,339. 18s. 7d. This sum has been applied to the reduction of the preliminary expenses account in the general balance-sheet, and a further sum of £834. 4s. 5d. has been taken from profits to extinguish this account. The revenue account shows a credit balance of £8,096. 6s. 9d., which, with the balance of £619. 4s. 3d., brought forward from last account, and £1,339. 18s. 7d., the balance of premiums above referred to, makes the total amount to the credit of net revenue account £10,055. 9s. 7d. After deducting interest on debentures £2,214, placing to renewals and depreciation fund £1,500, writing off preliminary expenses £2.174. 3s., and providing for sundry small items £175. 15s. 2d., there remains a balance of £3,991. 11s. 5d. The Directors recommend that this should be applied to a payment of dividends for the past year of 6 per cent. on the Preference shares, and of 5 per cent. on the Ordinary shares, leaving a balance of £666. 9s. 4d. to be carried forward to next account.

During the year extensive alterations, embodying the latest improvements in the arrangements of the generating and distributing plant, have been made at the Company's Cheyne-walk station, which was acquired in 1893. This station is now in full work, and has capacity for considerable increase of plant. The new sub-station in Pavilion-road is also in complete working order. The number of lamps added in 1894 is 6,621, bringing the total on December 31st to 47,286.

The Six per Cent. First Mortgage Debentures, amounting to £30,000, issued in the early days of the Company, are repayable on September 29, 1895. There are also Second Debentures amounting to £6,900 outstanding, which are terminable at six months' notice. To enable the Directors to make provision for the redemption of these debentures, and to provide capital for necessary extensions, a resolution will be proposed to the shareholders for their sanction extending the power of the Directors to borrow or raise money to such an extent as they may from time to time think expedient, provided that the amount so owing at any one time does not exceed the amount of the subscribed capital of the Company.

Mr. George N. Marten has been elected to fill the vacancy caused by the death of Sir George R. Prescott, subject to confirmation of the shareholders. The retiring Directors, Major-Gen. C. E. Webber, C.B., and Mr. George N. Marten, are eligible, and offer themselves for re-election, as also do the auditors, Messrs. Cooper Brothers and Co.

Birmingham Electric Supply Company (Limited).

The following is the report of the Directors to be submitted at the ordinary general meeting of the Company, to be held at the offices, Dale End, Birmingham, on Thursday next, the 7th inst., at noon :—

The amount of net profit, including the balance of £409. 12s. brought forward from last year, is £5,609. 5s. 6d. Out of this the Directors recommend the payment of a dividend of 4 per cent., absorbing £2,754. 18s. 6d., placing £1,602. 15s. 3d. to the credit of the depreciation reserve fund, and a further sum of £250 to the general reserve fund, carrying forward the balance of £1,001. 11s. 9d. to next year's account. On making the above appropriation, the total of depreciation, general reserve, and of undivided profits will amount to £6,864. 0s. 8d. There has been a steady increase in the Company's business during the past year, the total number of 16-c.p. lamps, or their equivalent, on order, December 31, 1893, was 10,223, and on the same date in 1894 the number was 12,138. The additions since the close of the financial year have brought the number up to 12,551. Several motors have for some time past been working from the Company's system, and, with the reduced scale of charges for current used for this purpose, their general adoption is only a question of time as their convenience and economy become known. During the past year Parliament has confirmed the Provisional Order extending the Company's operations over Edgbaston and the jewellers' quarter. These areas should ultimately form valuable additions to the Company's business. The capital expenditure during the year amounts to £12,674. 1s. 1d., and includes a portion of the expenditure on account of buildings to complete the works at Dale End, the addition of new plant and the extensions of mains and services. The Directors have acquired certain freehold and leasehold properties in Newhall-street and Monument-lane for works in connection with the new Parliamentary areas, the cost of which forms part of the capital expenditure of the year; and as they have made arrangements to at once carry out such portions of the works as may be necessary to supply these areas, it is proposed to shortly call up the balance of unpaid original capital. To further provide for the additions to the Company's business, the following resolution will be submitted to the shareholders—viz: "That the capital of the Company be increased by £100,000, divided into 20,000 shares of £5 each (making the total nominal capital £200,000), to be issued at such times and on such terms as the Directors may from time to time think fit." It is thought desirable that a quotation on the Birmingham Stock Exchange be obtained for the Company's shares, and with this object a resolution will be proposed authorising the Directors to relieve members of the Birmingham Stock Exchange from the operation of Articles Nos. 24 and 25. Mr. George S. Albright and Mr. G. H. Johnstone are the retiring Directors, and are eligible for re-election, as are also the auditors, Messrs. Sharp, Parsons and Co.

Northampton Electric Light and Power Company (Limited).

The sixth annual report of this Company states that the position of the Company continues to improve. The lamps fixed (8-c.p. or equivalent) at the close of last year were 5,300, against 4,600 in the last report. The net revenue was £662 7s. 8d., compared with £536 1s. 1d. in the previous year; whilst the cost of production per unit steadily decreases. The increased profit has been earned notwithstanding two successive reductions in the price of current. The consulting engineers report that the plant in the generating station is in a thoroughly satisfactory condition, and upon their recommendation the Directors are of opinion that for this year it will be sufficient to carry £100 to the depreciation account. They recommend £170. 7s. 11d. be applied in payment of the dividend on Preference shares to the end of the year 1893. Interest on borrowed capital and temporary loans having also been provided for, there would be left £77. 19s. to be carried forward.

NEW COMPANIES, STATUTORY RETURNS, &c.

W. AND J. ROBINSON (LIMITED).—This Company was registered on February 20th, with a capital of £40,000 in £5 shares, to acquire the business of electrical and general engineers, carried on at Bootle by William H. and John L. Robinson, and to carry on the business of electrical and general engineers, electricians, manufacturers of and dealers in electrical and scientific apparatus, and the general business of an electric light company in all or any of its branches. The subscribers (with one share each) are:—William H. Robinson, John L. Robinson, William Poulson, William Thomas, James Eastham, Alfred Rowland, and William A. Weightman. The first Directors are to be appointed by the signatories to the Memorandum of Association.

TUPPERS' ADVERTISING (LIMITED).—This Company was registered on February 1st, with a capital of £2,000 in £1 shares, to acquire a patent for an "improved advertising device," and to acquire the business carried on by the Crown Jewel Advertising Company, at Birmingham, and to carry on the business of advertising specialists, gas and electrical fitters and engineers, &c. Thomas W. Scott, electrical engineer, has joined the Board of Directors

UNIVERSAL GOVERNMENTS' ARMY, NAVY, AND COMMERCIAL MANUFACTURING COMPANY (LIMITED).—This Company has been registered with a capital of £937. 10s. in 75,000 shares of 3d. each, to erect rolling mills, forges, factories, &c., and to manufacture and deal in machinery, armour plates, ammunition, dynamos; and as engineers, shipbuilders, &c.

CITY NOTES.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended February 24th were £949, as against £945 in the corresponding period of 1894, being an increase of £4. The total receipts for the half-year amount to £7,988, as against £7,610 for the corresponding period of 1894, an increase of £378.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—It is announced that the warrants for the dividends on the Preference and Ordinary shares of this Company have been posted.

ECONOMIC STEAM PRODUCTION.—The prospectus has been issued of a device for the more economic use of fuel in stoking operations. It is termed the "Empire" Economic Steam Producer, to exploit which a company has been formed with a capital of £80,000 in shares of £1 each. The prospectus states that the invention is intended to use the large quantities of waste fuel now accumulated, and to profitably employ the same in the production of steam power. The patents acquired are Nos. 18,136 (of 1893), 8,949 (of 1891), and 9,732 (of 1894). These patents describe a novel furnace, and a complete and scientific apparatus for the firing of steam boilers, which it is claimed can be readily applied to boilers of almost every kind without serious alteration to existing fittings. A testimonial accompanying the prospectus from Messrs. Andrew Handyside and Co. (Limited), states that a saving has been effected by the use of this furnace of from 20 to 30 per cent., according to the coal and other fuel used. The list of applications was opened on Wednesday last, and closed on Thursday.

GENERAL HYDRAULIC POWER COMPANY (LIMITED).—At the 13th annual meeting of the shareholders of this Company, on Wednesday, it was stated that the gross receipts for the year show an increase of £6,335 over 1893. A dividend at the rate of 6¼ per cent. for the past year was declared. The total length of mains laid by the Company and now working is 73½ miles, capable of running 3,000 machines, and using altogether 12,000,000 gallons of water per week. It was decided to increase the capital of the Company by the creation of 50,000 new shares of £5 each.

GREAT NORTHERN TELEGRAPH COMPANY.—Notice is given of the drawing of 100 £100 debentures of 1883 (Series B), which will be paid by Messrs. C. J. Hambro and Son, 70, Old Broad-street, London, E.C., on and after to-day (March 1st).

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 24th inst. amounted to £847. The amount for the corresponding week last year was £616.

MANCHESTER SHIP CANAL.—The report of the Directors of this enterprise for the half-year ended December 31st last records an increase of goods traffic of £11,235 over the preceding half-year, and an increase of £5,848 on the Bridgwater undertaking. Mr. W. H. Hunter has been appointed engineer to the Company, Sir Leader Williams retaining the title of chief engineer, and continuing to advise the Company on matters relating to engineering, and taking charge of the settlement of all pending disputes in which engineering questions are involved.

MERSEY RAILWAY.—In the report of the Directors of this Company for the second half-year of 1894, just issued, reference is made to the subject of working the railway by electricity or other motive power. The subject, the report states, is still receiving the consideration of the Directors, who hope by the date of the half-yearly meeting, to be held in March, to be able to report to the shareholders on the subject.

NATIONAL ELECTRIC SUPPLY COMPANY (LIMITED).—The report of the Directors of this Company, which was submitted to a meeting of shareholders held on February 13th, of which we have been unable to obtain any account, states that the business of the Company is making satisfactory progress. The expenditure on capital account stands at £64,081, an amount of £7,883 for preliminary expenses having been transferred to the general balance sheet, in accordance with the requirements of the Board of Trade auditor. The whole of the issue of £20,000 of debentures, bearing interest at the rate of 4½ per cent. per annum, has been taken up, and all contracts of the Company have been completed and paid for. The income for 1894 shows an increase of £1,433, and expenditure a reduction of £562. The works' cost per unit delivered to the consumer now compares favourably with that of any company in the country having a similar output. The demand for current for lighting shows a very satisfactory advance, and there is also a growing demand for current for power and cooking purposes. The plant and machinery, which have been working satisfactorily throughout the year, are capable of supplying double the number of lamps at present connected. No dividend is declared on the Ordinary shares of the Company, of which there is a total of £53,085 paid up. The full interest of 4½ per cent. is paid on the £20,000 Debenture capital, and the balance of £995. 7s. 1d. is carried to depreciation account. The total income from sale of current per meter at 7d. per unit for the year is £4,578. 4s. 11d., under contract for public lighting £726. 8s. 2d., and for motive power £225. 8s., giving a net total, after the deduction of discounts, of £4,619. 16s. 6d. To this is added £156. 9s. 7d., rental of meters and other apparatus on consumers' premises. The total expenditure is £3,783. 6s. 6d., of which £18. 11s. 8d. is in respect of depreciation of plant, machinery, &c. Management expenses figure for £1,071. 12s. 3d., of which £547. 6s. 1d. is for Directors' remuneration.

SANITAS COMPANY.—At the eighteenth general meeting of this Company, held on Tuesday, Mr. F. H. L. R. Moll, who presided, announced that the business for the past year had been eminently satisfactory, considering the depressed state of trade generally. He announced that it was the intention of the Company to increase the number of goods manufactured in order to meet competition, which, in the opinion of the Directors, was not carried on on legitimate lines. Mr. C. Kingzett, the Managing Director, pointed out in regard to the slightly decreased dividend that the Directors could have paid the usual 15 per cent., but that, for good reasons, it had been decided to write off for patents and goodwill the sum of £1,875. With regard to the proposal to issue the balance of the Company's share capital (10,000 shares), the Directors desired an expression of opinion on the subject from the shareholders. The Directors did not propose to issue the whole of the 10,000, although they had the power to do so. When the shares were issued they would be offered to the existing shareholders at par.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee appointed Wednesday last a special settling day in the provisional certificates of a further issue of £200,000 Five per Cent. Debenture Stock of the City of London Electric Lighting Company (Limited), and ordered these securities to be quoted in the Official List.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended February 22nd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,230

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Feb. 20.		Price Wednesday, Feb. 27.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 27.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	14 0	Anglo-American	40	41	40	41	4 17 7	Jan., Apr., July, Oct.	41	40¾
£2,993,660	Stock	28 0	Do. Preferred	75½	76½	75½	76½	6 4 7	" "	76½	76
£2,993,660	Stock	5/0	Do. Deferred	6¼	6¾	6¼	6¾	..	..	6⁹⁄₁₆	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 17 4	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	11¾	12¼	11¾	12¼	5 6 1	Mar., June, Oct., Dec.	12¼	11⅞
£75,000	£100	5%	* Do. 6 per Cent. Bonds (2nd Series, 1906)	109	113	109	113	4 9 1	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	148	152	148	152	4 12 1	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	6 14 4	February and August	13⅝	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	20¼	..
12,931	5	1/8	Direct Spanish (fully paid)	4	4½	4	4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9½	10	9½	10	5 0 0	" "	9¾	–
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	105%	4 6 9	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8¼	9	8¼	9	6 0 0	Jan., Apr., July, Oct.	8⅝	..
400,000	10	2/6	Eastern	16¼	16½	16¼	16½	3 18 9	" "	16¼	16⅜
70,000	10	6%	Do. 6 per Cent. Preference	17½	18	17½	18	3 6 8	" "	..	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	124	127	124	127	3 3 0	May and November	126	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	108	105	108	4 12 10	February & August	..	..
250,000	10	2/6	Eastern Extension	17¼	17½	17⅜	17⅝	4 0 8	Jan., Apr., July, Oct.	17⁵⁄₁₆	17
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	123	126	123	126	3 3 6	February & August	..	..
£62,700	100	5%	* Do. 6 p. c. (Austln. Gov. Sub.) Debs. 1900	104	107	103	107	4 13 11	January and July	..	..
£95,100	100	6%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	104	107	103	107	4 13 11	" "	..	–
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106	109	106	109	3 13 11	February & August	107⅝	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 4	May and November	..	..
180,227	10	1/6	Globe Telegraph and Trust	9¾	9⅞	9¾	9⅞	4 11 2	Jan., Apr., July, Oct.	9¾	9¹¹⁄₁₆
180,042	10	6%	Do. 6 per Cent. Preference	16⅝	16⅞	16⅝	16⅞	3 11 3	" "	16¾	16¹¹⁄₁₆
150,000	10	5 0	Great Northern	22	22½	22	22½	3 11 1	Jan., April, and July	22⅜	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	106	109	106	109	4 11 9	March & September	105¼	–
17,000	25	12 6	Indo-European	53	65	53	55	4 10 11	May and November	51	–
37,648	10	6/0	London Platino-Brazilian	6	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	105	109	105	109	5 13 2	March & September	..	–
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	105	108	3 14 5	..	..	–
11,839	8	4/0	Reuter's	3	4	3½	4½		April and October	4¾	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	118	123	118	123	4 17 7	" "	120	..
15,609	10	6/0	West African Telegraph	4	6	4	6	..	January and July	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	103	106	103	106	4 16 7	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	98	103	7 15 4	June and December	..	..
88,321	10	6d.	West India and Panama	1	1¼	1	1¼	..		1⅛	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	6 6 8	May and November	11¹⁄₁₆	11
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	" "	9½	..
£80,000	100	6%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 10 8	June and December	..	..
64,242	16	3/0	Western and Brazilian	10½	11½	10	10½	3 6 8	May and November	..	..
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6½	6¾	–	..	6½	6⅜
33,129	7½	4/6	Do. 6 per Cent. Deferred	4½	4¾	4	4½		..	..	–
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	6 14 10	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	6 14 10	" "	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115	120	115	120	5 18 11	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	104	106	104	106	5 16 6	March & September	..	–
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	–	..	3½	..
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	¹⁄₁₆	³⁄₁₆	¹⁄₁₆	³⁄₁₆	..	May and November	..	–
171,504	£1	..	Oriental Telephone and Electric (fully paid)	⁹⁄₁₆	¹¹⁄₁₆	⁹⁄₁₆	¹¹⁄₁₆	..	Yearly	–	..
484,597	6	3/4	National	5¼	6¼	5½	6¼	4 6 11	June and December	6¾	6½
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	16	16	15½	16½	3 13 9	" "	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	16	16	3 15 0	" "	..	..
119,234	6	3/4	Do. 6% Non-Cumulative 3rd Pref.	6	6½	6	6½	4 0 0	–	6³⁄₁₆	6⅛
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	104	106	3 6 0	January and July	106	104⅜
58,000	6	1/0	United River Plate	1	2	1	2	..	" "	..	–
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	86	91	86	91	5 9 11	" "	..	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	13½	14½	13½	14½	..	–	13¾	13
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15½	15¾	15½	15¾	3 16 2	..	15⅝	..
£100,000	Stock	6%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	136	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	6	5½	5	6½	3 12 9	–	5½	..
£57,400	£100	6%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	..	–
8,322	£5	..	House-to-House Electric	..		..		–	–	..	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		–	..	..	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		–	January and July	–	–
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7¼	7½	7½	7⅝	–	–	..	–
111,000	5	..	London Electric Supply	..		½	½	..	..	..	–
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	9¾	10¼	9¾	10¼	2 8	..	10¼	10
£150,000	Stock	4½%	* Do. 4½% Debs.	118	120	118	120	3 15 6	June and December	120	118
6,452	£10	..	Notting Hill Electric	7	7½	7	7½	..	..	..	..
19,980	£5	4 6	St. James and Pall Mall xd	7¼	8	7½	8	..	–	..	–
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8½	9	17 9	–	..	..
69,900	5	..	Westminster Electric Supply (fully paid)	..		..		2 16 3	–	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	8	1 6	Brush Electrical Engineering	2⅝	2¾	2⅝	2¾	5 5 8	–		
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2⅜	2⅝	4 11 6	–	2⅝	⅜
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	115	118	115	118	3 17 9	March & September	117	..
20,000	6	8/0	Crompton and Co., 7 per Cent. Cumulative Pref.	3	3½	3	3½	–	January and July	..	..
12,139	6	..	Edison and Swan United	–		–		–	–	–	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	–		–		..	–	–	..
120,000	2	..	Electric Construction	½	½	½	½	–	–	..	..
12,846	2	2 9¾	Do. 7 per Cent. Cumulative Pref.	1¼	1¾	1¼	1¾	..	–	1½	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1½	1⅝	1½	1⅝	–	–	1¹⁄₁₆	1⅛
20,000	6	..	Fowler-Waring Cables (fully paid)	¾	1⅛	¾	1½	–	..	..	..
60,000	10	10/0	India Rubber, Gutta Percha, &c., Works	23	24	23½	24½	5 5 4	February & August	24	23½
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 8 5	March & September	..	–
15,905	£10	..	International Okonite Ordinary	..		..		–	..	..	–
10,000	£10	..	Do. 8 per Cent. Preference	–		–		–	December and June	..	–
20,000	9	..	Manchester Edison-Swan "A" (£1 6s. paid)	—	⅛	—	⅛	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	43	46	45	47	6 2 3	March and July	46	45½
£150,000	100	6%	Do. 5 per Cent. Bonds	104	107	101	107	4 13 0	January and July	..	..
37,514	£5	–	Woodhouse and Rawson Ordinary (£3 16s. paid)	–		–		..	–	..	..
41,098	£5	..	Do. Preference (fully paid)	–		–		..	–	..	..
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	9½	10½	10	11	4 10 11	..	..	..
£30,000	10	..	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1¼%	City and South London Railway xd	40	43	40	43	2 12 1	May and November	..	–
7,000	10	6%	Do. 6% Perpetual Preference xd	14	16	14	15	3 0 8	..	..	–
£67,130	Stock	4%	Do. 4% Perpetual Debenture	130	133	130	131	3 0 2	May and November	132⅜	..
87,500	£10	2%	Liverpool Overhead Railway	8³⁄₁₆	8¹¹⁄₁₆	8³⁄₁₆	8¹¹⁄₁₆	2 3 8	..	–	..
6,295	10	6%	Do. 5% Preference	13	13½	13	13½	3 15 6	..	–	–
125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July	–	–

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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NOTES.

Lord Rayleigh, Prof. Thorpe and Prof. Crookes, members of the Council of the Royal Society, and Mr. R. E. Crompton, Mr. Alex. Siemens and Prof. Kennedy, members of the Council of the Institution of Electrical Engineers, have been nominated to act as a committee to consider, with Major Cardew, the recent explosions at St. Pancras, and to report upon the subject to the Board of Trade. We hope that this committee, which met on Monday and which will meet again to-day, will give some attention to other cases of gas explosions in electrical conduits.

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Two interesting letters upon the discovery of metallic sodium on the insulators at St. Pancras appear in our correspondence columns. The first of these, from Mr. Keiffenheim, relates to salt glaze, and it is sufficient to say that all salt-glazed insulators for electric supply purposes must be condemned, even though they may serve for telegraphic work. Mr. Keiffenheim goes on to observe that nearly all qualities of glass contain sodium or potassium. But glass is not porous, and cannot absorb moisture; many attempts have been made to decompose and dissolve glass, and the conditions under which electrolysis can take place are well understood. Stoneware is, however, as Messrs. Doulton and Co. remind us, a very comprehensive term, applying to a large class of pottery products, and it becomes necessary for engineers who propose to use such material to ascertain which qualities are suitable and which are unsuitable for electrical purposes. The fact of the use of stoneware and porcelain for telegraph insulators is quite beside the mark—the voltage is too low to do any damage, and the resistance is carefully watched. The insulation resistance of a supply main and of a telegraph wire cannot be strictly compared, since the conditions are so different, but it is safe to say that the insulation which has been tolerated of late at St. Pancras would render the working of a telegraph circuit impossible.

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Messrs. Doulton and Co. allude to the more highly vitreous forms of stoneware, and say that they are excellently adapted for chemical manufacturing processes, since of all available materials it is best able to withstand corrosive action. But this, too, is beside the mark, for electrolysis is altogether different from corrosion. We admit, however, that if the body of the ware is thoroughly vitrified all over its surface it is almost inconceivable that any electrolysis can take place. But then we have the conditions of glass, and might as well use glass in such cases as the St. Pancras conduits. Messrs. Doulton and Co.'s great experience in the manufacture of many kinds of pottery should enable them to make their own conduit systems safe. Whether the St. Pancras insulators were worthy to be called stoneware, whether they were only salt-glazed earthenware or some other kind of crockery, will be thoroughly investigated by the committee which is examining the matter; but the fact remains that the actual resistance of the material is very low, quite apart from any surface leakage, and this is sufficient to condemn it. A curious feature of the matter is that the sodium is found in globules almost as fluid as mercury. This, of course, points to the presence of an alloy.

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Our recommendation of glass as an insulator for bare copper mains is questioned by both of our correspondents; but we need only add to our remarks of last week the observation that the leakage of glass under these circumstances is practically confined to surface leakage due to condensed moisture, and that is dried off at and near the point of contact with the live mains. There need be no cause for alarm about the use of porcelain switches and other fittings. Porcelain is in general even more vitrified than ordinary stoneware, and though as safe as glass, whether wet or dry, would be too expensive to use for such conduits as those at St. Pancras, where the copper strips, being unstrained, must be supported at frequent intervals. We doubt whether 10,000 volts applied to damp porcelain would electrolyse it, for the first effect would be to dissipate the moisture, and thus to stop any further action. But the same course of reasoning, if indeed there was any reasoning, might have been applied at St. Pancras before the difficulty arose.

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Apart altogether from humanitarian considerations, the fewer accidents that occur in connection with electric lighting the better. To that end we commend Major Cardew's mild and moderate suggestions to all who are responsible for high-pressure apparatus. For how did the poor fellow come by his death at Bristol? He was sent to dust down a fuse-board with one hand gloved. The board was horizontal, with four 2,000-volt bare-fuse terminals standing out vertically from it. The man had neither an insulated platform nor rubber shoes to stand on. It was obviously only a question of time for the cleaner-down to receive his death shock. The Board of Trade Inspector grimly remarked that he should not care to work at such a job in such a manner in such a place. India-rubber boots and an insulated platform for the man, and substantial vulcanite guards for the exposed terminals, were bare necessaries of existence.

Mr. Addenbrooke's observation in our correspondence columns, that the parallel running of alternators was settled years ago, relates only to the keeping in step, and is as obvious as the fact that the Mordey alternator runs in parallel with perfect success—under certain conditions. These conditions are to be found at Bournemouth and other places, but the letters which we have received from the engineers of such stations throw no light whatever upon the difficulties which seem to have arisen elsewhere. We suppose that all Mordey alternators are pretty much alike, and therefore the conditions which vary must be those of driving, synchronising, the nature of the load, or other details of station working. A knowledge of the necessary conditions would be of supreme interest and value to engineers and users of these machines, and it is with reliable information on these points that we should like to close this controversy.

Although it is generally admitted that Parliament has no right to upset an agreement entered into by the Executive Government, an attempt was made to exercise some such right last Friday in the matter of the understanding arrived at between the Post Office and the telephone companies just before the present Administration came into office. The votaries of Parliamentary control, combined with the advocates of municipalised industry, and assisted by the enemies of all the monopolies, presented at one period of the evening a quite formidable front—so formidable that the Postmaster-General had to consent to an inquiry, though in terms differing materially from what had been asked for. His answer to the complainants was complete; may it serve to enlighten some of the malcontents as to matters on which at present they display a woful ignorance. A competition among telephone exchanges is about the last thing that any man would advise who understands what he is talking about. The insincerity of the outcry against monopoly is plainly revealed in its desire to confer one upon every municipality. Of course, London was cited as a crying example; and, of course, the London County Council were prepared to undertake the work for half the money—but that was on Friday evening.

The Wright method of charging has resulted in such a large net profit that the Brighton Corporation has experienced the rare and agreeable sensation known as an *embarras de richesses*. In this pleasant dilemma the Lighting Committee naturally sought the counsel of the originator of the difficulty. Mr. Wright's aim was to encourage a steady consumption, rather than one which had a low average with occasional big maxima. His plan, it may be remembered, was to charge 7d. per unit until the quantity consumed amounted to a use of the average maximum demand for at least two hours a day, after which only 3½d. was charged. In order to dissipate the present net annual profit of over £5,000, Mr. Wright has proposed, and the Lighting Committee has agreed, that the reduced rate shall in future be 3d., and shall come into force after only one hour's daily consumption of the maximum demand; meter rents, also, are to be nearly done away with. Electrical engineers generally will congratulate Mr. Wright on the financial success of his novel and somewhat complicated method of charging, and many a central station engineer will, we doubt not, sigh for an equally docile and intelligent *clientèle*. It is quite right that good customers who have done the sowing should enjoy the resultant harvest. The next donative, however, should, we think, be showered upon the ratepayer, whose money, it must be remembered, was risked in this electric lighting venture. A wide extension of street arc lighting, at no cost to himself, would probably be better appreciated by that gentleman than a microscopic reduction in the rates.

An instructive example of the mutual assistance and advantage which may be rendered by two municipal undertakings, when they are judiciously combined under the same management and the same roof, is afforded by the joint waterworks and electric supply station of St. Lazarus, near Posen. A brief description of these works will be found in our issue this week. The advantages of the arrangement in this instance appear to be numerous. In the first place, the sale of water is sufficient to cover the entire working expenses, so that the revenue from the electric supply business is all clear profit. In the second place, the pumping of water makes an excellent day load, which in itself tends to reduce the working expenses. And lastly, the electrical plant seems to make adequate return for the good services rendered by the hydraulic plant, by tiding the latter over the awkward pinch which arises when there is a conflagration in the parish, and when extra pressure of water is needed. For, at such a time, the electric storage plant is used for driving a high-pressure water pump. There is a neatness and reciprocity of action about the entire dual plant which is charming to the engineering mind. In this country, some approach to a similar system has been made by the municipality of Worcester. But at that town the waterworks and the electric supply station are widely separated, and the dynamo engines do not drive the pumps direct as at St. Lazarus, but always through the medium of the electrical plant. The combined works at St. Lazarus are an example of the benefits which may be derived from the exercise of forethought and judgment in laying out municipal works.

Light Railways.—The President of the Board of Trade hopes to introduce his Light Railway Bill before the close of the present week.

Worcester.—The demand for current at Worcester is proving very satisfactory. Some 8,400 8-c.p. lamps are now either connected up or applied for.

Electric Bills in Parliament.—The Vestry of Lambeth have presented a petition against the proposal of the City and South London Railway Company to extend the time for carrying their line to Clapham.

Institution of Civil Engineers.—At the last monthly ballot, among the members elected were Messrs. Basil Mott and F. J. Sprague (New York), and among the associate members Messrs. John Hesketh, H. F. Parshall, and J. F. C. Snell.

The Pacific Cable.—Under date, Washington 4th inst., Reuter's agency states that the Senate has withdrawn the amendment to the Diplomatic Appropriations Bill providing for the sum of 500,000 dollars for the laying of a submarine telegraph to Hawaii, thus definitely killing the project.

Chess by Cable.—An important chess competition between the Manhattan Club and a leading London club is being played at the Criterion, London, W., the various moves in the game being recorded over the Commercial Cable Company's lines.

Electric Light Wiring.—A special course of four evening lectures on "Electric Light Wiring" will be given by Dr. R. Mullineux Walmsley at the Heriot-Watt College, Edinburgh, commencing on Monday next, March 11th. The lectures will be delivered on consecutive Monday evenings, at 7 o'clock.

The Niagara Power Plant.—Much disappointment, says the *Western Electrician* of Chicago, is expressed in Buffalo at the announcement of the Secretary of the Niagara Falls Power Company that all electricity likely to be developed by the plant of that concern has been contracted for, and that none will be delivered to Buffalo for many months to come.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
Hongkong—Macao	Dec. 31, 1894.	Feb. 19, 1895.
Latakia—Cyprus........................	Nov. 27, 1894.	—
Martinique—Paramaribo	Feb. 21, 1895.	—
Cadiz—Teneriffe	Feb. 23, 1895.	—
Constantinople—Odessa............	Feb. 25, 1895.	—
Alexandria—Port Said	Mar. 2, 1895.	—

Accumulator Traction in Germany.—An arrangement, only requiring the assent of the town authorities of Hanover, has been come to by which the tramway company have agreed to work the whole of their lines electrically by means of accumulators, the change to be completed within five years. The Moabit-Grossgörschenstrasse tramway line in Berlin is now being worked electrically by accumulators.

Royal Institution.—At a general monthly meeting of the members of the Royal Institution, held on the 4th inst., the special thanks of the members were returned to Sir William J. Farrer and Mr. John Douglas Fletcher for their donations to the Fund for the Promotion of Experimental Research at Low Temperatures, and to Mr. Hugh Spottiswoode for a portrait of his father, the late Mr. William Spottiswoode.

Electrical Communication with Lighthouses.—On Tuesday a sharp discussion arose in the House of Commons over the Board of Trade vote for £2,500 in connection with electrical communication with lighthouses. Many members urged that all the money for this purpose should come and could come out of the light dues; others urged that the lighthousemen were already overworked and underpaid. The vote, however, was ultimately passed.

Central Station Coal Consumption.—In the report of the Data Committee of the National Electric Light Association, which was made public at the recent Cleveland meeting, it is stated that the average of ten sets of figures supplied from American stations showed a coal consumption which we work out at 6·8lb. per kilowatt-hour generated. The best figure was a trifle under 4lb., at a station in which triple expansion direct-coupled engines were used, the coal being one-half soft, one-half hard screenings.

Glow Lamps.—An electrical supply firm at Halifax, Nova Scotia, recently received the following letter from an anxious inquirer in Cape Breton:—

> "Will you kindly let me know all particulars about the incandescent lamps which you have advertised in the *Recorder*? That is, what is used in them; is it kerosine oil, &c., or, if not, what it is? And can the material be easily obtained? Also let me know if the light from your lamps is much superior to the ordinary kerosine ones. I am desirous of getting one or more of them, and would like to know all about them."

Institution of Electrical Engineers.—The following were admitted to the Institution at the last meeting:—*Foreign Members:* Mr. H. Fleetwood-Albright, of Philadelphia. *Associates* (9): Dr. E. H. Barton, D.Sc.; Capt. F. Baylay, R.E.; Lieuts. A. H. Dumaresq, R.E., M. E. R. Maunsell, R.A.; Messrs. Nelson Dodge, F. B. Foy, H. Nash, W. Ll. Phillips and Eustace Thomas, B.Sc. *Students:* Messrs. F. I. Caley, N. Endacott, A. T. Gordon Smith, R. E. C. Harpur, H. G. Nicholson, E. F. Watson, and N. I. Wilson.

American Patent Law.—On Monday last the United States Supreme Court, at Washington, gave a decision regarding the well-known Bate refrigerator patent case. This case has been accepted as a test. The decision of the Court was that the date of the issuing of a patent, and not the date of application for such patent, determines whether patent rights in America expire simultaneously with the patent rights secured abroad. In the case under consideration the Court decided that the invention for which Mr. Bate received a patent in America was previously patented abroad, and that therefore the United States patent expired with the earliest foreign patent. This decision of the Supreme Court seriously affects the position of many leading electrical patents now running; for instance, the Hunnings telephone transmitter patent is now void in the United States.

The Thunderstorm of January 23rd.—At a recent meeting of the Royal Meteorological Society, Mr. W. Marriott gave an account of the thunderstorm and squall which burst over London so suddenly on the morning of January 23rd. It appears that this storm passed across England in a south-south-easterly direction at the rate of about 47 miles an hour, being over Northumberland at 4 a.m., and reaching the English Channel by 11 a.m. Thunder was first heard in the vicinity of Leeds, and accompanied the storm in its progress across the country. One of the most remarkable features of the storm was the sudden increase in the force of the wind; for in London it rose almost at one bound from nearly a calm to a velocity of 36 miles an hour. This sudden increase of wind caused considerable damage, and at Bramley, near Guildford, twenty-eight trees were blown down along a track 1,860 yards in length.

The Bristol Fatality.—The recent fatal accident to the Corporation workman formed the subject of an inquiry by Major Cardew on Tuesday last. Mr. W. J. R. Wilcocks, an improver, gave evidence: The deceased was dusting the fuse-board, which intervenes between the mains and the transformer. He was wearing an india-rubber glove on his right hand, and started working with that hand. By-and-by he put his left hand to the duster, and, inserting the duster in the slot into which the fuse-end fitted, pulled it backwards and forwards. He looked up as if to speak to witness, and touched one terminal with his bare knuckles. There was a "scizzling" noise, the deceased uttered a cry, and was drawn rigidly upon his toes, so that he leaned against the fuse-board, but did not clutch it. Wilcocks pulled him back, tried artificial respiration, and went for a doctor. The knuckles of three fingers on the left hand were scorched and split to the bone.—William Coleman, brother to the deceased, said Robert Coleman was an experienced workman. He knew the danger of touching high-tension conductors.—In reply to Major Cardew, it was stated that the deceased was wearing ordinary boots, and Wilcocks said he was confident he only touched one terminal.—Major Cardew said he would visit the transforming-room, and see what were the arrangements, and this he proceeded to do. The fuse-board is supported horizontally on a pedestal of red bricks, from which it is oil insulated. Four bare terminals stand out vertically a couple of inches above the board, and the slotted ends of each pair are connected by fuses carried on a porcelain bridge, which serve as an insulated handle for the removal of the fuses. The floor of the cellar is uninsulated, and is formed of cement about as dry as a cement floor in a cellar usually is. Major Cardew called attention to the fact that there was abundance of room, and asked if a second fuse-board could not be fixed so as to have no current passing over the one being cleaned. Major Cardew said he should not care to work with one glove in the place. He suggested that india-rubber boots would be an additional precaution. The terminals and adjustments were very exposed, and he recommended they should have placed around them a guard of vulcanite, substantially made, but shaped so as not to interfere with the dusting of the fuse-board. He would also have the terminals and metal adjustment painted red.—Mr. Faraday Proctor made a note of the recommendations, and Major Cardew added a suggestion that the floor should be covered with asphalt, and the pedestal supporting the fuse-board should be of glazed bricks, or should be enamelled with a non conducting material,

NOTE ON ELECTRIC PERCUSSIVE DRILLS.

BY ALBION T. SNELL.

I have from time to time drawn attention to the progress made in the construction and use of electric percussion drills, and in "Electric Motive Power" I summarised, as far as possible, the position up to date. Since then I have received from Mr. Hugo Drobz, mining engineer to the then Grand Duke Albrecht at Zsakarocz, an interesting account of work done by a Van Depoele drill made by the Thomson-Houston Company. In considering the use of electricity, this gentleman was influenced by the fact that the district was very scattered, and offered no advantages for the use of compressed air plant; and as water power was available, he rightly deemed that the cheapest plan would be to utilise this electrically. After examining the various drills in the market, he selected the Van Depoele, and has been more than satisfied with his choice.

I need not recapitulate the details of the drill, for they have been described more than once in these columns, but a general idea can be gathered from the longitudinal section in the accompanying figure (1), in which the various parts are clearly shown.

The dynamo was a Thomson-Houston compound-wound machine giving 220 volts, running at 1,600 revolutions per minute, and the revolving brushes from which the pulsating current is derived made 450 revolutions per minute. The bits used were of the usual type with cross cuts, the widths of the edges varying from about an inch to an inch and a-half.

Preliminary trials were found necessary to instruct the men in the routine of the work, of course; but in a short time they acquired facility in handling the machine and experienced no difficulty after the start. Ordinary miners were put to the work, and a locksmith attended to the dynamo and turbine.

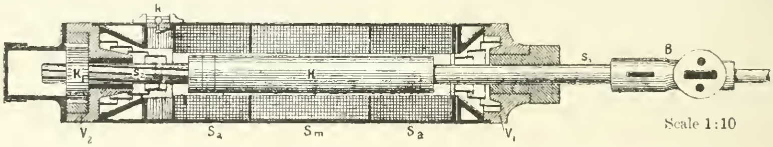

Fig. 1.—Longitudinal Section of Van Depoele Percussive Drill.

K is the iron core of the solenoid attached to the bit shaft s_1, and the tool holder is shown at B. The two coils s_a are traversed by a constant current and have opposite polarities. The centre coil s_m is traversed by the pulsating current. V_2 is the helical spring to receive the shock of the instrokes, and V_1 that of the outstroke if the bit strikes short of the mark. The connections are made at the covered terminals shown at k.

It was found in working that the current averaged from 15 amperes, when the drill was working at its best, to about 20 amperes when the bit stuck to some extent in the hole, and when it jammed the current rose to as much as 25 amperes, after which the coils began to heat rapidly. It took about 20 minutes to mount the drill on the tripod ready for work, but it was readily shifted and brought to bear on fresh parts of the heading after this was done. Holes were bored at all angles to the vertical and horizontal, but the most favourable were inclined downwards, because the weight of the bit and iron core then added to the momentum of the blow, and water could be easily kept in the hole.

To electrical men the most interesting feature will be the degree of heat attained by the coils and body of the drill when subjected to continuous work. Judging from Mr. Drobz's experience, there appears to have been no trouble from this cause so long as the drill was working under proper conditions, *i.e.*, not jamming in the hole. This gentleman says that the temperature of the coils did not rise much until after about three hours of practically continuous working, and that under normal conditions the temperature never rose more than 60 C. above that of the surrounding atmosphere. This being the case, it is evident that a considerable advance has been made in this type of drill, and we may look for even further improvements.

As may be expected, the chief difficulty was found in the insulation of the coils, which, apparently of asbestos, broke down from time to time and so caused sparking. This, in the opinion of the engineer, rendered the drill as then constructed dangerous for use in a fiery mine. This is, however, a mere detail of construction, and is probably remedied now. As regards the durability of the windings, it appears that one may expect, says Mr. Drobz, to drill from 500 to 700 holes without repairs. All the other parts of the machine are well made and repairs to them are cheaply and easily made, and the machine is not affected by water or accidental external damage.

Mr. Drobz found it difficult to estimate the exact power absorbed, as he had no suitable apparatus for measuring the lag of current behind the pressure in the centre coil, but the makers state that the drill absorbs 2·8 E.H.P. when the readings are 220 volts and 20 amperes. This, of course, gives no idea of the actual efficiency of the drill, *i.e.*, the ratio between the power in the blow and the power delivered to the coil. We must wait until some more favourable opportunity occurs for making these measurements. But practically the net efficiency is not of so much importance as the strength, durability and reliability of the machine to work from day to day without undue repairs. The efficiency is of secondary consideration.

The following table of average results with this electric drill will show what has been accomplished:—

Date of trial in 1893.	Kind of rock.	No. of holes bored.	Total depth of holes bored in feet.	Depths bored per 10min., in inches.	
				Including fixing.	Boring only.
Feb. 20 to April 29...	Ironstone.........	560	1,351	16·9	10·8
April 29 to Sept. 29...	Light green slate	1,598	4,327	15·5	11·0
Sept. 29 to Dec. 30 ...	Dark green slate	1,222	3,470	11·0	8·33

In the first six months of 1894 two of these drills, working alternately, drilled 2,461 holes, equal to a total depth of 725ft., without any damage to the insulation of the coils; in fact, these coils had been in use for nine months, making in all 4,094 holes, and were still in good order on June 30th last. It is evident that, as these results extend over a period of nine months' working, they fairly represent the conditions of practice, and they may unhesitatingly be taken as conclusive proof of the suitability of this electric percussion drill for use in driving "headings." The holes bored varied in depth, usually from 2ft. 6in. to 4ft., but holes up to 6ft. were bored without difficulty, and deeper ones could have been made if there had been need for them.

In order to compare them with the performance of a compressed air drill, Mr. Drobz gives the following results obtained by a "Dinsburger" drill:—

Class of rock.	Depth bored per 10 minutes, in inches.
Limestone and early gypsum.	11·4
Conglomerate.	10·0
Stratified rocks.	9 0
White.	10·75
Red and white.	9·25

It thus appears that the electric and air drills in question are about equally efficient as regards rate of boring.

The cost of attendance and repairs with the electric drill plant Mr. Drobz finds to be only one-quarter of that with the compressed air plant. He has not yet been able to make an accurate comparison between the cost of power and hand drilling, but has ascertained that considerable saving both in time of boring and cost per unit length of hole bored is realised by the electric machines. It is needless to emphasise the fact that this must be so, especially when natural water power is available.

The Union Electric Company of Berlin are now introducing a "Marvin" electric percussion drill manufactured by the Thomson-Houston Company of America, which has two coils and weighs only 200lb. This requires a two-phase current to energise it, and is said to be superior to the Depoele type of drill. One of these is to be worked at the iron mines of the late Archduke Albrecht at Bindt, near Marksdorf.

Mr. Drobz is to be congratulated on the success he has attained, and to be heartily thanked for the carefully compiled data which he has placed in evidence for the use of mining engineers.

REVERSIBLE REGENERATIVE ARMATURES AND SHORT-AIR-SPACE DYNAMOS.*

BY W. B. SAYERS, ASSOCIATE.

The subject of the present Paper is the development of the commutating device for continuous-current dynamos which I had the honour of bringing under your notice two years ago, and which has since been put into practice to a considerable extent by Messrs. Mavor and Coulson, of Glasgow, and other firms.

It will be remembered that in my former Paper I described a machine the armature of which generated its own field, the usual field magnets being replaced by simple [-shaped iron blocks, which Lord Kelvin, on viewing the machine, at once appropriately called "keepers." This property of a generator armature, when commutated on the backward lead, of producing or augmenting, as the case may be, the effective magnetic flux may, I think, be correctly described as a regenerative property, and I, therefore, propose to call armatures capable of being so commutated "regenerative armatures."

I may here state what are the advantages secured by the use of the devices about to be described.

1. The commutation of slotted or tunnel armatures—which, it is generally admitted, are very desirable from a mechanical point of view, but the iron-embedded coils of which necessarily have a high coefficient of self-induction—is successfully performed, and that with the shortest permissible air space and minimum exciting power in the field.

2. Not only may such armatures be successfully commutated, but speaking of generators they may be commutated on the backward lead, and when this is done, the magnetic circuit may be the shortest possible (and consequently the lightest possible) while still allowing sufficient space for shunt winding, the forward turns on the armature securing an approximately level or even when desired a rising characteristic, the shunt only requiring to be sufficient to give the initial field required for the light load E.M.F.

3. It is found practicable to commutate very heavy currents without having resort to duplex or triplex winding, and consequent many part commutators, or of going to four or more poles for large machines, and this, coupled with the fact that the iron-embedded conductors do not require to be laminated, renders large armatures on my plan not more but rather less expensive to build than the older types, thus doing away with the main objection which has been raised to the use of commutator coils, *i.e.*, that the cost of the armature is increased by their use. As an example, a machine will be found described later on, having only 36 parts in commutator; main conductors of solid bar; almost lightest possible magnetic circuit, the output being 800 amperes and 100 volts at 420 revolutions per minute, the combined efficiency of engine and dynamo being 87 per cent.

Reversible Regenerative Armatures.—It was found that in many cases it was a serious drawback to machines constructed with regenerative armatures on my plan that they could only be run in one direction; in other words, the device was not reversible without structural alterations in the armature. I found a solution to this difficulty, however, in the construction shown in Figs. 1 and 2. In these figures A^1 and A^2 represent two sections of the main winding of a drum armature; *b* is a commutator coil, which is connected to the main winding at the junction A^3, between coils A^1 and A^2. C is a commutator blade. The direction of winding is the same in the two figures; but in Fig. 1 the direction of rotation is represented as being clockwise, while in Fig. 2 it is counter-clockwise. A little study of these two diagrams will show that the commutator coil acts in precisely the same way in whichever direction the armature rotates, the brushes being always set with a backward lead, so as to bring the side of the commutator coil B^1 or B^2, as the case may be, which is behind the point of connection (A^3) to the main winding under the edge of the flux horn. It will be noticed that in both cases only one side of the commutator coil *b* is operative, the other side being in a position in the interpolar gap where normally there is no effective field.

I do not propose on this occasion to take up time with a minute description of the action of this device, the action of the reversible form now described being substantially the same as the simple form described in my earlier Paper. In a few words, however, I may say the effective part of the commutator coil is still well under the flux horn when the commutator bar to which it is connected comes into contact with the heel of the brush, while the commutator coil immediately preceding it, which is under the brush and momentarily carrying the full current, is just passing out of the field, and consequently is the seat of a weaker and rapidly falling E.M.F.; the result of which is that the current flowing from the main winding is rapidly transferred to the more backward coil which is still in the strong part of the field and so is the seat of maximum E.M.F. In this way a third commutator bar comes under the heel of the brush, the action already described is repeated, and so the commutation proceeds. (*See* Fig. 9.)

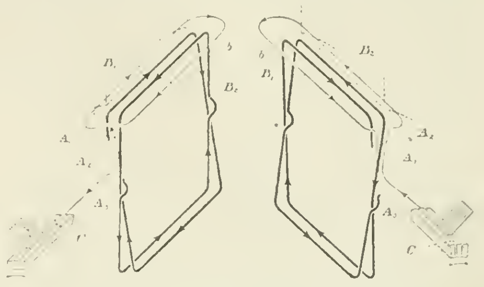

Fig. 1. Fig. 2.

Elements of Reversible Winding.

I do not know whether it has been generally noticed that a close analogy exists between the problem of sparkless commutation and the problem of preventing knocking in a high-speed engine. In the latter case the valve must have a certain amount of lap and lead in order to give a sufficient compression and put on the live pressure at the proper time to just bring to a stand the motion of the connecting rod, piston, &c., at the moment the crank is on the dead centre, and to restart them in the opposite direction. Just as the inertia of the reciprocating parts of the engine must be overcome by the steam pressure, and not by the crank action, so the reversal of the current direction of the armature sections against the self-induction (the electrical analogue of inertia) must be overcome by internal electromotive forces, and on no account by the make-and-break action of the commutator plates and brushes. I think the analogy between these two things is strikingly complete.

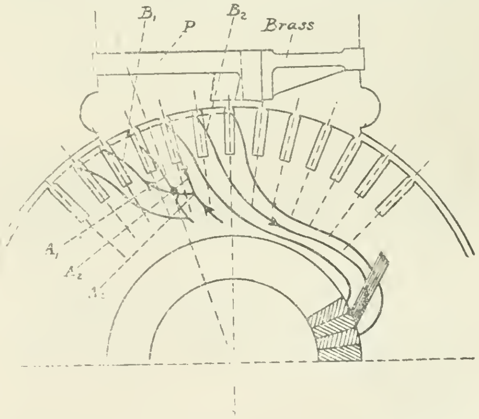

Fig. 3.

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* Paper read before the Institution of Electrical Engineers.

Auxiliary Devices.—In the simplest form of reversible machine only half the length of the commutator coil is effective in producing the reversal when the armature is running in a given direction. Fig. 3, however, shows a means of bringing both sides of each coil into operation. P is a pole-piece forming an extension of the flux horn, leaving a recess having an angular breadth approximately equal to, or a little greater than, the angular width of each commutator coil. The commutation is effected in this recess the section of main winding being located about midway in this recess at the time when the current in it is changing. It will be seen that the same action as has already been described takes place with regard to the part of the commutator coil which is behind the plane of commutation; but, in addition to this, the forward part of the coil next in front—in which the current is falling—has come under the polar extension, and as the field under this extension is of the same direction as under the main portion of the polar surface, while the coil is cutting it in an opposite sense, this coil is the seat of a back E.M.F., which operates against the current in this coil, and so assists in producing the reversal of the main armature section, which is in series between the two commutator coils under consideration.

In Fig. 3 it will be noticed that the polar extension P is shown in full, spanning four teeth—that is, one tooth more than the number embraced by a commutator coil. Using Dr. Thompson's notation, the breadth of a commutator coil is 3β: Dr. Thompson uses β to signify the angular breadth of a section of armature winding or of a segment of commutator, and, according to what I have said in the Paper as printed, this should be the angular breadth of the space spanned by the polar extension P. Since writing this Paper, however, I have found it to be a great improvement to make the polar extension P span $= 3 - 1\beta$, or $2{\cdot}5 - 1\beta$, according to the nature of the winding.

The advantages secured when the polar extension P spans this additional extent of the armature are: (1.) The whole armature current is never carried by one commutator coil, as it is for part of the time in the former construction, but is divided between two and between three alternately; as a consequence, the maximum value reached by the current is only about half as great compared to the value reached when the polar extension has the shorter span, and, moreover, the period occupied by the rise and fall may be as much as double, so that the time rate of change of the current, both in commutator coils, and also, of course, in the section of main winding undergoing commutation, is greatly reduced. The opposing E.M.F. of self-induction is, of course, correspondingly reduced, so that a much heavier current may be sparklessly commutated when the polar extension is made to span the greater breadth. (2.) When the span of the polar extension is equal to the angular width of a commutator coil the bearing surface of the brush must not be greater than the width of one commutator segment; but when it is made to span the greater width the brushes may cover anything between one or two segments, so that the length of commutator may be reduced without diminishing the area of surface in contact between the commutator and brushes.

In designing machines with a polar extension such as I have described, it must be borne in mind that, as the flux conveyed by the extension P enters the armature at a point past the plane of commutation, it is non-effective in generating E.M.F. as it enters and leaves the armature on the same side of the plane of commutation; it must, therefore, be treated as leakage, and provision made for this non-effective flux in the cross-section of the field magnets.

Number of Segments in Commutator.—The necessity hitherto found for using a large number of sections in the commutator, and of resorting to duplex or triplex winding in the case of large low-tension machines, ceases to exist when machines are designed on the lines I am describing, and the number of segments is governed practically by the difference of potential it is advisable to allow between adjacent commutator plates. Of course, it would generally be inadvisable to reduce this number sufficiently to make the current undulatory to an appreciable extent, unless for machines for arc lighting.

That nothing is gained by using a large number of sections in the commutator is easily found from theoretical considerations, and is borne out by experience. Consider a two-pole drum armature having 24 coils in series generating the E.M.F.—that is, a total of 48 coils. If we use a 48-part commutator, the time occupied in the reversal of an armature section will be 1/48th of the time of one revolution. If, however, we use a 24 part commutator, the time occupied will be 1/24th. The reversing E.M.F. will therefore be acting for twice the time in the latter case, as compared with the former. In addition to this, in the latter case the angular distance between successive commutator coils is doubled, so that the one which is going out of circuit is farther away from the pole tip, and so well out of the fringe; so that the reversing E.M.F. (which is always the difference between that generated in the coil going out of circuit and the coil coming into circuit under the brush) is greater with the lesser number of segments. And, again, whereas, in the first case the opposing self induction is that of one main section plus two commutator coils, in the second it is only two main section plus *two* commutator coils—that is, less than double; and then, most important of all, the rate of change is only one-half in the latter case of what it would be in the former. The reduction of the number of bars in the commutator has the further advantage that it allows of the brushes bearing on a larger arc of the commutator surface, so that a smaller width of brush is necessary. It would not do, however, to reduce the number of slots, or tunnels, in the armature, and put two coils in each instead of one, as this would have the effect of increasing the self-induction four times.

Design of Slotted, or Tunnel, Armatures.—Just as the steam engine designer makes his reciprocating parts as light as possible consistent with strength, so it is worth while to so design the slots, or tunnels, in an armature as to get the least amount of self-induction; and this is to some extent antagonistic to other desirable features in short-air-space machines.

In the first place, in order to keep down the self-induction, the opening at the top of the slot should be as wide as possible consistently with its not exceeding the limit where appreciable loss would occur through eddies in the polar surface of the field magnets. The width of this opening, as stated in my former Paper, should not exceed one and a-half times the air space. I usually make it about one and a-quarter times. Next, the number of conductors in each slot should be as small as consistent with considerations of cost of manufacture; though, as already shown, it is advantageous in many cases to make the number of commutator blades as small as possible—the conductors in two or more pairs of slots forming but one section of the winding. In Figs. 3, 4, and 5 are represented some designs of slots which have given satisfactory results in machines made by Messrs. Mavor and Coulson. In Fig. 3 is represented a plain slot with reversible commutator coils, the number of segments in the commutator being equal to the number of slots in the armature core. The commutator coil embraces 3 teeth, or has an angular breath of 3β. There are thus two commutator coil wires and two main armature conductors in each slot; of the two former, one only is in operation at a time, the second belonging to a commutator coil further back under the pole, and which has not yet come into circuit under the brush. Fig. 4 represents a slot having a groove planed near the top on each side into which the round wire forming the commutator coil is slid. In this design the number of commutator segments is half that of the slots, and the commutator coils half that of the main coils; the commutator coil embraces 5 teeth, and its angular width is thus $2{\cdot}5\beta$, there being two convolutions of main winding to each section, but each convolution wound in a separate pair of slots. The alternate wires come into operation in succession, the wires intermediate between these belonging to commutator coils further back, and not in circuit for the time being. This design, in addition to advantages already pointed out, permits of the armature being a little smaller in diameter, and also requires no binding, the commutator coils effectively securing the main conductors in their position in the core. Fig. 10 is a diagrammatic representation of the winding. In Fig. 5 is represented a construction adopted in an 80-kilowatt machine for direct coupling, the speed being 420 revolutions per minute. This machine I shall describe later on. The number of commutator blades is one-half that of the slots, but equal to the total number of convolutions of main winding. Instead of the conductors at opposite potentials—*i.e.*, those connected at the time of commutation to the opposite brushes—being in the same slots as

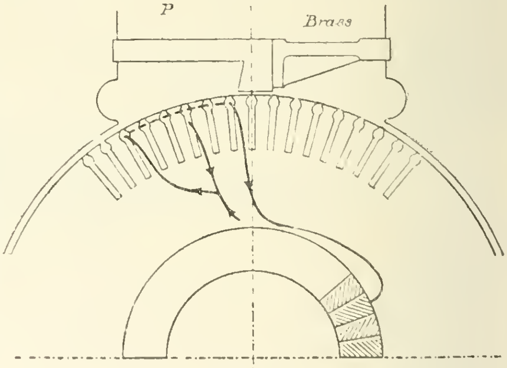

Fig. 4

is the case in the other two figures, these are wound in separate slots, each convolution of the winding passing through slots which are one removed from being diametrically opposite. Figs. 11 and 12 represent diagrammatically this winding. The result of this construction is that the self-induction of a main armature section is only about one-half of what it would be if there were two conductors in one slot, both undergoing commutation at the same time.

The quotient of $\frac{\text{output in watts}}{\text{revs. per minute}}$ gives the size of A machine. We have lately, at Messrs. Mavor and Coulson's works, taken to calling this the machine constant.

I find it very convenient in fixing the size of a machine to take as a basis the total flux **N**, and this I make proportional to the square root of the machine constant. Having **N** fixed, the areas of all sections of the magnetic circuit are found by dividing **N**, plus the leakage allowance, by the value of β which is desired in each portion of the magnetic circuit. Thus the output of the machine is taken as being proportioned, not to the third power of the lineal dimensions, but to the third power of the square root of the cross-sectional area at any given point in the magnetic circuit. Proceeding in this way, the preliminary calculations are not hampered by having to take into account the space occupied by the shaft, the depth of teeth, &c.

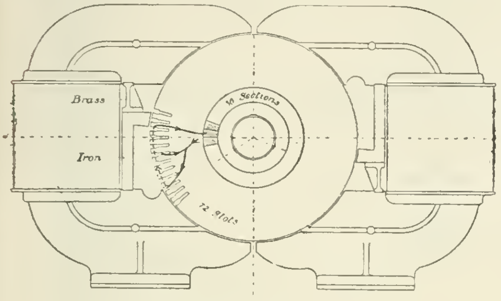

Fig. 5.—80 K.W. Dynamo, 400 revs., constant, 200.

$$\mathsf{N} = \frac{\text{Machine constant}}{l} \times 1{,}350{,}000.$$

The current which may be commutated in machines of the type I am describing is given by the empirical formula :—

$$i_x = \frac{\mathsf{N}}{l \times X \times n}.$$

Where i_x = the current per slot in main winding.
N = total flux per pole.
l = length of armature core in centimetres.
n = number of slots.
X = a variable depending for its value on the average coefficient of self-induction of main winding and commutator coils.

In some 30-kilowatt machines having a constant of 39·5, the armature cores measuring 34·3cm. long by 34·3cm. diameter, the value of X is 17, the form of slot being similar to that shown in Fig. 3.

In the 80-kilowatt machine herein described, having a constant of 200, the value of X is 13·5. The fact of this machine working sparklessly with the lower value of X is due to the method of winding and to the larger openings at top of slots. The value of X depends upon the form of slot, and especially on the width of the opening at the top and in the disposition of the conductors in them. The coefficient of self-induction L is greater in the main conductors than in the commutator coils, owing to these being deeper in the slots and greater also in the lower conductors than in those near the surface for the same reason. I take the self-induction of the end connections as negligable compared with that of the portions of conductor embedded in slots.

This empirical formulæ is, of course, capable of being developed into a scientific one by substituting the true values of L for the quantity X and taking all the particulars of the winding length of air space and other conditions into account. The formula, however, is only independent of the speed at which the machine runs so long as the resistance of the conductors remain a negligable quantity, which it does throughout a considerable range.

Parallel Running.—It is almost unnecessary to say that machines for running in parallel must not have a rising characteristic—at any rate, when combined with their driving power. I have made no experiment with direct-driven plants ; but it is evident that if a combined plant running on the governors gives a falling characteristic, two or more such plants would run parallel, although the dynamo, when driven at absolutely *constant* speed, had a rising characteristic. Of course, the characteristic is under the control of the designer, and, apart from questions of permeability of the magnetic system and relative magnetising powers of shunt and armature, depends upon the position of the plane of commutation relatively to the neutral plane.

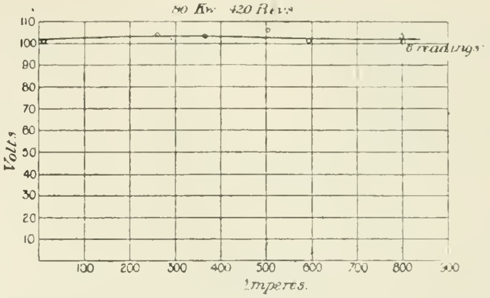

Fig. 6.

Take Fig. 6, which is the characteristic of an 80-kilowatt machine when driven at a constant speed. This shows a rise up to 300 amperes, after which there is a gradual fall down to full load. If driven at a rigidly constant speed, or if coupled, or run from the same power supply, so as to both run at the same speed, two such machines would not run in parallel with safety. Fig. 7, however, is the characteristic of the machine and engine combined, when the latter is running on its governors. The increase of speed with light loads is sufficient to transform the characteristic into a falling one, from which it results that two such separate plants would run in parallel perfectly. As I have already said, however, there is no difficulty about designing a machine to have a falling characteristic, even if driven at constant speed.

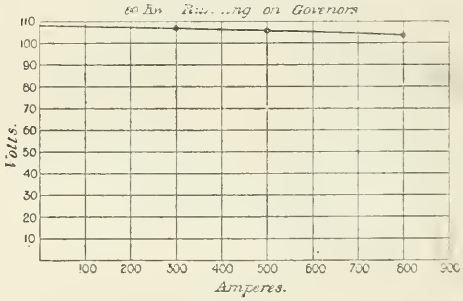

Fig 7

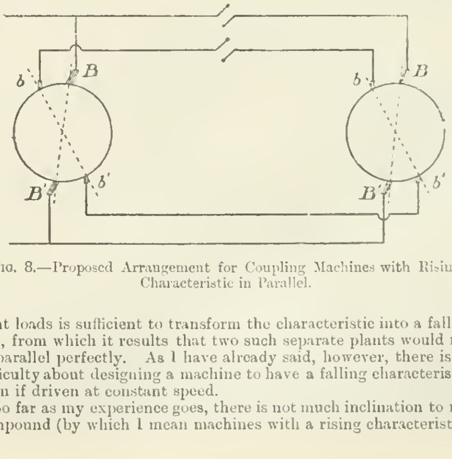

Fig. 8.—Proposed Arrangement for Coupling Machines with Rising Characteristic in Parallel.

So far as my experience goes, there is not much inclination to run compound (by which I mean machines with a rising characteristic), machines parallel in this country; but if it were desired to do so the arrangement which suggests itself—a modification of the well-known method for machines with compound winding—is shown in diagram (Fig. 8). The brushes B B are the main ones, set with a backward lead, while *b b* are small subsidiary brushes, set on the forward lead. Suppose one machine were started, and it were desired to connect the second one in parallel,

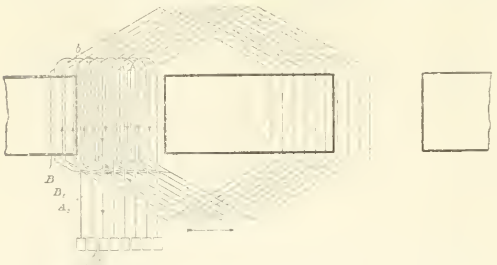

Fig. 9.—Diagram of Winding, with One Commutator Coil to each Turn of Main Winding.

the second machine would be started, and its E.M.F. adjusted in the usual way; the small brushes *b b′* on the first machine would then be put down; next the two small, and after that the two sets of main brushes on the second machine. When connection is established between the two armatures at the four points *b′ b′* and B′ B′ on the same side of the commutators, part of the current traversing the coils between the two planes of commutation will leave the first armature by the small brush, and flow through similar coils on the second armature, just as the current from the series coils on compound machines splits up between the two series coils when they are first thrown into parallel in the well-known arrangement. The other brushes may then be put down and switches closed, when the small brushes on the forward position will give stability to the system, in the same way as the independent connection to the brushes keeps compound machines from any tendency to play into each other. Although I have not tried this arrangement, I think there is no doubt that it would work satisfactorily if it were desired to run machines with a rising characteristic in parallel. It is usual, however, in central station work in this country to use shunt machines, and to control the current from each machine by means of a variable resistance in the shunt; and no doubt it will generally be preferred to use machines with a slightly falling characteristic for running in parallel, so as to avoid all complications. I may point out that with short-air-space machines considerable regenerative power is required in the armature in order to get even a moderate fall in the characteristic.

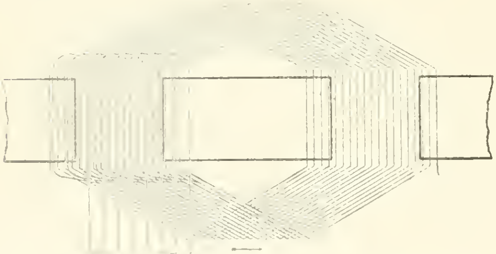

Fig. 10.—Diagram of Winding, with One Commutator Coil for every Two Main Convolutions.

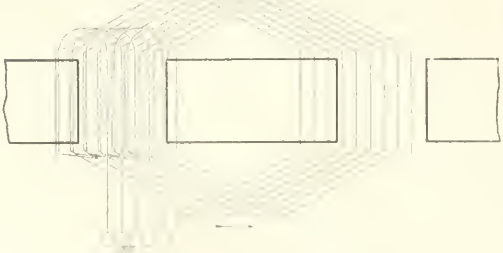

Fig. 11.—Diagram of Winding of 80 K.W. Dynamo.

Rocking Brush-Holders for Reversing Motors.—For reversible motors the fact of the regenerative armature requiring a forward lead instead of a backward one, allows of a very simple and reliable automatic arrangement for shifting the brushes on reversal of direction of rotation. The rocking arm carrying the brush-holders is mounted on the shaft, and suitably bushed and lubricated so as to move freely; the friction of the brushes causes it to be carried round with the armature until brought up by stops which limit its travel in either direction. These stops are, of course, adjusted so as to keep the brushes in the proper position for sparkless commutation. Thus the position of the brushes is automatically changed without any sparking, as during the time in which the brushes are travelling from one position to the other immediately after a reversal they do not move relatively to the commutator, but travel round with it until brought up by the stops; so that there is no relative motion of commutator and brushes until the proper position is reached, and consequently no sparking (see Fig. 13).

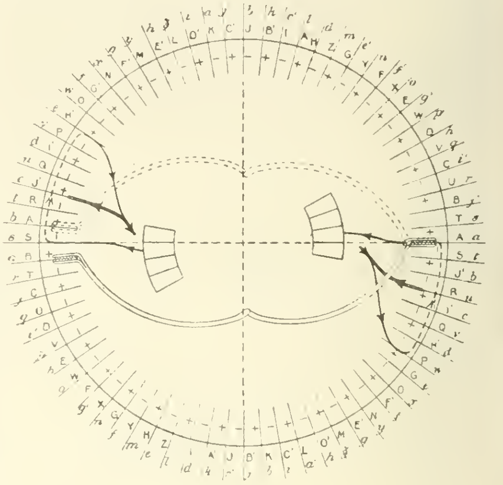

Fig. 12.—80 K.W. Dynamo.

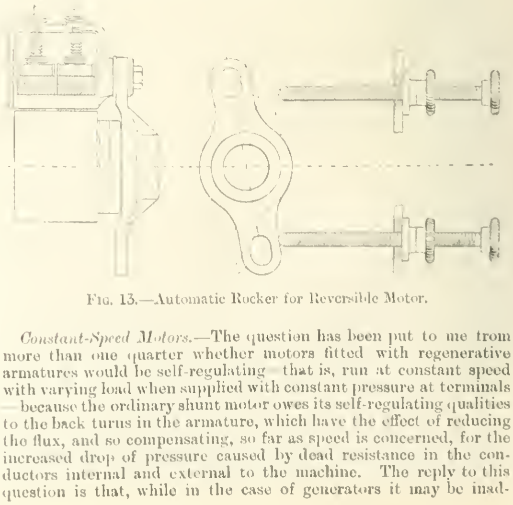

Fig. 13.—Automatic Rocker for Reversible Motor.

Constant-Speed Motors.—The question has been put to me from more than one quarter whether motors fitted with regenerative armatures would be self-regulating—that is, run at constant speed with varying load when supplied with constant pressure at terminals—because the ordinary shunt motor owes its self-regulating qualities to the back turns in the armature, which have the effect of reducing the flux, and so compensating, so far as speed is concerned, for the increased drop of pressure caused by dead resistance in the conductors internal and external to the machine. The reply to this question is that, while in the case of generators it may be inadvisable to reduce the air space below a given value on account of the crowding up of lines due to the large armature reaction, causing a diminution in the total flux, and so bringing down the characteristic, in the case of a motor this action can be taken advantage of and the air space reduced to a safe mechanical clearance ; the reduction of the total flux due to crowding up will then tend to compensate for drop of pressure due to dead resistance. So that in the case of a motor we obtain the happy concurrence of lightest weight and minimum cost with best regulating qualities.

Description of 80-Kilowatt Dynamo built by Mavor and Coulson—420 Revolutions per Minute.

Armature.—Diameter over all	....	21 inches.
,, core	....	17⅛ ,,
,, hole in discs	....	4¼ ,,

Total flux (effective), N = 20,600,000.

The main winding consists of 72 bars solid copper, $1{\cdot}33 \times 0{\cdot}2$ inch, connected at ends by "butterfly" connectors. Each bar is placed in a separate slot, and the connectors join the first to the thirty-sixth bar at each end. Thus the two bars in each convolution are one division less than diametrically opposite. The arrangement is that represented in Fig. 5. Referring to Fig. 5, the commutator, or reverser, bar which is just under the pole-tip is joined at the commutator end to the commutator blade. At the distant end it passes over to the slot seventh removed, through which it returns and is joined to the main bar, which lies in the slot third removed from it.

Magnets.—The magnets are of (so-called) cast steel, and each half is made in two parts, with a division between them, ½in. wide, parallel to the magnetic flow, in order to reduce the crowding up of the lines from cross induction, thus carrying out Prof. Thomson's suggestion.

The polar angle is	120°.
The air-gap	¼ inch.

The shunt-winding consists of 325lb. of No. 12 wire.

Number of turns	2,016.
Resistance at 120°F.	10·7 ohms.
Current	9·35 amperes.
Ampere-turns	18,800.*

The weights are as follows :—

	Cwt.	qr.	lb.
Magnets, steel castings, &c.	35	3	2
Magnet coils	2	3	17
Armature (shaft, core, and commutator).........	20	3	15
Windings, main coils, reverser coils..............	4	3	12
Bearing, rocker, brush-holders, &c................	3	3	1

The engine was built by Messrs. Belliss, of Birmingham, and their test showed an efficiency of $\frac{\text{E.H.P.}}{\text{I.H.P.}} = 86$ per cent.

While this test was being made, however, the shunt coils were coupled in parallel, with a resistance in circuit which dissipated 1 per cent. of the total energy. So that the real efficiency of the combined plant is 87 per cent.

Speakers whose remarks are prefaced by an asterisk have returned their proofs revised.

DISCUSSION.

*The PRESIDENT (Mr. R. E. B. Crompton) said the subject of Mr. Sayers' Paper was one of exceeding importance to them all at the present moment. They all knew the subject of short air space design was to minimise the quantity of material necessary in the construction of dynamos and motors, and they knew that in ordinary designs with short air space they had great trouble with the commutators and the commutating arrangements generally. Mr. Sayers claimed, and he (the President) believed justly so, to have overcome those difficulties, but up to the present time it had not been an easy matter to make the machines reversible, and they had now to thank him for the further development he had put before them that evening.

*Mr. F. V. ANDERSEN said he had not had much experience with tunnel wound armatures. This arrangement, which was that adopted by Mr. Sayers, required, if a good machine were to be made, the solution of a number of difficult problems. It brought with it a number of troubles which they did not meet with when they used smooth core armatures. He would not criticise the plan adopted by Mr. Sayers for removing the troubles connected with the tunnelled armatures. He was looking forward with some anxiety to seeing one of Mr. Sayers machines running ; for if he succeeded, then his plan must be quite generally adopted, except in one particular case, where shunt machines were required. He could not, of course, make shunt machines on this plan, and many of the machines now wanted in special cases must be shunt machines. Mr. Sayers' machine, although its field might be shunt wound, was virtually a compound machine.

*Mr. SAYERS said he would point out that the machine shown in Fig. 5 was a shunt machine. The suggested new method for parallel working was only for use when the machines were so designed as to give rising characteristics.

Mr. ANDERSEN : Yes, but I mean the danger of reversal will come in on account of the regenerative action of the armature

*Mr. SAYERS : Well, I do not find that. I have had some experience with that, and I do not find that even with a rising characteristic any actual reversal takes place on account of the very small number of turns in the armature as compared with the field.

*Mr. ANDERSEN, resuming, said in his opinion it was only a question of so proportioning the actual shunt which was put in in the ordinary way to the back turns in the armature to avoid it That, of course, would effect the saving in material that they had in the ordinary way in this armature. He wished to thank Mr. Sayers for the valuable details he had given such as the very businesslike statement giving all the particulars of weights of an 80-unit machine at a given speed. It might be of some interest if he gave a few figures which he had picked out from his own designs, and in which he could show a reason for his statement that there was a most important saving to be gained in the weight of the machine. Taking the first four items, magnets, magnet coils, armature and windings, Mr. Sayers's figures came to about 64½ cwt. for the active material of the 80 kilowatt machine. Taking the ordinary well-known single-horseshoe machine, if they made it a first-rate cool and sparkless machine, with 96 per cent. electrical efficiency, and made an equivalent machine on that plan, which was a very general one, the weight of those four items, when they went economically about the design, he found to be 85½cwt. Mr. Sayers' was 75½ per cent. of that, so that there was a gain of 24½ per cent. This gain, of course, did not go right through all the items ; the armature was larger and heavier in Mr. Sayers' than in the ordinary machine. There was some 34 per cent. more weight in the core and shaft, and 21½ per cent. in the armature copper. In the labour, too, he suspected that Mr. Sayers' machine was considerably more expensive, as a good deal of labour was involved in the larger armature and the larger amount of armature copper. Still, so far as compound machines were concerned, there must be approximately a saving of 10 per cent. in the cost. The advantage of fixed brushes he considered to be great where they could have them. They were unnecessary in central stations, but they were an important improvement.

Mr. W. M. MORDEY said he had not intended to speak ; but he should like to make an objection to a new term that Mr. Sayers had tried to introduce. He thought they ought to be very jealous in regard to the introduction of new terms. Although the term mentioned in the second paragraph had received the apostolic benediction of Lord Kelvin, he ventured to think they ought not to receive the name "keeper" for field-magnets. What was the origin of the term keeper ? In the prehistoric days the cave men found that ordinary magnets kept their magnetism longer if they put a nail across them, and they called that a keeper. But there was no kind of analogy between that and the function played by the field-magnet. Then he would like to object to the use of the new term "regenerative armature." If it was different from other armatures, let them call it the "Sayers'" armature. Still another term he objected to even more strongly, and that was the use of the word "blades" for commutator sections. They had been in the habit of calling them "sectors." The object of the Paper, as he understood it, was to introduce to them an improvement by which Mr. Sayers had made his very clever arrangement suitable for machines that were capable of running in either direction. They were glad to know that he had got over that difficulty. He had got over it by using twice the number of commutator coils, or by using twice the space for commutator coils. With reference to the reduction of the number of sectors, the number of parts in the armature, Mr. Sayers pointed out that with his arrangement it was not necessary to have a large number of sectors in the commutator. But if they reduced the number of sectors too much they got a circuit in which the current was pulsating. Mr. Sayers' correcting arrangement was not applied to the outside circuit, so that if the outside circuit had any self-induction you got sparking due to the outside circuit.

*Mr. H. A. MAVOR said the Paper necessarily interested him as the manufacturer of the machine which it described. He wished to give the fullest credit to Mr. Sayers for the energy he had shown in overcoming the difficulties incident to the projection of so entirely new a method of design, and his firm had great pleasure in standing by and paying the piper for the experiments—all the more pleasure that, he was glad to say, not one of the machines had turned out to be an experimental machine. That, he thought, indicated the possession by Mr. Sayers of what he might call the rectifying eye, or the commutating eye, because, of course, in the first instance, the construction of these machines was not a question of calculation. Experiments had to be made ; and, as Mr. Sayers had told them the formula on which he based his practice now was an empirical one, and the fact that that empirical formula had been made up by experience in a large number of machines, all of which had been satisfactory, was rather remarkable. In the Paper there was reference to a variety of sections of slots which had been used in these machines. So far as he could see, only two sections had been shown. A great many others had been tried, and all gave satisfactory results. With regard to the question of parallel running, he (the speaker) had had the opportunity of making some experiments with the 80-kilowatt machine represented in Fig. 5, and, so far from experiencing any difficulty whatever in switching it into parallel, the expression used by the engineer-in-charge was that it was "greedy for the load." It took up the load very easily, and without any shock to the engine driving. It would be evident to them, he thought, that if the machine had a rising characteristic the engine immediately pulled up, and the difficulty remedied itself. In this machine, however, the turns were not very many, and the characteristic was almost horizontal. That was an experimental result which would probably relieve the minds of some who feared that parallel running would be difficult with those machines. He might mention that the difficulty was called prominently to their notice by the attempt to run two machines in parallel which were driven off the same shaft. That was found impossible. The machines were slightly rising in characteristic, and could not be joined. It was not necessary that they should be; but the difficulty could have been got over in a simpler manner than by the use of an auxiliary brush by putting on a turn or two of back series winding to bring down the characteristic. With regard to the fixed position of brushes, that was not quite arrived at in large machines yet, but he thought now they saw their way to it, and that it was not far off. The amount of motion required for the brushes in these machines was very slight indeed. In the 80-kilowatt machine, the largest contructed so far, the brushes required to be moved at half load, and remained fixed up to full load, and in the same position from half load down to no load.

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* This means 9·400 ampere-turns in each limb of magnets.

*Mr. H. RAVENSHAW said he thought it was generally agreed that Mr. Sayers' invention was one of the best and most real of the last few years in connection with dynamo work. At the same time he must say that Mr. Sayers put his extra copper in the wrong place; he put it on the armature, which increased the complication of that part of the machine. Any continuous-current armature was, at the best, a very complicated affair, with a very large number of bars, a quantity of solder, as a rule, and tape, and string, and other things! It really was, from an engineer's point of view, a very unmechanical job. An alternating dynamo was, as a rule, very much simpler. Since Mr. Sayers read his first Paper he had made a few experiments with what he had always known as a "cross-field" dynamo, one with a non-sparking pole at right angles to the ordinary field. [The speaker showed a diagram of the machine, and a curve showing the result of his experiments reproduced.] It was an ordinary notched armature, with 72 commutator sections and 72 notches, armature 10¾in. diameter, core 14in. long, 100 volts and 150 amperes. He altered the magnets slightly, so as to get more room, and fitted a small electro-magnet in the middle of each magnet-bar, pointing to the centre, and having the same clearance as the ordinary pole-pieces. The cross-field dynamo was, he believed, originally due to Mr. Swinburne. It had been a well-known design, but he had always understood it was not really practicable. He wound the cross-field coils with a small wire, so that they could be separately excited. He put a certain amount of load on the machine, and then varied the current in the cross-fields until the machine did not spark. He then increased the cross-field current until the brushes began to spark, and then reduced it until they began to spark again, getting the mean readings which he had plotted on the diagram. The black line showed the actual ampere turns in the armature; the little crosses showed the ampere turns on the cross-field. They would see that they practically agreed with the ampere turns of the armature. The larger crosses and circles combined showed two points where the machine sparked; one current was too small, the other too large. This was not a complicated arrangement. The cross coils were quite small, and the machine worked perfectly without sparking. As a matter of fact, when one worked it without the cross-field it sparked very little, or not at all; but when the load varied, the brushes had to be constantly rocked to prevent sparking. With the cross-field the brushes were at right angles, and the machine was reversible. The clearance was $\frac{3}{32}$nds of an inch a side.

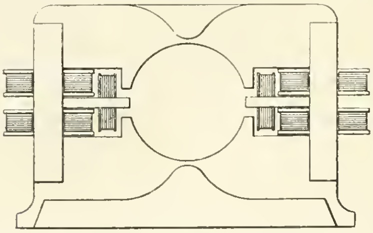
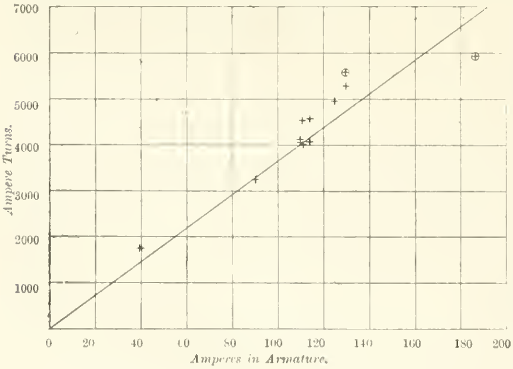


Diagram of Dynamo arranged with experimental "non-sparking" Pole Piece



Curve showing results of Experiment.

*Mr. H. F. PARSHALL said that in the discussion it seemed to have been assumed that the depth of the air-gap was of the greatest importance in practice in determining the amount of sparking, change of load, &c. He was not of that opinion. Assuming he was correct, the air-gap in the case of projection armatures would be determined from considerations such as the effect of eccentricity of the armature. With respect to the pole-pieces the mechanical strains due thereto and the effect of the magnetic or electrical unbalancing of the armature circuits. Referring to the dimensions given by Mr. Sayers, he noted, on account of these considerations, Mr. Sayers had adopted the same air-gap as he (Mr. Parshall) had found advisable under similar conditions and entirely without reference to sparking, although subsequent experiments had shown the correctness of his (the speaker's) assumptions as to proper length of air-gap. The effect of the current in an armature as to sparking was to distort the flux in the air-gap, and to set up during the period of commutation a counter E.M.F. due to self-induction. If, therefore, it could be shown that outside the limits fixed by mechanical considerations varying the length of the air-gap did not greatly affect the distortion of magnetic flux nor affect self-induction of an armature coil when in the position of commutation, it was demonstrated, he thought, that the air-gap was not at all so important as supposed. Referring first to distortion, it was shown by Dr. John Hopkinson that the distortion with smooth core armatures was $2\,K\,m\,c/l = d$, where d = distortion or difference in lines per unit area between the two extremities of the pole arc, K equals the pole arc or some large fraction of it, $m\,c$ the magneto-motive force of the armature, and l the length of the air-gap. In the case of projection armatures the formula required modification. The reluctance of the circuit around which the magneto-motive force $2\,K\,m\,c$ acted was in the first case dependent on the air-gap, and the displacement of the magnetic flux in the air-gap was in that case proportional to the current in the armature. In the case of projection armatures the formula became $2\,K\,m\,c = 1\,d\,l + (a+d) f_1 l_1 - (a-d) f_2 l_1$, a being the initial magnetisation in the projections, f_1 the force of magnetisation, d the displacement flux, l_1 the length of the projections, in which case obviously l (or length of air-gap) became of less and less importance as the magnetisation and length of the projections was increased; d might then be made as small a fraction of a as desired by simply varying the proportion of area of the projections with respect to the section of the polar surface. In practice he had found it economical to limit the length of the air-gap to the smallest possible amount consistent with mechanical considerations, and to so proportion the area of the projections that a small distortion of the flux as compared with the initial flux was accompanied with a relatively great increase of reluctance in the projections, in which case projection armatures might be made less subject to distortion than smooth core armatures. Then with respect to the inductance of an armature coil in the plane of commutation, it had been found by direct measurement that the increase of inductance was not very great outside the length of gap defined as mechanically necessary, even when a coil was advanced so that its sides were immediately under the poles. Extremely small air-gaps were under all cases in large machinery mechanically objectionable. With respect to the statements as to self-induction and distortion, he might point out that in the arc of commutation the inductance E.M.F. in a coil was $Es = 2\pi n L c 10^{-9}$. For sparkless commutation $2\pi n L c 10^{-9}$ = E.M.F. generated by the flux, or $2\pi n M 10^{-8}$, or $L c 10^{-1} = M$ (change in number of lines during period of commutation). Having, then, the values of $L c$ and M, each of which might be easily determined by calculation or by experiment for a given type, the lead of the brush, the arc of commutation, and proper width of brushes is determined. Having reference to the weights quoted by Mr. Sayers, he might say that they did not show any saving in material over several good types of dynamos with which he was acquainted, the extra cost of the additional armature winding being neglected.

*Mr. W. B. ESSON said this question of slotted armatures possessed a good deal of interest for him, because he used to make slotted armatures a long time ago—about ten years ago; and so far from the width of the clearance of the air gap being about two-thirds of the width of the slot, which he thought it was in Mr. Sayers' he used to have his clearance only about one-third of the width of the slot, and he never had any trouble from sparking at all. The fact was that when they had the air gap sufficient to stop the heating of the pole pieces the machine worked perfectly without any sparking, and, of course, without the complication shown by Mr. Sayers. He looked at this question of construction, of course, from the manufacturer's point of view entirely, and he should like to know how the cost of the machine compared with the cost of an ordinary machine. Mr. Sayers had not explained—in his hearing, at least—the 80-kilowatt machine. If the magnets were made of steel—and it looked as if they were—it was a very expensive casting. These steel castings cost, he supposed, at least 25s. a cwt., and they could buy machined forgings at 18s. Another thing about that machine which struck him was that if they wanted to make a different size of machine—say, 6in. longer—it was not so very easy. They had to carve their patterns about to do it, and that, of course, every manufacturer knew was a very expensive job. Whenever anything went into the pattern shop he knew it would not come out under a few sovereigns. It also seemed to him that the cost of connecting up the commutating coils, and providing for them in the armature, must add considerably to the total cost of the machine. He would like some definite information on the point. It was really the labour they wanted to save in the construction of machines. He should like to have particulars from Mr. Sayers as regards the cost of the machine. He was quite free to admit that this was, perhaps, from a scientific point of view, a great step in the construction of dynamo machines; but he must ask for a little information before he accepted all that was claimed for this machine.

*Mr. G. L. ADDENBROOKE said the first thing they had to remember was that they had to deal with an accomplished fact. On the last occasion when this machine was brought before the Institution it was, perhaps, more or less of a speculation ; but a large number of these machines had now been built, and were working satisfactorily. The question was, What advantages had they over ordinary machines from a user's point of view ? Most of those who had spoken at present had been builders of dynamos, and everybody, of course, did not care to change their practice. He thought the machine was a considerable advance on previous practice, and unless something else of the same character was introduced he thought it must come in. In the first place, of course it was a very great advantage to have all the conductors positively driven. There was the other point, that, having the conductors beneath the surface of the iron, they were not limited in the diameter of the armature. Then, of course, the size of the machine was greatly reduced, much more, perhaps, than might be imagined, and when he saw the 80 kilowatt machine described at Belliss's, in comparison with machines of somewhat similar output, it seemed almost a toy, and there was no doubt, where weight and size were considerations, the machine would be very desirable. As regarded keeping the brushes absolutely in one fixed position, he thought it was only fair to say he did not think that was quite attained. The arc through which the brush required moving was certainly exceedingly small, but they did require some movement, and he thought it followed, to a certain extent, from the nature of the problem. What they wanted to get rid of was, of course, the energy which existed in the coil when it was cut out of the circuit, and this energy was dependent on the amount of current that was flowing in that coil, and as this varied it was necessary to move the line of commutation nearer or further from the poles. The E.M.F. curve of the coil and the back E.M.F. curve had also to be exactly of the same size and shape if perfect sparklessness was to be obtained.

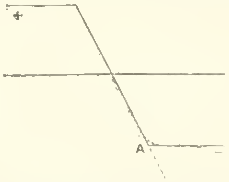
*Mr. C. C. HAWKINS said that through the courtesy of Messrs. Mavor and Coulson he had had an opportunity of seeing the 80-kilowatt dynamo described by Mr. Sayers running, and he could bear witness to the efficacy of the auxiliary pole-pieces, which were shown in Figs. 3 and 4. He thought it was very doubtful whether without those reversing pole-pieces the 800 amperes could be successfully commutated in consequence of the short air-space of the dynamo. But the chief objection to them was that to an appreciable extent they increased the magnetic leakage ; from Fig. 5 it was easily seen that there was a comparatively dense flow of lines through the reversing pole-pieces, which immediately turned into the portion of the iron covered by the exciting coil. A peculiarity in the Sayers dynamo was that the brushes may require to be shifted backwards as the load increases in order to get *less* reveraing E.M.F., the essence of the device lying in the differential effect of two reverser bars The author foreshadowed the use of a very small number of sections in the commutators of his machine, and on that score claimed an advantage in the design of armatures for large dynamos carrying heavy currents. Well, he thought it would be found in practice hardly possible to work with a number of segments much less than, say, 30. The efficiency Mr. Sayers mentioned in his Paper sounded high. But on going into figures it did not appear that this efficiency was at all unreasonable. In some experiments which his firm had been carrying out, they had measured the power required to revolve one of those tunnel-wound armatures in the excited field. In the ordinary continuous current dynamo, if the eddy current loss was measured in the same way the determination could be applied to the full load case, certainly by increasing it by 25 per cent. at the outside, but it would be interesting if anyone could give any information as to accurate tests on the efficiency at full load of toothed armatures. It would require careful experiment, and probably many indicator diagrams, before it could be finally settled.

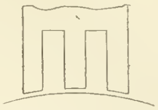
Thursday, February 28th.

Prof. SILVANUS THOMPSON said he thought there was a main line of ideas running through Mr. Sayers's work, which diverged in two directions. He wanted to get over the eternal difficulty of sparking at the brushes, and, having got over that difficulty, to re-arrange his machine so as to employ the iron and copper to a greater specific advantage. What were the ways suggested hitherto of preventing sparking ? The original way, which they still used, was to give the brushes a forward lead, so that the reversal of the individual coils or groups of coils might take place just at the moment when they were entering a magnetic field of the right kind to balance the E.M.F. of self-induction of that section. A number of auxiliary devices had been employed. It had been proposed to employ an air-blast to blow out the spark, and it had been proposed, he thought by Mr. Mordey, to create somewhere or other in the neighbourhood of the commutator an auxiliary magnetic field, also to blow out the spark. Both these methods presumed that the spark was there to be blown out. Then there was the method of auxiliary poles, which had been attempted by many inventors, Mr. Swinburne and others. Then he thought Mr. Sayers had, at an earlier period, proposed a method very like that of auxiliary poles, by notching the pole-piece so as to produce a change of magnetic field in a certain place, and by that means obtain a sparkless reversal at some particular point, instead of having to put the brush forward to the tip of the forward pole-piece. Then there came the method that was known generally by the name of Prof. Ryan, and which he believed was also independently suggested by Prof. Forbes, and which some others of them were working at at the same time—it was a thing in the air—of cross-compounding, of winding a series coil over the armature—across it in fact—so as to compensate for the cross-magnetising effect. The objection that was taken when Mr. Sayers read his former Paper, that his armature could only be used for revolving in one direction, he had now removed by the further development of bringing the commutator coils round at two places on the armature. Before passing away from this subject of prevention of sparking, he would like to know whether any member had had any experience of two other known ways of at any rate mitigating the difficulty about sparking at the commutator ? Had anyone had experience of running the commutator actually in oil, so that the spark might be crushed out of existence by the oil, instead of being blown out or killed by a magnetic field ? Secondly, had anyone had any experience of the method of killing out sparks which had recently been described by MM. Hutin and Leblanc in a machine they had invented for the purpose of commutating alternating currents into continuous currents ? The apparatus of Hutin and Leblanc looked very nice indeed on paper. At the commutation of every armature coil there was a small jump, a vibration backwards and forwards of the magnetic field of the armature. Hutin and Leblanc enclosed the entire armature in a stationary squirrel cage of copper. That was to say, they perforated the pole-pieces just below their surface with a number of holes all round. A number of parallel copper bars were inserted ; these were surrounded by copper bands in front and behind, and the armature lay in a squirrel cage. Now, the tendency to shift the magnetic field backwards and forwards would certainly set up eddy currents in this squirrel cage. These eddy currents would tend to oppose any change in the magnetic field, and the result, he was told, was —and it ought to be so on paper—that it maintained the magnetic field in a uniform position in spite of this commutation taking place, and therefore they might fix their brushes once for all and have no sparking. If all this was realised in fact he thought it was a most important thing. He would be very glad indeed if anyone could speak of that device. He was very much struck in 1893, in looking at the machines, not only in the Chicago Exhibition, but in various factories up and down the United States, that so very small a proportion of the machines, whether continuous current, alternating current, or motors, had smooth armatures. The smooth-core armature, in fact, appeared to be an entirely obsolete construction in America. He had therefore regarded the smooth armature as an entirely bygone construction, but it was rather interesting to find a discussion being raised there as to whether a smooth armature was not better than a slotted one. He had hoped Mr. Sayers would have said something about the use of his machines as continuous-current transformers. They knew he had done something in that respect, using some of these short air-space compensating armatures for the special purpose of, to use the expressive American term for such machines, "boosters." Might they know something more about those "boosters" and their performances ? Mr. Sayers gave them some figures about the weight of a machine—the 80-kilowatt output machine. Certainly the figure obtained was fairly high. He was thinking of the matter rather from the point of view of the motor. They had a machine there which weighed about 67lb. for every horse-power which it exerted if run as a motor. But in 1883, when Profs. Ayrton and Perry read their historic Paper, they laid much stress upon the weight of a motor, trying to have the lightest weight for a given power ; the best figure they could arrive at was 90lb. gross weight per horse-power. They had gone on a good deal since 1883 in various matters, but was not this 67lb. still rather a high figure ? Was it true that if they adopted one of the polyphase methods of transmitting power the 80-kilowatt motor would not weigh more than 25lb. per horse-power ? If that were so he thought they ought to be able to make a continuous-current machine which should have a less weight per horse-power than 67lb. In the abstract there was a way of looking at the use of copper and iron which ought to throw some light on the question of the construction for the minimum weight. The whole function of every dynamo was, after all, to put it in a very abstract way, merely to produce variations in the coefficient of mutual induction between two coils, one of which happened to be fixed and the other movable, with an iron circuit in common. The coefficient of mutual induction between two copper coils, if they had equal weights, and were heated equally—the coefficient of mutual induction between two copper coils, if they were going to lose a fixed amount of energy in them and no more, would be a maximum if they divided them into equal parts, and put as many turns of such copper into one as they put into the other. Was it advisable to go as far as Mr. Sayers, who was inclined to put all the copper on the armature, and leave none on the field magnet ? He did not wish to express too strong an opinion on this matter, as it was an *à priori* way of looking at it. Hardly anybody in the world was at the present time working at the old commonplace problem of improving the continuous-current dynamo ; Mr. Sayers was the one man who had done anything in that way for the last two years, and they had to thank him for bringing his work there.

*Dr. DU RICHE PRELLER said the point to which he wished to refer in Mr. Sayers's Paper was as to the considerable saving in weight and cost which he claimed. The type of direct current dynamo and motor with slotted armature that he (the speaker) was most familiar with, was the C. E. L. Brown type, and it might not be uninteresting if he made a few comparisons between Mr. Sayers's machine and Mr. Brown's type In the first place, he should like to point out that mere reduction in weight did not necessarily mean reduction in cost. Even granting that Mr. Sayers reduced the weight, he did not think it showed any gain whatsoever over machines such as those of Mr. C. E. L. Brown. The total weight of Mr Sayers's 80-kilowatt machine worked out at 3½ tons, equal to 100lb. per kilowatt. Now, Mr. Brown's 60 and 90 kilowatt motors only weighed 2·7 and 3·3 tons, or 90lb. per kilowatt. All the machines he had referred to had air spaces of 8mm., and ran absolutely without sparking. As regarded the question of short air space Mr. Parshall had already disposed of that. The next point he would like to mention was the efficiency. He believed Mr. Sayers gave the dynamo efficiency at 95 or 96 per cent., which seemed very high. The motors and dynamos of Mr. C. E. L. Brown gave 93 per cent. On the whole, he did not see much advantage in Mr. Sayers's machines. If Mr. Sayers had really reduced the weight, all he could say was that it must have been too heavy before.

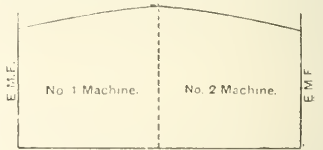
*Mr. SYDNEY EVERSHED said he hoped he might be forgiven if he reminded the meeting that the subject under discussion was not the definition of the word "tunnel" or the definition of the word "slot," but rather, given an armature which had what some people called "slots" and other people called "tunnels," how were they going to commutate it sparklessly? He thought it would be rather unfortunate if the discussion were left in the position in which Prof. Thompson left it, as though the question of commutating sparklessly were one simply of getting rid of the spark as though a spark were an unpleasant thing to look at. That was not the question at all. The real problem was how to remove a coil from one circuit with its current in one direction, and place it in another circuit with its current in the opposite direction, and to do that without damaging the commutator. They might bathe the commutator in oil if they liked, but they had to get rid of the energy in the coil, and do it in the proper manner. The question of commutation was one fairly easy to understand. They had to take the coil out of one circuit and put it into another, and the first thing was to short-circuit the coil. Having got it short-circuited, they had some induction threading it, and the next thing to do was to get it out, and the best way was to shove some in in the opposite direction. The moment they did that the current went to zero. Remember, they had not much time to do these things. Having shoved the right amount of induction in, and, of course, having got the current down to zero, it immediately began rising up in the other direction, and at a certain instant it was exactly at the right value to be put into the other circuit. If they could happen to break the short circuit at that instant then they got sparkless commutation. Now, where were they to get that reversing or negative induction from that they were to put into the coil? The old way was to hunt for a place on the dynamo where there was some induction of the right sort. In 1887 Mr. Swinburne went carefully into the question of reversing pole-pieces, and at Chelmsford he (the speaker) had the pleasure of seeing a great many drawings which made it appear that Mr. Swinburne was going to patent every conceivable form of reversing pole-piece. Mr. Sayers, for some reason or other which he (Mr. Evershed) was still somewhat at a loss to discover, proposed to take his coil to the induction, and as he did not want to have any back ampere turns on his armature as he would have if he shifted the brushes forward, he took the connector between the coil and the commutator sector to a place under the pole where there was an induction of the right value, namely, induction proportional to the current going out of the machine. Now, that seemed a more complicated way of effecting the object in view than providing a reversing pole-piece and putting some main current turns round the pole-piece, because, in the first place, although the weight of the machine might be reduced, it was perfectly clear that the labour of winding the armature was increased. The chance of breakdown was also considerably increased. It was, no doubt, an admirable way of reversing, but to his mind somewhat too complicated. But supposing this question of sparkless commutation had been got over in one of these two ways, how were they to get the full benefit of the advantages? They could only get the full benefit when they could devise a notched armature which could be run with practically only mechanical clearance between the outside of the armature and the pole-piece, and as they saw from the diagrams, particularly diagram 5, they were still obliged to have large clearance in order to avoid eddy currents in the pole-pieces. The reason was simple. If they wound the coils through holes or tunnels in the armature, they had such an enormous induction round them that the reversing pole-pieces or commutator coils had a great deal too much work to do. Another point was that it was only for an instant that the current in a short-circuited coil on a notched armature was of the right value to enable them to put the coil into the circuit, and unless all the coils were absolutely identical in the value of their coefficient of self-induction the induction suitable for one coil would not suit another, and the result was that they never got rid entirely of sparking. He ventured to make a suggestion which might have nothing in it, but which he would give for what it was worth. What they really had to aim at was not only to make a negative E.M.F. in the coil by shoving negative induction into it, but, after having reduced the current to zero and raised it to the right value again, they wanted to keep it there for a sensible time. If they imagined the current in the coil was flowing, as shown in his rough sketch (reproduced), at the instant of short circuit that current began to drop, and they could make it drop as fast as they pleased by putting in induction in the other direction at any rate they liked. It went down as shown, and up in the other direction. Now, A was approximately the point where they had to put the coil back into the circuit, and it was perfectly obvious, if the current was rising at anything like that rate, it was impossible to hit on the right spot for every coil in the armature. What they wanted was to obtain a curved line, as shown, so that the current, having reached its right value, remained thereabouts for a sensible time. When he said sensible he meant compared with regard to the whole time the coil was short circuited, and it appeared to him it ought not really to be a problem impossible of solution to arrange the induction of the reversing pole piece in such a fashion that it should be powerless to get the current beyond that value. With reference to the method of attaching reversing pole pieces to a Manchester type dynamo, shown by Mr. Ravenshaw on the wall, a disadvantage was that the current turns they had to put on the pole piece were approximately equal to the cross ampere turns due to the current in the armature. But suppose they made a reversing pole-piece (between the other two poles) which was a complete little magnetic circuit in itself—that was formed of E-shaped stampings (*see* sketch). That type of reversing pole-piece ought to require very few ampere turns on it to produce the right field, for the simple reason that they had not got to fight against the cross ampere turns in the armature, and he could not help thinking that that was far more easy to deal with than the commutating device of Mr. Sayers.



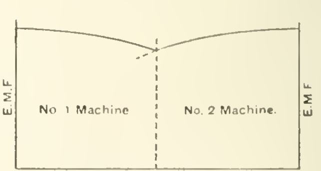


The PRESIDENT (Mr. R. E. B. Crompton) said he thought there had been rather a tendency to undervalue Mr. Sayers's invention, not as an invention, but on the ground that a plain slotted armature was sufficient. That showed considerable want of knowledge on the part of those who made the remark. It was well known that the slotted armature had been gradually making its way from year to year, and that it presented great advantages in the way of making a good stiff, strong, mechanical job, and in reducing the copper required on the field magnets. But it had also been contended that it had disadvantages in the way of producing difficulties at the commutator, and Mr. Sayers was really the first person who had tackled that difficulty, and that was the whole question. He also wished to join issue with Dr. Preller when he compared the efficiencies of Mr. Sayers's machines with the efficiencies of Mr. Brown's. No man had a higher respect for Mr. Brown that he, but Mr. Brown worked for a different market. Mr. Sayers had been working for the English market, which had a very high standard of efficiency; Mr. Sayers had been trying to produce a machine to compete with the machines of Siemens, the Electric Construction Company, and others well known to have an efficiency of 96 per cent., sometimes of 97 per cent., and producing it every time they were called upon to produce it. This was a state of things which was unknown on the Continent of Europe. He did not believe any Continental manufacturer was ever called upon to produce machines of such high efficiency, and there was practically no demand for them on the Continent. They had been educated up to the point of supplying these high efficiency machines, and they were necessarily, so long as they were smooth armatures, somewhat weighty. The continuous-current machine, of which Prof. Thompson spoke rather slightingly, was certainly one of the most perfect pieces of mechanism ever seen; but it was costly, and it was with the view of reducing the cost and the troubles at the commutator that Mr. Sayers had brought forward his invention.

Mr. SAYERS said the first question with which he would deal was that raised by Mr. Andersen, who said one of the objections to the use of the slotted armatures was the heating of the pole-pieces. Now, there was no heating whatever of the pole-pieces, and no imaginable loss of power from that cause if the proportions which he had already given were carried out.



Rising Characteristic.



Falling Characteristic.

Mr. Andersen made some remarks about the arrangement for running the machines in parallel. Of course, the coupling of those continuous-current machines in parallel depended solely and wholly on the characteristic. He had made two diagrams (reproduced) which would make that clear. If the machines had a rising characteristic it was quite easy to see that they could not possibly run in parallel, because, suppose No. 2 machine had a little more current than No. 1, the machines being identical, the consequence would be that its E.M.F. would be higher than that of No. 1, and it must give more current to the circuit, and the result of its giving more current to the circuit would be that it would rise still further; while No. 1 machine, generating less current, had a lower E.M.F., and so the thing would be unstable and would go slap over immediately, and No. 2 machine would take the whole of the current and send a back current through No. 1. But if the machines had a falling characteristic, the result of coupling in parallel was quite different and the arrangement was quite stable. The lower diagram represented two machines with falling characteristics.

The current was taken off No. 1 machine in consequence, causing the E.M.F. to rise, so that the advantage was one in which stability would at once be attained—the division between the two would become equalised instead of getting upset. Mr. Andersen was also the first to discuss the weight question. He might say that the ratio he had found between his weights and those of other makers on the ordinary lines, comparing two pole machines, was about five for his machines against eight for other people's. Referring to Mr. Parshall's weights and also to those given by Dr. Preller, the point to note was that both those machines were four-pole, but if he made his machines four-pole he made them half the weight, or at any rate considerably less. He could not say that he had worked it out or definitely designed a machine, but according to Mr. Kapp's reasoning it was so, and he had not been able to see anything wrong in that. Mr. Mordey called attention to the fact that he made his armature reversible by doubling the commutator coils. Now, that was the case from a certain point of view. But from another point of view it was not at all the case. The doubling of the commutator coils, the making of them reversible, allowed of the use of his form of polar projection. Now, the use of that pole-piece was to increase the effectiveness of a commutative coil by something like 75 per cent.

Mr. MORDEY said if Mr. Sayers would make it clear why he used a reversing pole-piece at all it would be a great assistance. Seeing that he had the whole armature, and could range over it where he liked, and could choose what E.M.F. he liked to get by his reversing coil, it seemed to him (the speaker) that the reversing pole-piece ought not to be a needed addition.

Mr. SAYERS said he was just coming to a reason for using the reversing pole-piece. In the 80-kilowatt machine he had not taken full advantage of what he was going to describe, but there was undoubtedly in the use of that reversing pole-piece a means of very largely increasing yet further the output for a given weight of machine, for the simple reason that the amount of current that could be commutated was increased by its use by something like 75 per cent. In this particular machine, to say the least of it, he knew quite well that by simply increasing the weight of copper on the armature, and not making any other increase except the necessary increase in the depth of tooth, he could increase the output of that machine to 120 kilowatts. The reason was—and this dealt with another point in the general criticism—that the increased load did not destroy his reversing field. He wanted to lay great emphasis on that. Several speakers had formed the impression that his main object and his main advantage had been to get a regenerative action from the armature with the view of keeping up the voltage, the compounding to keep a level characteristic. But the chief advantage of the thing was that one could not put enough current on to the armature to destroy the reversing field, although they might get up to the highest possible saturation; then it was quite true they could not get any further, yet they had nothing like the conditions which one had in an ordinary machine, where, if the load exceeded a certain amount, one destroyed the commutated field completely, and had nothing to work with. Now, having got the reversing field indestructible, as it were, by the current in the external circuit, the output of a machine did not depend in any way upon the total induction or upon the mass of iron. He knew quite well, of course, that there would, for economic reasons, be certain proportions which would turn out to be best, but otherwise there was no limitation. The reason for that was this: the self-induction of the main section of an armature with holes or tunnels was proportional to the length. If they shortened the armature then they reduced the self-induction in proportion; but if they shortened the armature and increased the diameter, so as to keep N constant while they lessened the self-induction, they did not lessen the reversing effect of the commutator coils, and the consequence was that, providing they went on shortening the armature and increasing the diameter, there was no limit whatever to the amount of current they could commutate with a given amount of field. It was from such considerations as these, and also from the possibilities of what could be done with multipolar machines, that he made the statement that his machine, as regards weight and output for weight, was beginning where other types left off. Mr. Ravenshaw had spoken of a machine of which he had very kindly made a diagram. His remarks were in the direction of showing that this was not the impossible construction which it was supposed to be; but he thought if Mr. Ravenshaw attempted to work out a machine of this size, he would find, although perhaps not impossible, it was impracticable. If he worked it out, he would find that he would require at least as much copper on the reversing pole-piece as he (Mr. Sayers) had on the whole machine. He thought the auxiliary pole suggested by Mr. Evershed a far more likely thing in the direction of reversing pole-pieces; but he thought even that would be found to be rather difficult to design. He was exceedingly interested in the figures of Mr. Parshall's machines. Mr. Parshall's method of getting over the sparking difficulty was quite similar to the method adopted years ago in connection with smooth-core machines, that was to say, he stiffened up the field. Mr. Esson said that he had made machines up to 60 kilowatts 10 years ago which were non-sparking. There were degrees of sparking. Ten years ago they were hardly used to seeing a machine at all that was absolutely without a spark at the commutator. Whilst he was on this point about degrees of sparking, he might say a word in reply to Mr. Evershed. Mr. Evershed called attention to the fact that it was an exceedingly nice thing to hit the non-sparking point exactly. But it did not follow that because there was not precise coincidence there would be sparking. There must be a minimum D.P. to give any spark at all. Consequently they had a certain margin in which there would be a slight variation, but not sufficient to produce a spark. He might say that with the alteration which he had made, and which he had described in the Paper, of extending this pole-piece, the position of the brush was not at all sensitive. He had a 32-kilowatt machine made with this extended pole-piece, and the brush could be shifted 0·1in. on the commutator without any sparking whatever, or any sign of sparking. Prof. Thompson asked if anyone had had experience of running a commutator in oil. He had not himself done so, but it was within his knowledge that the late Mr. J. E. H. Gordon used a commutator entirely immersed in paraffin oil in connection with the first large alternating machines which he made at the Telegraph Construction Company's works. An attempt was made to commutate those currents into continuous currents. He (the speaker) never saw it working, but Mr. Gordon had told him it was a complete failure. Prof. Thompson described a very ingenious arrangement by Messrs. Hutin and Leblanc of surrounding an armature with copper in order to prevent a fluctuation of the field and thereby do away with sparking. He had not done that exactly, but he had done a very similar thing: he had used the copper in the very same kind of way. In order to reduce the self-induction of an armature, he had placed a thick piece of copper just over the place where the current was being reversed, and he certainly found that effective—not to any very great extent, but it had an appreciable effect. He would conclude with the question of cost. He was not at liberty to give any figures; it was quite natural that he should not be. But he must say that he was surprised that this question of cost was looked at in the way it was. His experience, and the experience of others, was that these armatures were, to say the least, not more expensive to build than those of the ordinary type. In large machines they got rid of the necessity for laminating the conductor, and of the necessity for winding double or treble, or of going to four poles. They could make a two-pole machine such as that shown with only 36 sections in the armature, and working with a current of 800 amperes. He did not think anybody had done that before.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, March 8th.

Physical Society.

5 p.m. Exhibitions of I. A Voltameter, by Mr. Naber; II. The Focal Heliostat, by Dr. G. Johnstone Stoney; III. An Improvement in Siderostats, by Dr. G. Johnstone Stoney. The following Papers will be read:—"A New Harmonic Analyser," by G. U. Yule; "The Electromagnetic Field," by H. N. Allen.

Institution of Electrical Engineers.

8 p.m. Students' Meeting at 28 Victoria-street. The following Paper will be read:—"Incandescent Lamp Manufacture," by Leonard Johnson.

Royal Institution.

9 p.m. Evening Discourse:—"The Physical Work of von Helmholtz," by Prof. A. W. Rücker.

SATURDAY, March 9th.

Royal Institution.

3 p.m. Afternoon Lecture (II.):—"Waves and Vibrations," by the Rt. Hon. Lord Rayleigh, F.R.S.

MONDAY, March 11th.

Northern Society of Electrical Engineers.

6:30 p.m. Council Meeting at the University College, Liverpool.

7 p.m. Ordinary Meeting at the University College, Liverpool. The following Paper will be read:—"The Scientific Principles of Electrical Engineering," by F. G. Baily.

TUESDAY, March 12th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. The following Papers will be read:—(I.) "The Kidderpur Docks, Calcutta," by William Duff Bruce; (II.) "Note on the Movement of the Walls of the Kidderpur Docks," by James Henry Apjohn.

THURSDAY, March 14th.

Institution of Electrical Engineers.

8 p.m. Ordinary Meeting at 25, Great George-street. The following Paper will be read:—"The Electrolysis of Gold," by N. S. Keith.

FRIDAY, March 15th.

Royal Institution.

9 p.m. Evening Discourse: "The Rarer Metals and their Alloys," by Prof. Roberts-Austen, F.R.S.

The Welsbach Light and the Glow Lamp.—Herr Mutzel, says the *Gas World*, has published the following results showing the relation between the light of the glow lamp and that of the Welsbach lamp. The glow lamp is 4·04 times as bright in the ultra-red as the Welsbach is; 2·59 times as bright in the red (of wave length 760), and 1·67 times in a more orange red (wave-length 686); 1·15 times as bright in the orange, 1·00 in the yellow (589), 0·95 in a more greenish yellow (570), 0·83 in yellowish green, 0·81 and 0·79 in green, 0·91 in blue green, 1·00 and 1·05 in bright blue, 1·20 and 1·36 times as bright in the dark blue, and 1·51 and 1·74 times in the violet. The Welsbach lamp is therefore decidedly weak, as compared with the glow lamp, in the red rays, and consequently appears to give a cold colour. But the Welsbach is stronger in the red than arc lamps are, and positively appears warm in tone when contrasted with sunlight.

The Electrician.

(The Oldest Electrical Journal, 1861–1878).

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THE SAYERS ARMATURE.

Nearly two and a half years ago, Mr. W. B. SAYERS' specification of his improved method of effecting commutation in continuous-current dynamos was registered by the Patent Office as accepted; and so long since as May 11, 1893, his first Paper, read before the Institution of Electrical Engineers, was almost universally acclaimed both by dynamo designers and by the technical press as describing a really novel invention of great promise. Once again Mr. SAYERS has taken up the subject in a further Paper, wherein he describes the ingenious means by which he has rendered his armatures reversible, and has increased their commutating capacity by the addition of auxiliary reversing pole-pieces.

In spite, however, of the interest which was manifested in the invention on its first appearance, and of the favourable reception with which it then met, it cannot be said that in the interval it has won much way into everyday practice. Indeed, with the exception of Messrs. MAVOR and COULSON, we believe that only two British firms have so far constructed Sayers machines. The attitude of our consulting engineers and manufacturing firms would appear to be fairly described as one of philosophic interest in the new departure, tempered by a good deal of practical conservatism; and to this fact must be ascribed the disappointing character of the discussions at the last two meetings of the Institution. No speaker rose to say that he had found, by actual firsthand experience, that the device worked well, but that its cost was prohibitive; on the other hand, no speaker rose to say that even though the invention was easily applied, yet the advantages claimed for it were found to be illusory. Other means of obtaining sparkless commutation were described, and even illustrated on the walls; but whether the Sayers winding, when fairly tried in practice by others than its inventor, had been found to be successful or economical, or both, or neither, was a point that the discussion left shrouded in obscurity.

As at the meeting when Mr. Sayers' first Paper was read, most of the remarks, save those of the author, were based on supposition and speculation, and even the practical application and results of the invention did not appear to be too well understood. The question of the weight for a given output received a considerable, and, to our thinking, an undue amount of attention. There are cases where the weight of a dynamo or motor does become of very great importance, but they are not many; and when the traction experts begin to emphasise the advantage of the weight of a motor in increasing adhesion, the ratio of the pounds of material to the kilowatts of output loses much of its interest. Further, the question was vaguely discussed without regard to the all-important item of speed; the ratio of the watts to the revolutions per minute, or as Mr. Sayers calls it, the "constant" of a machine, determines its size, and must be known before comparing its weight with that of any other design. Nor, again, was there any definite statement as to the number of poles, or the style of bedplate of the machines under comparison. It would appear to us that for any given type of field-magnet and size of machine the advantage of the Sayers winding in lessening the total weight admits of little question. Given a smooth-wound armature core of, say, 10in. diameter, let the winding be massed into two or more layers, and let teeth of iron be inserted in the gap thus left between the conductors; the diameter of the armature is thereby increased to, say, 12in., but the increase in the weight of iron is only that due to the teeth, and the copper remains the same, save for the addition of the commutator coils, or "reverser bars." The poles require to be bored out to a larger diameter, but the air-gap can now be reduced from, say, $\frac{1}{2}$in. on either side to $\frac{3}{16}$in. With an induction of no more than 5,000 C.G.S. lines per square centimetre, every half-inch in the length of air-gap means 5,000 ampere turns of exciting power, so that a reduction of some 6,000 ampere turns has been made out of a previous total of, perhaps, 14,000 ampere turns, or even less. Not only can the magnet coil be lightened, and the magnetic circuit be shortened, to an extent which distinctly overbalances the increase in the weight of the armature, but the reduction in weight is largely made in the more expensive item of the copper.

There remain the important questions of sparking at the brushes, and of cost of manufacture. The theory of commutation in the original form of the Sayers armature was beautiful in its simplicity. The leading reverser bar under the brush is moving in a very weak field, the trailing reverser bar under the same brush is moving in a strong field; as the load is increased, the reaction of the armature current still further strengthens the strong field at the trailing pole-tip, and so produces the required increase in the net reversing E.M.F. Thus, the increased armature current itself supplies automatically its own antidote, and it should be unnecessary to shift the brushes at all. A difficulty may, however, be suspected in obtaining a rise of field, and of reversing E.M.F., exactly corresponding to the increased self-induction of the loop or loops being commutated. Without such exact correspondence the brushes cannot occupy a fixed position without sparking. To this point Mr. Addenbrooke addressed himself, and from his evidence we learn that in the 80-kilowatt dynamo, of which Mr. Sayers gave the details in his Paper, the brushes required to be moved in order to obtain sparklessness, although the angle of movement was but small. Possibly the auxiliary reversing pole-pieces may with greater experience be turned to better account as regards fixity of the brush position. Their size and position relatively to the trailing pole-tips admit of numerous changes, and such alterations in the proportions and shape of both reversing pole-pieces and pole-tips may yet enable an expert designer to obtain a curve of reversing E.M.F. which approximates sufficiently closely to the combined curve of increasing self-induction and increasing ohmic loss.

On the all-important question of £ s. d., however, we are unable to glean any detailed information from the recent discussion, although Mr. Sayers was indeed prepared to go bail for an actual saving in total cost in a machine built on his plan. Yet even if experience should prove to tell against tunnel-wound armatures, the most adverse critic may admire the ingenuity which Mr. Sayers has shown in overcoming the objection to his original method of winding, on the score that only one direction of rotation was possible for a given armature. It has been asked under what circumstances is a dynamo required to run in either direction; but it is not difficult to imagine cases in which it is inconvenient to group a set of machines so that they all run in the same direction. In such cases it is almost essential that the armatures should be interchangeable, even if a spare armature, common to all, be not in question. Finally, when the armature is reversible, it becomes possible to make use of both sides of the commutating loops by means of auxiliary pole-pieces, and the further advantage is thereby gained of an increase in the reversing capacity. How far this may be necessary must depend on the particular details of the design, but at least it renders it probable that the output of the armature is limited sooner by the heating than by sparking due to a deficiency of reversing electromotive force.

REVIEWS.

Electric Lighting and Power Distribution. By W. Perren Maycock. (London: Whittaker and Co. 1894.) Second edition.

This work has already made its appearance in the form of three separate volumes; it now comes before us as a single volume, bound in stiff covers, but with the three lists of its contents spread variously about the book at the places where each separate part commences. Mr. Maycock tells us that he was induced to write this work on account of there being "no really reliable elementary work" that he "could recommend to the beginners" in his classes. At the same time, Mr. Maycock tells us that "the reader is expected to have some acquaintance with the fundamental principles of the science of electricity and magnetism." From these remarks we are able to judge of his standpoint in producing the work, and we may say that it is a standpoint with which we utterly disagree. He offers an elementary book on a subject which cannot properly be treated, as an *educational* work, on the elementary and non-mathematical basis which he has adopted. We should raise no such objection to a book intended for artisans who have no opportunity of attending evening classes, for whom mathematics are out of the question, but who wish to acquire some elementary knowledge of electrical work. This, however, is not a book of that kind.

Annuaire pour l'An 1895 publié par le Bureau des Longitudes. (Paris: Gauthier-Villars et Fils.)

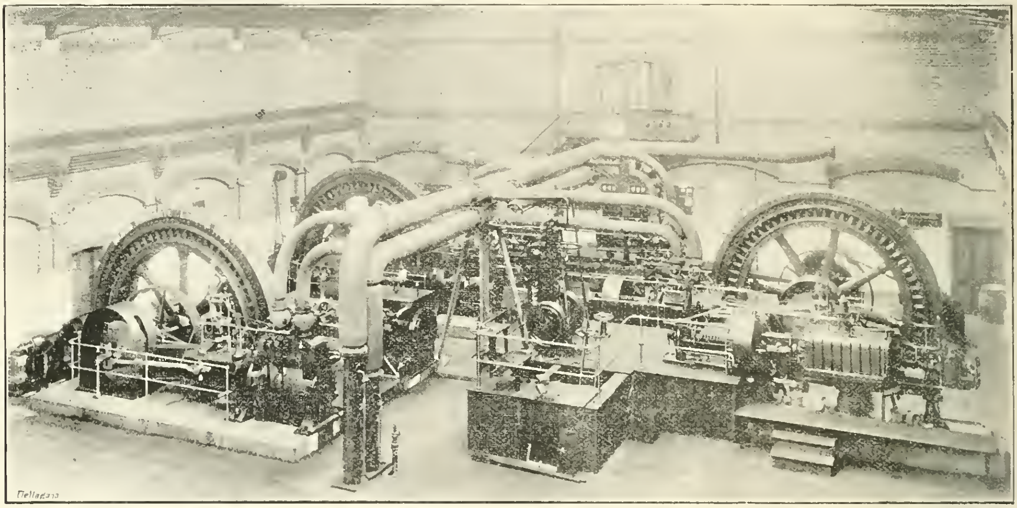
This well-known annual scientific work of reference contains no new feature of note this year. The electrical section is still without any reference to the important resolutions of the Chicago Congress of two years ago, and the so-called legal or 106cm. 1 sq. mm. ohm is still to the front.

Kalender fur Elektrotechniker. 1895. Edited by F. Uppenborn. (Munich and Leipzig: R. Oldenbourg.)

The German "Munro and Jamieson" endeavours to keep itself within manageable pocket-like dimensions by submitting to a process of dichotomy, most of the purely mathematical and physical data being relegated to Part II. There are no additions of note this year.

PORTSMOUTH ELECTRIC SUPPLY STATION.

Since our description of the Portsmouth municipal electric supply station last June (see *The Electrician*, Vol. XXXIII., p. 157), on the occasion of its inauguration, considerable increase in its business and extension of its plant have taken place. The two 212-kilowatt flywheel alternators, built by Messrs. Ferranti and Co. in conjunction with Messrs. Yates and Thom, who supplied the steam plant, and the 150-kilowatt Parsons steam turbine, have proved inadequate to meet the growing requirements of the system of supply, and a third flywheel alternator, of the same type and capacity as the other two, has been added.



Horizontal Compound Condensing "Corliss" Engines and Flywheel Alternators.

The accompanying illustration shows the station as it is now equipped, and gives a very clear view of the system of steam pipes. It may be remembered that there are two independent main steam ranges, each having a branch connection with every boiler and with every engine. In the engine room these ranges are superposed one on the other, and pass down the middle of the room between the engine and dynamo sets. In our previous article, already referred to, we fully described the alternators. We are now enabled to give some further particulars about the engines. These are of the horizontal compound side-by-side condensing type, and have been built by Messrs. Yates and Thom. They are designed to run at a speed of 96 revolutions per minute at all loads, the electric frequency being 50. The condensers and pumps are situated under the engine, being worked by a bell-crank lever attached to the engine rod. The air pump is 19in. in diameter, and has a stroke of 11¼in. Jet condensers are used, the water being obtained from and rejected into the harbour. The stroke of the engine is 36in., and the diameters of the high and low-pressure cylinders are 15in. and 28in. respectively. The piston speed is 576ft. per minute. The cranks are set at 90deg. The steam distribution is effected in both cylinders by Corliss valves and trip motion, and a dead-weight governor acts on the admission valves to vary the cut-off as the load varies. The governor makes 235 revolutions per minute at ordinary speed. The cylinders are placed on either side of the flywheel alternator, and disc cranks are used.

THE PROPAGATION OF MAGNETISM IN IRON.

The following is an abstract of the discussion which followed the reading of Dr. John Hopkinson's very interesting Paper at the Institution of Electrical Engineers on the 21st ult. Speakers who have returned their proofs revised have their names prefaced by an asterisk :—

*Dr. J. A. FLEMING said most of those present were old enough electrically speaking, to recollect the year 1882, to which they looked back as to part of the middle or dark ages now. Dr. Hopkinson would recollect very well that in the early part of 1882, when he and the speaker were connected with the old Edison Company, they had made many experiments different forms of dynamo machines which had been designed by Dr. Hopkinson as improvements on the old Edison machine, and he (the speaker) recollected particularly one machine, in which Dr. Hopkinson had abolished the multiple iron legs, which Edison had thought an advantage, and substituted for them great oval legs in the dynamo machine. When they came to try this machine it took ten minutes or a quarter of an hour to excite itself. A long time after that he recollected trying experiments with a field magnet of one of those original big Edison machines, called "the Jumbo," which stood once in the cellar at Holborn Viaduct. One of them was at the present time working in Victoria Station, and the field magnets of another were taken down to the Edison-Swan works at Ponders End, where they lay for some time. On one occasion they joined up this field magnet coil in series and passed a current from a secondary battery to magnetise the field magnet. He recollected distinctly how great their astonishment was to find that the current required six or seven seconds to become steady. Those field magnets, if he recollected rightly, were something like 6in. or 7in. in diameter, so that, although the magnetising current was not remembered at the present time—at least he did not remember it—that figure agreed very well with the number Dr. Hopkinson had given. The latter had told them that with a magnet 12in. in diameter the whole of the magnetic effect took over 40sec. If they took the square root of that, viz., six or six and a-half, they found that in field magnets of that size the magnetic events would be all over in 6sec. or 7sec., and that practically was the case. These experiments opened up to them a world of suggestion. One thing they naturally did was to connect together in their minds very forcibly the mode in which a current increased in a wire, and the mode in which the magnetic induction increased in a core. It had been shown that these two things were, from a mathematical point of view, identical in behaviour, and there they had been shown most admirably on the screen how this was so.

*Capt. CREAK said he dared say they knew perfectly well that on board ship, when there were compasses within a certain distance of the dynamos, they were liable to be disturbed. The dynamos in certain classes of Her Majesty's ships were symmetrically placed with regard to the compasses, one on each side, and the action had been that, supposing they were running the port dynamo at night, and the engineer found it was not running well and used the starboard dynamo instead, they would have a change of 4deg. in the compass. However, they had so far got over this that, supposing they were running the port dynamo, they were able, by an arrangement of switches, to use the starboard dynamo as a corrector; the correction was absolute. But what he wanted to point out, in confirmation of what Dr. Hopkinson had said, was that he found they had to wait about four minutes for complete compensation, whilst during this time the compass was markedly uncertain in its indications.

*Mr. W. M. MORDEY said he was particularly interested to hear a confirmation of the practice that they had all drifted into in the matter of transformer design—to find, in short, that the degree of lamination that had been adopted was confirmed by Dr. Hopkinson's researches. Some three or four years ago he made a test with the object of finding whether the penetration in laminated iron took place evenly over the whole area of the sheet. Although the length of certain parts of the magnetic paths was necessarily greater than that of others, he found the magnetic density uniform. He accounted for it by assuming that any tendency to a greater density in any one place would be counteracted by the relatively stronger permeability elsewhere. Another matter bearing closely on, and explained to him by Dr. Hopkinson's results, was that of the excitation of a solid core by a redressed current. On a few occasions he had designed alternators with large solid cores the magnets of which were excited by redressed alternating currents, currents of 100 periods redressed by an ordinary commutator. He expected to find the arrangement wasteful. He started with the idea that he might have to laminate this magnet if he wanted to make the apparatus efficient. To his surprise he found this was not the case. He found it required the same current, measured on a Siemens dynamometer, to excite it. That he was prepared for. But he also found the watts were very little higher than with a direct current. Apparently with a redressed current, the magnet settled down to a certain stable magnetic condition, there being only a very slight surface fluctuation. He might remind Dr. Hopkinson of some curious experiments of Prof. Hughes, who found that when he magnetised steel bars or needles he had a number of layers of magnetism of different polarity, and by dissolving off the surface of the needle he made its poles change inside.

*Mr. SYDNEY EVERSHED said there was one point in the Paper to which he should like to call attention, and that was that the problem with which Dr. Hopkinson had dealt, namely, the penetration of induction into an iron core, had hitherto been regarded as an abstruse mathematical one. Some years ago a Paper appeared in *The Electrician* (Vol. XXVIII., p. 599), by Prof. J. J. Thomson, on The Penetration of Induction into Thin Laminated Bars, and as in all such cases he was obliged, in order to make the problem practicable for mathematics, to assume that the permeability of the iron was constant, and, of course, he attained a result—a result which would be applicable to theoretical iron, but not to practical iron. Dr. Hopkinson, however, had always gone on a totally different line in his work, and he thought they all ought to be grateful to him for showing them so good an example of his method. Many years ago, while most electrical people were attempting to predetermine the characteristic of a dynamo by some mathematical function more or less complex, Dr. Hopkinson threw all that over and appealed directly to Nature. Taking the curve of the magnetisation of iron, he was able to show us how to design a dynamo from a knowledge of the magnetic nature of iron. Since then they had all designed dynamos in that way. Now, Dr. Hopkinson dealt with this matter in precisely the same way, and used mathematics in a perfectly legitimate manner. Here was a material like iron, which had a most complex law as regards magnetisation, a law which could not up to the present be treated mathematically. The only way was to see what one could do by pure experiment, and having got a sufficient number of results, Dr. Hopkinson was then able to make legitimate mathematical deductions and show how thin a transformer plate ought to be in order that there might be no serious loss, how thin the armature core discs ought to be, and so on. He thought that point should be left forcibly impressed on their minds as a lesson to younger experimenters to follow on the lines of Dr. Hopkinson.

Mr. G. L. ADDENBROOKE thought Dr. Hopkinson's experiments bore in a very important manner on the design of alternators. They knew that the parallel running of alternators was largely dependent on the self-induction between the armature and field magnets. Of course, the self-induction between the armature and the field magnets was dependent entirely on the permeability of the magnetic circuit. He fancied it had been assumed hitherto that the permeability of the magnetic circuit was the ordinary permeability which they would rely on in calculating the magnetic strength of the field: but it was evident that wherever they had large masses of field magnets in an alternator the self-induction apparently could not rise to the amount that they would anticipate in the ordinary way, and that therefore the reaction of the armature on the field magnets could not be quite so great as otherwise would be anticipated.

*The CHAIRMAN (Prof. George Forbes) said the subject was one of the very greatest difficulty to attack. It was one which they had all wished to get information about ever since they had been studying magnetism, and most of them had been very frightened in trying to attack it in any way whatever. He remembered, in the celebrated Gaulard-Gibbs case, Lord Kelvin made a statement that the difference between a laminated core and a solid core was perfectly well known, and that it was possible to calculate the effects that were produced by substituting the divided core of a transformer by solid iron. He did not know whether Lord Kelvin ever went into the mathematical investigation and plotted it out. If so, it would be a great addition to science. However, Dr. Hopkinson he (the speaker) thought wisely, left out the mathematical calculation, and tackled the problem directly by experiment, and it certainly had led to results which they must look at as of the greatest value. He supposed everyone had observed something of the phenomena of sluggishness in masses of solid iron, not only in the way in which Dr. Hopkinson and Dr. Fleming had mentioned, but in the length of time taken to measure the resistance of the fields of dynamo machines. It was extremely important to have learned from Dr. Hopkinson the fact that if they made an experiment upon a magnet of any sort and got certain definite results as to the time taken for certain phenomena to be accomplished, they might from that experiment foretell the time that would be taken to go through the same experiment with a magnet ever so much bigger or ever so much smaller, it being simply proportional to the square of the linear dimensions. A remark of Capt. Creak's about the effect of the dynamos upon the ship's compasses made him inclined to wonder why it was that Her Majesty's ships could not be supplied with dynamos of what was commonly called the "iron-clad" type.

*Dr. HOPKINSON, in reply, said he should like particularly to thank Mr. Evershed for his quite too kind remarks; but he thought Mr. Evershed was right in saying that the proper way to use mathematics was not to choose the facts so that the mathematics would easily deal with them, but to take the mathematics so far as they would go upon the facts as they actually were. There was one thing which always struck him about matters of this kind, and that was that when there was any little bit of credit—he did not know that there was much in this—but when there was credit due for work of this kind it seemed all to go to the man who, being the senior, was regarded as the principal. He did not want that to be the case here, because it was a matter of fact that not only had the labour of this thing fallen upon his lieutenants, but a good deal of the initiation of it too. The ideas were not all his own, by any means, and Mr. Ernest Wilson had contributed a very great deal of original thought to it, and, in fact, they had been so much in conference about it that he did not think either of them could sort out from this matter which ideas were those of the one from those which belonged to the other. It did not stop there; they had had help from the student-demonstrators in King's College, and the zeal with which they had worked had really astonished him. He really thought if he had asked them to try an experiment at any hour of the night or morning they would have done it. When one had help of that kind one could put a job through although one had not much time in which to do it.

A COMBINED ELECTRIC LIGHTING STATION AND WATER WORKS.*

Of late years small towns and independent parishes have been paying more attention to their water supplies and lighting than they used to do. The Government, for sanitary purposes, has helped a great deal in this respect, inasmuch as they have recommended, and in some cases ordered, the erection of water works. As in most cases small towns and parishes are at the present time almost exclusively lighted by means of petroleum, and as in course of time the demand for light, and that of a better quality, has increased, so it seemed expedient when erecting water works to settle the question of lighting at the same time. That this can be achieved in the best and cheapest way by employing the electric light, says Herr Luhn, is so well known that I need not go into explanations of the advantages of this mode of lighting. I therefore merely give you a description of the central station and water works which the parish authorities of St. Lazarus, near Posen, had built by the Helios Company, in order to supply the 3,000 inhabitants with a good drinking water and a good and cheap means of illumination.

Borings for water were carried out under Herr Beyer of Berlin, an expert in well-sinking, on a piece of ground belonging to the authorities. Results showed an unlimited supply of an excellent drinking water, and the authorities requested a number of firms to draw up plans and tender for the building of a central station and water works. The order was placed with the Helios Company, and in the autumn of 1893 operations were commenced.

The boiler plant comprises two Cornish boilers. Next to the boiler house is the large engine house, and in a corner of it is the pump shaft, 21ft. deep and 18ft. in diameter. At the bottom of this shaft are two pumps, both of which have an output of 6,600 gallons per hour. One is a compound steam pump, whilst the other is driven by an electromotor by means of tooth-wheel transmission. In the shaft are also placed two air vessels, 29·5ft. high and 5ft. in diameter, which are used in place of an expensive pressure tower, and so cheapen the installation. In the engine-room there is a 50-H.P. engine, which belt-drives a dynamo direct from the flywheel. The engine is horizontal, single cylinder, non-condensing. The special construction of the dynamo, and especially of the armature, results in almost perfectly safe working, so that a reserve set has not from the beginning been thought necessary. In fact, since the commencement of working, March 15, 1894, not the slightest interruption in the engine plant has occurred. At each side of the entrance to the pump shaft are two air compressors, electrically driven. These compressors serve to raise the pressure as may be desired. The greatest working pressure (in case of fire) in the water mains is five atmospheres. Next to the engine-room is the accumulator room, which contains a battery of 136 cells.

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[*] Abstract of a Paper read at Cologne by Herr Ober-ingenieur M. Luhn of Berlin. From the *Elektrotechnische Zeitschrift.*

The battery is capable of running 200 incandescent 16-c.p. lamps for seven hours, and can be used, in case of an outbreak of fire at night-time, to drive the electrically driven pump as well as the compressors, so that the stoker can stoke the boilers in peace. A feeding main is carried from the central station to the middle of the distributing network, which is carried out on the three-wire system. The arc lamps for street lighting are on a separate circuit, which can be cut out or in from the central station. All conductors are carried on porcelain insulators fastened on paraffined wooden posts 26ft. high. A telephone wire is also carried on these posts, which connects the engine house with the office of the authorities, and also a signal wire, by means of which the attendant who sleeps in the engine house can be warned in case of an outbreak of fire.

The working of the central station is carried out as follows:— During the day, when the consumption of water is greatest, the accumulators are charged and the water supply is worked by the steam pump. When the accumulators are charged, and in the morning before the boilers are heated up, the electrically-driven pump is worked from the accumulators, in case of a large demand of water. At dusk the current is taken direct from the dynamo, and at eleven o'clock in the evening, when the street arc lamps are cut out, the further supply of current is taken from the accumulators. If a fire should occur in the night the attendant, who is wakened by the alarm, starts the electric pump and one compressor working. Such an arrangement is of extreme value when a fire occurs at night, and the authorities have had opportunity of convincing themselves of the perfect working on the occasion of a large fire in the early hours of the morning. By employing automatic current regulators, automatic oiling apparatus on all the moving parts of the steam engine, and by using ring oiling arrangements on dynamos and motors the working of the plant is so simple that one engine driver and a stoker can look after the whole central station. When the extensions are completed these two men will also be sufficient.

The charge for current is 3pf. per 100 watt hours (about 4d. per B.T.U.), and water costs 2d. per 220 gallons. Since the goods station at Posen has taken the water for the locomotives, the sale of water has covered the entire cost of working, so that the income from the sale of current is clear profit. In future the charge for current and water will no doubt be lowered.

The excellent results obtained at St. Lazarus have caused the parish of Wilda to give the Helios Company, in the autumn of last year, the order for a similar plant of about double the size. The arrangement in Wilda differs from that of St. Lazarus, as the position of the ground water does not necessitate the pumps being put in a special shaft. As water for condensation is plentiful, which was not the case at St. Lazarus, the steam engines will here be condensing, and so in Wilda they should have still better working results than at St. Lazarus.

In answer to questions, Herr Luhn said that the working voltage was 2×100 volts. Iron meters were used. The arc lamps were placed four in series, and the distance of the feeding point from the central station was about 700 yards. The potential at the distributing point was kept constant by means of a return wire to the central station. The cost of the electrical plant was £3,750, and the total cost £5,000.

ELECTRIC HEATING AT THE VAUDEVILLE THEATRE.

The introduction of electric heating at the Vaudeville is of great interest to the electrical profession as marking an era in the practical use of electricity for warming purposes. The fact that heat produced by electricity at the present rates is more expensive than by other systems would seem to prohibit its use in large buildings; but it does not follow that, the cost per unit of heat being higher, the total cost of heating for a certain period will be higher also.

The authorities at the Vaudeville found it necessary to provide some system of warming, and, after considering the usual methods, they came to the conclusion that electricity offered advantages over all others. A trial was made with four large radiators of the "Crompton-Dowsing" type, taking 12 amperes, with a total of 36 sq. ft. of heating surface. These radiators were connected with the lighting circuit, and placed in the best positions for warming the most important parts of the theatre. A week's trial showed excellent results, and it was evident that with more heating surface sufficient heat could be obtained for all requirements. An order was, therefore, placed with Messrs. Crompton and Co. (Limited) for the supply of electric radiators to be fixed around the skirtings on either side and along the front of the orchestra. These radiators (Fig. 1) are of "box" form (wall radiators), that is, they have a front radiating surface studded with projections, fixed in a cast-iron case, which is screwed by means of lugs and insulators to the walls and partition. Each box radiator is 2ft. long and 1ft. wide, and therefore offers a radiating surface of 2 sq. ft. The air is allowed to circulate between the casing and the wall, so that an extra heating surface is obtained. There are six box radiators on either side of the theatre and twelve attached to the partition in front of the orchestra. The latter are cased in at the back, and a good current of air is obtained by carrying the casing below the boxes containing the radiators. The four large portable radiators (Fig. 2), originally on, trial are arranged for use either in the stalls or at the sides.

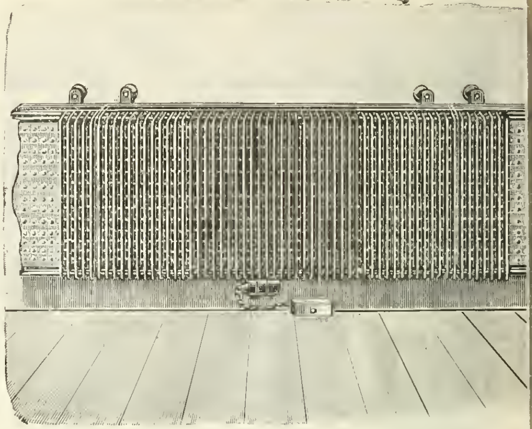


Fig. 1.—Box Pattern of Electric Heater at the Vaudeville Theatre.

Two wall sockets are fixed on each side and four on the chair supports in the centre of the stalls. By means of these connectors the radiators may be employed to warm the centre before the performance begins and afterwards removed to the sides. Each radiator, portable and fixed, has a patent safety connector, and can be detached from the circuit at will. The radiators reach the usual temperature of hot-water pipes, and they are found to produce quite sufficient heat. The average temperature of the theatre inside, after the radiators have been working a reasonable time, is about 60° when the corridors are about 40°. Most theatres are subject to draughts from the frequent opening of doors and from the stage; but, notwithstanding these, the temperature at the Vaudeville is maintained fairly constant.

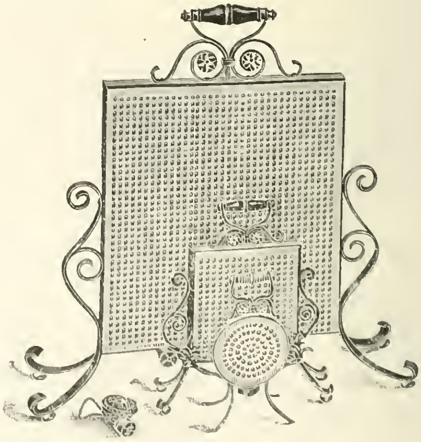


Fig. 2. Portable Electric Heater at the Vaudeville Theatre.

The current taken by each large portable radiator is 12 amperes, and the small box radiators take 3 amperes each, making in all a total of 114 amperes, but as only two of the large radiators are found necessary, the current actually used for warming the auditorium is 90 amperes at 100 volts. Thus it will be seen that nine units per hour are required when the whole apparatus is in full work, and the cost at 4d. per unit is 3s. per hour. To warm the theatre, therefore, for a period of four hours, the cost is 12s., and it is believed that a suitable hot water system (particularly with gas as the heating agent, as proposed for the Vaudeville) including attention, loss of heat in transmission and in other ways, would cost as much. Besides, there is the danger of a red-hot furnace in close proximity to the stage, and this is obviated by the use of electricity. Another distinct advantage makes electric heating far preferable to other systems, and that is, the perfect regulation. Thus, the whole or any number of the electric radiators may be put on or cut off at will, and there is no fear of over-heating the theatre and thus making it uncomfortable at any time. No attention whatever is required with the electrical radiators, and any of the theatre attendants can turn the current on or off according to the requirements of the case. Owing to the fact that the radiators have not to be turned on until a short time before the performance begins, the state of the weather may be judged and the heat graduated accordingly. In comparing the up-keep of the electrical plant with hot water systems, Messrs. Crompton state that the former will in all probability be considerably less than the latter, owing to the fact that there is no furnace to burn out, and no rusting or wearing out during long periods of disuse. Electric radiators are found to be very durable, they are not required to reach high temperatures, and they offer a large radiating surface.

The installation at the Vaudeville has been carried out with great care. Henley's cables of high insulation are used, and the switches, cut-outs, safety connectors, &c., are of the latest and best type. This being a pioneer installation, some difficulties were at first experienced with regard to the insurance rules, none of which were applicable to the special circumstances of the case. Mr. Musgrave Heaphy, of the Phœnix Fire Office, who had to pass this work, has now drafted out a set of rules with regard to electric heating which will be applicable to all work of the kind in future.

The cost of installing the electric heating apparatus at the Vaudeville has come out at about the same as for hot water heating, and, taking all into consideration, the electric system of heating offers many advantages over the older forms of heating employed, which would justify even a higher price.

It may be stated that electric radiators are on trial at several other theatres and public buildings, and in many places where other systems of heating are in use it is proposed to employ these radiators for temporary assistance in extra cold weather, or for use at a moment's notice when no provision has been made for warming the building in the usual manner.

THE ST. PANCRAS EXPLOSIONS.

The following correspondence has been sent us for publication:—

Board of Trade (Railway Department),
7, Whitehall-gardens, London, S.W.,
February 28, 1895.

Sir: Adverting to the interview which you were good enough to give me yesterday, and to the conversation which we had on the subject, I am directed by the Board of Trade to state for the information of the Electric Lighting Committee of the St. Pancras Vestry that Major Cardew, the electrical adviser of this department, has discovered in his investigations into the recent explosions in the street boxes used for electrical supply in St. Pancras that a remarkable deposit on some of the insulators contained a considerable quantity of the metal sodium.

The presence of this metal, which is highly inflammable by contact with water, appears to be so grave a source of danger, and to afford so reasonable an explanation, in connection with the accumulation of escaped coal gas, of the several explosions which have recently occurred, that it devolves upon the Board of Trade, without any delay whatever, to investigate the causes of the deposit of this substance with a view to its prevention, and in this investigation they have asked for the assistance of the Royal Society and of the Institution of Electrical Engineers.

In the meantime, in order to prevent as far as possible the recurrence of similar explosions, the Board of Trade would strongly urge that the Vestry, through their Electrical Committee, should immediately

(1) Provide a thorough system of ventilation for their conduits and street boxes.

(2) Reduce as far as possible the space in their street boxes within which an accumulation of gas can occur.

(3) Make a thorough inspection of their mains and remove the above-mentioned deposit wherever it is found to exist.

As regards the means to be taken for prevention of the recurrence of such deposit the Board of Trade hope to be able to communicate with you further without delay.—Yours, &c., Courtenay Boyle.

The Chairman of the Electric Lighting Committee,
St. Pancras Vestry.

Electricity and Public Lighting Department,
St. Pancras Vestry Hall, London, N.W.,
March 1, 1895.

Sir: A special meeting of the Electricity Committee was held last evening, when the Chairman reported the Conference held at your offices on Wednesday last on the subject of the recent explosions, and your letter of the 28th ult. was considered.

I was instructed to inform you that the Committee desire to record appreciation of the courtesy shown by you in the desire to assist the Vestry, and are thoroughly in accord with the Board of Trade in their desire to prevent a recurrence of the explosions that have recently taken place.

With regard to the several recommendations contained in your letter, the Committee have instructed their engineer to have fixed without delay ventilating pipes for getting rid of any accumulation of gas in the manholes and culverts, and pending further consideration respecting reducing the size of the manholes to fill them up as far as practicable with bricks; extra men have also been engaged inspecting the mains and removing whatever deposit may be found on them.

The Committee note the Board of Trade have asked the Royal Society and Institution of Electrical Engineers to investigate into the causes of the deposit of the metal sodium, and that the Board will inform the Vestry the result of such investigation.

The Committee also expressed a hope that the Board of Trade would bring pressure to bear on the gas company to remedy the defective state of gas mains and services in this district, and thus remove the primary cause of the explosions.—I am, &c.,

Sir Courtenay Boyle, (Signed) A. E. Pycraft.
Board of Trade.

PARLIAMENTARY INTELLIGENCE.

THE TELEPHONE AGREEMENT.

On Friday evening last Mr. BENN moved:—

"That a select committee be appointed to consider the proposed Draft Agreement between the Postmaster-General and the National Telephone Company, and report with reference to the monopoly which may thereby be created; the granting of telephone licences to municipalities; and generally on the future policy of the Post Office with reference to the extension of the telephone service. That the committee have power to call witnesses and send for papers and records."

The agreement in question, he said, grew out of a policy which was declared in March, 1892, by the late Chancellor of the Exchequer. The desire was to make the telephone service more useful to the country, and the late Chancellor of the Exchequer said:—"The trunk lines will be taken over by the Government, leaving to the localities the working of the local exchanges. If this is done, I believe the public will be better served than if the Government take over the whole business, because there will be a competition in the localities to serve the public as well as it can be served." In a Treasury minute of May 23rd it was said "the intention is to meet, as far as possible, the views of municipal authorities." The next step was the Telegraphs Bill, which was introduced in May and rushed through the House by June. The London County Council protested against the haste in passing that Bill. The heads of the arrangements were initialled on August 11, 1892, and he was very anxious the House should regard them as merely a provisional document, and in no sense a binding document. Although inquiries were made for it, hon. members had not the privilege of seeing the document until 1894, and when, as it was produced with the Agreement in the midst of the holidays, it was impossible for municipal authorities in the House to express an opinion. The signing of the Agreement was only deferred after considerable pressure had been brought upon the Government. It was a very serious document, because it brought them face to face with a new and unrestricted monopoly which, in regard to the telephone service, meant increased charges, the killing of competition, the death of municipalised telephones, a vexatious interference with public rights, and, what was more important than all, the prospect of paying through the nose in 17 years' time for a gigantic property. The Postmaster-General told a deputation of the London County Council that he regarded the Agreement as a sealed and settled document; he said it was solemnly signed and could not be departed from. In reply to a deputation from the Association of Municipal Corporations the right hon. gentleman said that new conditions could not now be imposed on the Telephone Company. He (Mr. Benn) submitted that the Draft Agreement could not be regarded in any such light. In the first instance it was an Agreement between three parties—the Post Office, the National Telephone Company, and the New Telephone Company—and what happened between the signing of the heads of arrangement and the presentation of the Draft Agreement to the House? The National Telephone Company absorbed the New Telephone Company, and thus the monopoly was created. He was certain that if the Committee which considered the question had been face to face with one company no such heads of arrangement would have been sanctioned, and he asserted that a company which endeavoured to get behind a Committee of the House of Commons by secretly buying up an opposition company was not entitled to any consideration at the hands of the House. It was perfectly ridiculous to regard the document as a solemn document when one of the parties to the Agreement acted in such an extraordinary and improper manner. If the document was of the settled and sacred nature which the Postmaster-General seemed to think it was, why was it not placed on the table of the House in 1892 so that the municipalities might have an early opportunity of considering it? It was perfectly competent for the House to regard the document merely as a provisional arrangement, and he submitted that the subsequent action of the National Telephone Company deprived the heads of the arrangement of anything in the nature of a sealed and settled contract. The Postmaster-General seemed to strongly deprecate competition. It was a very inconvenient thing to have two or three exchanges in any town or city, but it must be evident to the House that competition was the only protection the public had against high charges, and that if competition disappeared they must have clauses as to maximum charges, as to the limitation of dividends, as to the obligation of supply. In this case they had nothing of the kind. What was a very unfortunate feature of the case was that the Post Office and the National Telephone Company had gone into partnership in a monopoly of a most objectionable kind. He thought it was a very important point in this question that they should know how much the public had to pay for the luxury of allowing the Post Office to be associated with the National Telephone Company. The hon. member then quoted the figures, showing the increased trunk charges under the new arrangement. In Sweden the charges were much lower than here, and surely they could do in a country like England what was done in Sweden. What was proposed to be charged £10 to £20 in London was done in Manchester for £6 and in Stockholm for £4. The question which immediately concerned him was the charge in London. One-seventh of the business of the Company emanated from the metropolis. The County Council looked on this as so grave a matter that they came to the conclusion that, so far as the local service was concerned, they could secure a much better service than that rendered by the National Telephone Company at half the price. If they looked on that entirely with regard to subscriptions it meant a saving of £50,000 a year. No wonder the County Council regarded the matter as one of great importance. They considered that the service was a disgrace to the country, and that it was due to this fact that comparatively few persons bothered themselves with the telephone. It was not, however, so much a matter of pounds, shillings and pence as a matter of going back upon great principles. Some of them believed that municipalities worthy of the name should own and control enterprises having anything to do with the breaking up or the using of the streets. He should submit once more the proposition with which he started. He had said that this proposed Agreement was distinctly contrary to the policy of the Government. Municipalities had not had an opportunity of considering it. He submitted that the Agreement could not be regarded as valid, and that it was wholly prejudicial to the best interests of the people at large.

Captain BAGOT, in seconding the motion, said that in this matter they were behind every other country in the world. The development of the telephone in comparison with commerce was almost at a standstill, and the Agreement which was being that night considered was looked upon with almost universal dissatisfaction. Competition was entirely debarred, and a gigantic monopoly was established. The Postmaster-General stated that it was very desirable that there should be no competition, and that it would be rather disadvantageous to the best interests of the telephone service. Surely the objections raised might very easily be obviated? He thought there was good cause for not looking upon the Agreement as similar to that made by the late Government three years ago. In the first place the position of affairs since that time was entirely changed, and in the second place the terms of the Draft Agreement seemed to go beyond the Treasury minute, and were not in accordance with the policy of the Postmaster-General and the Chancellor of the Exchequer in the late Government. It was clearly intended by the late Government, when they made the agreement, that there should be free competition in the public interest, and that private companies and local authorities should be granted licences subject to the terms of the Treasury minute. To that policy the policy of the present Postmaster-General was diametrically opposed, for under the agreement it would establish a gigantic monopoly. He denied that this was a rich man's question. A question which was of the very greatest commercial interest could not in any way be looked upon as a rich man's question. Working men and poor men were just as much interested in the commercial supremacy of the country as anybody else. In these days, when it was the universal opinion of the country that large private monopolies should not be allowed, it seemed to him that for the Government deliberately to establish a new and important one was a policy he could only describe as disastrous.

Mr. A. MORLEY said he could not help thinking that the last speech would have been much more appropriate to the Telegraphs Bill of 1892. The amendment before the House dealt with three subjects. It proposed, first of all, to refer to a committee the Agreement between the Post Office and the Telephone Company; secondly, it dealt with the question of municipal licences; and, thirdly, with the future policy of the department. The first of these three points referred to past history. The hon. gentleman introduced the matter in a temperate and moderate speech, and he hoped to be able to persuade him and the House of Commons that in this question of the agreement he (the Postmaster-General) had not had a free hand, and whatever his views might have been with regard to the agreement, he was necessarily bound to accept and adopt it. In the first place, when the question first came up, there were two companies which held licences for the whole country unrestricted in the operations which they were able to carry out. The public had, no doubt, begun to feel that the telephone service of the country was inefficient and inadequate, and had recognised the inability of the companies adequately to provide both for the local systems and also for the trunk-wire systems of the country, which would necessitate the expenditure of very large sums of money. The Government were alive to this fact, that the telegraph revenue of the country was being very largely interfered with, and they were also anxious to give facilities for the extension of the telephone service, which they recognised as very necessary for the commercial interests of the country. The Government were pressed very strongly to take the whole system of telephones into their own hands. Hon. members who sat in the last Parliament would remember that the hon. baronet the member for the College Division of Glasgow, in the month of March, 1892, brought forward a motion urging the Government to purchase the telephone systems, but the Government at that time did not see their way to a purchase. They had the experience of 1870 before them, when the Government of that day were forced to purchase the telegraphs, and they recognised that in undertaking a compulsory purchase of the telegraph systems they had to pay certainly twice, if not three times, their estimated value; and in these circumstances the late Government very naturally and very rightly hesitated to adopt a policy which might have led them into an extravagant purchase of the telephones. They, therefore, developed the alternative policy—the policy which had been described that night—namely, to take over the trunk wire telephone system of the country, and to give certain facilities to the companies to develop the local areas, and by so doing to restrict the operations of the companies to the local areas, and enable them to supply a more effective service for the use of telephone subscribers. That policy was fully described in a Treasury minute, and then the Telegraphs Bill of 1892 was introduced. That Bill and the Treasury minute were referred to a Committee of the House of Commons, and that Committee took evidence. He had no reason to think that any applications to be heard before the Committee were received from corporations, or that any application of the kind was refused. The suggestion that corporations were excluded from giving evidence was, as far as he knew, without foundation. The Committee reported that "they had considered the Bill and made amendments thereto," that in their opinion the responsibility for the details of the Agreement with the companies must rest with the Post Office, and that the Agreement should be laid before Parliament. He had asked the opinion of the members of the Committee, and he had been told by all that they intended no more than that Parliament should be informed of the result of the negotiations. The report did not say that the Agreement should be laid upon the table of the House for the assent of the House, and in the Bill itself no mention of such a condition was made. He had explained frequently that the Agreement was merely the embodiment in a formal legal document of the arrangement entered into by his predecessor. He had always declared that the Agreement was one which he was bound to carry out. The Bill then passed through Parliament, and the preliminary documents for carrying out the policy of the late Government were duly signed. The first section of the Act of 1892 declared that it was expedient to raise money with a view to carry into effect the scheme of the Postmaster-General for the development of the telephonic system, and, in particular, with a view to provide main lines of communication. That clause, he held, was a Parliamentary sanction of the scheme of the Postmaster-General, and it was impossible to say after reading that section that the policy of the late Government and the Agreement signed by the late Government had not been recognised formally in an Act of Parliament. The heads of the arrangement had now been embodied in a legal document, and the local areas had been settled between the Post Office and the companies. If it had not been for the time taken in settling the areas within which, for the future, the companies were to be restricted in their operations, the legal agreements would have been signed on August 11th, before the present Government came into office. The settlement of the areas was a matter of great difficulty and complexity, and in regard to it the telephone companies had acted very honourably. The view taken by the Government was that there was a contract entered into between the late Government and the telephone companies, from which they could not honourably withdraw, that they were bound to carry that contract into effect, and that in the circumstances they could not consent to the Agreement being made part of the reference to the Committee which had been asked for. He was not responsible for the terms of the Agreement, and he was content to rest his case upon the fact that when he accepted office he found the Agreement in existence. He could not honourably relieve himself from the obligations to carry it out. There had been misapprehensions as to the effect of the Agreement. He had seen it described in the daily papers as a "monstrous" agreement, and it had been stated that the Post Office was about to establish a huge private monopoly. But there was not an atom of foundation for that statement, as the Agreement created no monopoly. In fact, he thought he should be able to show that it precluded the possibility of any monopoly being acquired by the companies. Section 18 of the Agreement of the National Telephone Company declared that nothing should prejudice the right of the Postmaster-General to establish, extend, maintain, and work any system or systems of telephonic communication in such a manner as he should think fit or to grant licences for telephones to any persons on such terms as he might think fit. That was a complete reservation to the Postmaster-General not only of the right to establish telephones himself if occasion should arise, but also of the right to grant to other companies and private persons licences to work telephonic systems in competition with the existing licences. If the Agreement were not to come into operation, the position of the National Telephone Company would remain practically the same as now, except that they would have control over the trunk wires as well as over the wires in the local areas. The effect of the Agreement was that the Government took over the trunk wires and became responsible for them. The other matters dealt with concerned the interests of the telephone user much more than the interests of the Telephone Company. Fear had been expressed that the Agreement might possibly interfere with the rights of local authorities and corporations in respect of their highways and streets. He thought corporations were bound to keep in their own hands full control over their own streets, and they would be very unwise, in his opinion, if they allowed any private company or individual to acquire rights of interference over their streets. He was surprised the hon. member should have made the statement that there was any danger in this matter. The Post Office could confer no power upon the National Telephone Company, or any company, which was not subject to the absolute veto of the local authority. He confessed, therefore, he did not see any hardship on the local authorities, because they had the matter absolutely under their own control. A reference had been made to the charges for trunk wires. No doubt the Treasury laid down certain charges; but they were only suggested charges, and would be open to revision by the light of experience as to whether they were reasonable or unreasonable. On this point his experience was that the political and Parliamentary pressure brought to bear on the Post Office was much more effective than it ever would be over a private company with whom they could not get into contact. Now, he strongly held that in all matters proper to them municipalities did their work much more effectively than the central Government could; but there was a great distinction between telephones and such subjects as gas and water. Gas and water were necessaries for every inhabitant of the country; telephones were not and never would be. It was no use trying to persuade themselves that the use of telephones could be enjoyed by the large masses of the people in their daily life. (An hon member: "America.") He did not think his hon. friend was aware of the fact that in the large towns of America subscribers for the service which a £10 subscriber in London obtained had to pay £40 and £50. He went further, and said that in a town like London, or Glasgow, or Belfast a telephone service would be absolutely impossible if the large majority of the houses were furnished with telephones, so great would be the confusion caused by the increased number of exchanges. He was not stating his own opinion, but that of experts. What was wanted was prompt communication, and if there were a large number of people connected with the various exchanges, and a greatly increased number of exchanges, you could not get that prompt communication on which alone the *raison d'être* of the telephone system depended. Another argument against a municipal telephone system was that it was in no sense a local requirement. Year by year the telephone system was becoming more and more a national means of communication from town to town, and it was no more local in its attributes at the present time than either the post or the telegraph. He did not think anyone would say that the municipalities should have local control of the telegraph and post-office services. The telephone service was becoming internationalised. They had already spoken from London with Marseilles, and before long there would be telephone communication with every large town on the Continent. That view of his, that the telephone service was not local, but national and Imperial, had been confirmed in a rather striking way by that very Association of Municipal Corporations which had been quoted that night as opposed to the policy of the department. They passed a resolution containing these words:—"That the subject should be treated as an Imperial and not a local one." He ventured to think that the granting of municipal licences would be in effect treating it as a local and not as an Imperial one. The Government were not disinclined that this question should be fairly and openly considered, and therefore he was glad to be able to announce that they were prepared to assent to a Committee with the object of considering the question of municipal licences, and also the question of the advisability of competition that had been raised and upon which he had said very little that evening. He was as strongly opposed as any member of the House to the granting of a monopoly to the National Telephone Company or to any other company. He had resisted any attempt which might have been made to secure that end. He believed the monopoly ought to be in the hands of the Crown. He believed that the State who owned the monopoly was bound to provide, first of all, a reasonable and efficient service, and secondly, a reasonably cheap service to the public, either through itself or through its licensees. Therefore, if a case was made out in any locality that the service was either not reasonably efficient or not reasonably cheap, his belief was that the Government would be bound to take steps to secure that such an efficient and reasonable service was provided. He did not want to prejudge this question. He had stated his own view upon it. The Government were willing that the matter should be considered by a Committee, and they proposed, instead of the words of the amendment, to insert the following words:—"That a Committee shall be appointed to consider and report whether the provision now made as to the telephone service in local areas is adequate, and whether it is expedient to supplement or improve this provision either by the granting of licences to the local authorities or otherwise." That would enable the Committee to consider the arguments, *pro* and *con.*, on the question of competition, and he thought the House would recognise that in agreeing to the appointment of that Committee they had gone a long way—in fact, the whole way—to meet the wishes of the mover and seconder of the amendment with the exception of the Agreement, which they could not and ought not to consider other than a binding obligation on the Government.

Mr. CORBETT said so much dissatisfaction had been felt on this subject that no harm could result from a full and fair investigation by an impartial Committee. With regard to the objection to municipalities working their own telephone systems, it seemed to him that corporations which had carried on their waterworks, gas, electric lighting, and other undertakings with marked success could also administer this business in an effective way.

SIR J. GORST desired to say a few words on the policy of the Telephone Act of 1892. It was quite true, as the right hon. gentleman had said, that that policy became not the policy only of the late Government, but of Parliament, because it was embodied in the Telegraph Bill, which was considered by a Select Committee of the House of Commons, and by passing the Telegraph Act Parliament adopted and placed its own *imprimatur* on the policy which the Government had proposed. But what was the policy of the late Government? So far from being an attempt, as an hon. member had declared, to create a gigantic monopoly, it was really a successful attempt on the part of the Government to prevent a monopoly growing up. At that time the Government had indeed a monopoly in the telephones by law, but in fact it had not a single trunk line in its possession, but only a few insignificant telephone exchanges. The whole telephonic system of the country was gradually becoming absorbed by the companies, and there was a fear that by getting hold of all the trunk lines the companies would acquire, not a legal monopoly, but a practical monopoly which would have prevented the Postmaster-General from using his own rights under the law without a claim for compensation, which would have been very difficult to resist. Besides, the development of this business was making a very serious inroad upon the telegraphic revenue, and the taxpayers' interests were being very seriously affected by the *laisser faire* of the Government. Thus, it was the duty of the Government to make such proposals to Parliament as would prevent the monopoly, which was the property of the nation, from being practically destroyed: and their policy was explained in a Treasury minute dated May, 1892, and one of the clauses was as follows: "Unless the trunk wires are in the hands of the State, a monopoly injurious to the public interest would inevitably ensue, to the advantage of the company which first laid down such trunk wires." Then it was stated most distinctly that it was the object of the policy to secure "that expansion of the telephonic system which is called for by public opinion and the necessities of the case." It was necessary for the Postmaster-General to take possession of the trunk wires, and unless the Postmaster-General were then immediately ready to establish telephonic exchanges and to buy out the existing interests of the companies, he had no other course than to make a fair and reasonable arrangement with the existing companies, and so prevent the enormous outlay of public money which would have been necessary for taking the telephones over. The existing companies had only 19 years unexpired of their licence—a period now diminished to 16 years—and although the companies strongly pressed the Government, in consideration of their giving up the trunk lines and entering into the agreement now being discussed, to extend the period, the Government refused. The temporary nature of the licence was in itself some protection to the public; but the Government, in laying this policy before the House, were not satisfied with that alone. They reminded the telephone companies and Parliament that the right of the Post Office to establish telephone exchanges had been reserved by Mr. Fawcett, and would be maintained. "The Department holds itself ready, as in the past, to comply with the reasonable demands of any town or district for telephonic facilities." Further, they pointed out that no other licence for the whole country would be granted, and that no application would be entertained for a licence to establish a telephonic exchange unless it were backed by a resolution passed by the Corporation or other municipal authority of the district, and they proceeded then to say that in this way competition would not be excluded, but a check would be imposed on the formation of companies whose object was to force the existing licensees to buy them out. It was also to be distinctly understood that should licences be granted on other principles no company now or hereafter to be licensed should have any ground of action for breach of contract or want of good faith on the part of the Postmaster-General. What more could possibly have been done in the enunciation of the telephone policy to thoroughly protect the public and maintain the Postmaster-General's monopoly, while securing all reasonable facilities and advantages to localities? That policy was examined by a Select Committee and embodied in the Telephone Act of 1892. The Agreement was entered into under that policy; and he was glad that the Postmaster-General had stated that the Agreement could not now be upset even by Parliament. Parliament, of course, had power to do anything; but this was an Agreement entered into by the Government of the State and a public company: and if Parliament were to upset such an Agreement there would be an end to all public contracts and confidence. As to the future policy of the Government that was another question, and he could only regret that, instead of that policy being determined by the Government themselves, it was given into the doubtful hands of a Select Committee. He should have thought that the system of administering the affairs of State by Select Committees had already gone too far. Sooner or later the Government would have to stop that course and to assume its proper function of administering the affairs of the country.

Sir J. M. CARMICHAEL was glad the Postmaster-General had consented to have this question investigated by a Select Committee. He held the opinion that no Government Department ought to enter into any agreement with any commercial body—whether it was an agreement between the Secretary for Foreign Affairs and a company in Uganda, or an agreement between the Postmaster-General and a telephone company—without being first subjected to the review, the revision, the sanction, and possibly the rejection of the House. He said that without any distrust of the capacity or probity of the Government, no matter of what political colour that Government might be. In fact, it was the innocence of the Government that was their danger, because when any body of men trained in commercial life were brought into contact with a body of men trained in official life it always followed that the commercial gentlemen got the best of the bargain. It was therefore advisable that all transactions of this sort should be first submitted to the House, which was supposed to contain highly-trained intellect in every walk of life. What he had said was well illustrated by the Agreements. The Postmaster-General had said he felt himself in honour bound by any agreement entered into by his predecessor, and that he was bound to carry out the policy of his predecessor. But which policy was it, because the policy embodied in the Treasury minute of 1892 was entirely different from the policy set forth in the Agreement initialled by the late Postmaster-General and signed in full by the chairman of the telephone company? He gave his right hon. friend credit for trying to reconcile these two policies, because he had introduced into the new Agreement matter from the Treasury minute of 1892. What he complained of was that, while the Treasury minute encouraged competition in order to secure that there should be no monopoly, the Agreement practically provided that the existing companies were not to be subjected to competition. It was true the Postmaster-General had under the Agreement power to make arrangements with other companies or persons, which would include corporations. But when an application was made to the right hon. gentleman by Glasgow he declined to exercise that power. If there was any area at all in which competition could be allowed it was in an area of the size of Glasgow, which came next to London in proportion to population. The Postmaster-General claimed that his policy was endorsed by the Telegraph Act of 1892, but when that Act was passed the

Agreement which he considered binding had not been before the House. The Act of 1892 endorsed the policy of the Treasury minute of May, 1892. If the Postmaster-General would carry out the policy of the Treasury minute, allowing free and healthy competition, see that the companies to whom he gave competing licences were solid and fit to compete, and allow corporations and municipalities to enter into competition, he would be satisfied.

Sir C. CAMERON expressed himself in favour of the nationalisation of the telephones. There was nothing antagonistic to the ultimate realisation of that in granting licences to municipalities. Until the nation was prepared to take the matter up the municipalities might be intrusted with the telephones. The ultimate assumption of the control of the system by the nation would be facilitated rather than impeded by municipal co-operation. What was wanted was free competition. He was utterly opposed to the views of the Postmaster-General on the subject of the municipal working of the telephone. He entirely sympathised, however, with the appointment of a committee to inquire into the subject of competition and the feasibility of granting these licences.

Mr. GOSCHEN said, in the absence of the late Postmaster-General, who, with himself, had been specially responsible for the policy adopted in 1892, he trusted the House would be willing to give him a few minutes of its attention. There were two matters which he thought might be entirely separated—one was the Agreement, the other was the policy to be followed side by side with it. He would ask the House of Commons whether it realised what it would mean by disavowing this document. Hon. members feared that they had parted with certain rights; but if it could be shown, as it had been, that those rights were reserved to the Executive Government, the Agreement need not be attacked for the purpose of securing to the municipal corporations the right to exercise the powers they desired to exercise. It would be the first time in the history of Parliament, he believed, that a document signed by the Government was repudiated by the House. It would be evading the law if they were to endeavour to get out of a contract which had thus been entered into, and it would at least be considered very sharp practice. The House of Commons ought not to enter on a course of this kind. It was unnecessary to upset the Agreement, and he now contended that it would be inexpedient. He wished to say just one word or two about the position outside the Agreement. It was a question for her Majesty's Government how far side by side with the Agreement, and in virtue of the rights which had been reserved under it and reserved to Parliament, they would or would not allow further competition. It must be borne in mind, however, that competition in the question of telephones stood on a different footing from competition in other matters, because of the confusion it must necessarily involve. There might be many industries in which five or six companies might exercise their business at the same time, but great confusion would arise if that number of companies—or even two companies—sought to conduct telephone business together in the same area. Still, he attached less importance to that point, because the Government had offered to refer that matter to a Select Committee. The Committee, he gathered from the speech of the Postmaster-General, would discuss a number of questions—how far competition should be introduced, how far municipal corporations should be intrusted with the exercise of certain powers, and he was not sure whether or not it would be within the scope of their reference to consider the question of the purchase of the telephones. He was inclined to think that the words "and otherwise" would enable the Committee to do so. He desired to say here that the late Government were entirely responsible for the non-purchase of the telephones two or three years ago. The policy of the Treasury Minute had scarcely been impugned. By that policy they stood, and by that policy they hoped the Government would stand. With regard to the trunk lines he would point out to the hon. member for St. Rollox that if the Government had not bought the trunk lines no member from Glasgow could communicate with London except by the kind permission of the National Telephone Company. He had put his views very candidly before the House, and he hoped the majority of members would be satisfied with the offer made by the Government. That offer was made with considerable reluctance because the Government were anxious to maintain their own responsibility. The Committee would discuss the questions of municipal licences, of competition, and, if necessary, of the purchase of the telephones by the State. He hoped that hon. members would be satisfied with that result, and would not go the length of upsetting this contract.

Mr. LABOUCHERE said the real question was whether the House ought to have the right to ratify or to reject the Agreement. They did not quarrel with the Government for purchasing the trunk lines. But the Agreement went a great deal further and embodied all sorts of conditions and arrangements with the existing telephone companies. The report of the Committee on the Telephone Bill stated that the Agreement was to be laid on the table, and he entirely contested the Postmaster-General's statement that that simply meant that it was to be placed on the table in order that the House might be advertised of the fact that the Agreement had been made. It was said that the Agreement had been initialled by the late Postmaster-General, and that therefore it was binding upon his successor. But that Agreement was made with two separate telephone companies, the object being to prevent a monopoly and to create competition. Since then, however, one of the companies had absorbed the other, and therefore the fundamental basis of the Agreement no longer existed. His right hon. friend the Postmaster-General had given them a most distinct pledge that the Agreement should be laid on the table of the House and that they should have an opportunity of discussing it. But was he not trifling with the House if he led them to believe that an opportunity for discussing the matter was to be afforded. At any rate, that promise involved the right of the House to expect that the Agreement would not be ratified before they had a chance of approving it.

The CHANCELLOR of the EXCHEQUER said it would be a most serious thing if the House of Commons repudiated an agreement which had been made by the Executive Government. The administration of the country depended to an enormous extent on the good faith of the Government and the good faith of Parliament. If Parliament interfered with that principle it would strike a blow which would affect questions far wider than anything connected with telephones. As he understood the objection to the Agreement, it was that the Agreement had in some way or other deprived the Government of something which it ought to have. The Postmaster-General said it did not, and that he could set up any competition that he liked. In this matter they had to take into account various considerations. He remembered perfectly well an estimate made by Mr. Scudamore that the purchase of the telegraphs would cost about three millions, but ultimately it cost the Government ten millions; and at this moment the Government lost half a million a year by the telegraphs. It, therefore, required great caution in dealing with this matter. He thought the policy adopted was a sound policy. If they set aside the Agreement the Company would have a more complete monopoly than before. The member for Northampton spoke of a poor company and watered capital, but he knew nothing about that. Let him observe that the first thing the Committee would have to consider would be whether the provision made for telephone service in local areas was adequate—whether sufficient service was given at a proper price. If the Committee came to the conclusion that the service was not good or that the charges were too high, they would report against the Company. What would be the consequence? Some other service would be given in place of the service which was inadequate. The Company was, in fact, only acting as temporary agents for the Government, and if the Government were not satisfied they could give it in favour of some other persons. The Government desired to carry out the policy of the Minute of 1892. It was not denied that the House of Commons could do anything short of turning a man into a woman; it could, no doubt, repudiate the National Debt, it had the power to do so; but it would not be advisable. It seemed to him that everything which anyone could desire was included under the terms of the recommendation to the Committee.

Mr. PROVAND pointed out that the contention of the mover and seconder of the motion was to the effect that the policy of the present Government was not that of the last Government. They did not object to Parliamentary sanction for the buying up of the trunk wires, but rather to the method by which the purchase was to be effected. The Agreement went outside the Treasury Minute altogether. The difference between the Treasury Minute and the Agreement was that in the latter was included a new charge altogether for what were called terminals. These terminal charges would have the effect of checking competition. Down to the end of 1890 the National Telephone Company had an absolute monopoly. Since then they had had no monopoly whatever except what had been created and maintained by the Postmaster-General. He deprecated terminals which were now being charged, and said they were invented by the Agreement. There was no mention of them in the Treasury Minute, although it was claimed that it left a wide discretion to the telephone companies in the matter. Many other objections to the Agreement might be pointed out.

The CHANCELLOR of the EXCHEQUER said that the effect of the Agreement was to be before the Committee.

Mr. Benn's amendment was then negatived, and

On the motion of Mr. A. Morley, the following was agreed to:

"That a Select Committee be appointed to consider and report whether the provision now made for the telephone service in local areas be adequate, and whether it is expedient to supplement or improve that provision by the granting of licences to local authorities, or otherwise."

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *February 22, 1895.*

National Electric Light Association.—The Cleveland Convention closed yesterday after a very successful meeting. One of the features of the meeting was an address by Mr. Charles F. Brush on the early days of electric lighting, in which he related some amusing instances of the ignorance which then prevailed upon the subject of electricity. Among other things referred to in the address was the cost of carbons at the beginning of arc lighting, the price being then $240 per thousand. When this price was reduced, in order to stimulate the adoption of electric lighting, to $150 per thousand, Mr. Brush's company at first lost money in their manufacture, and the same was true when the price was next reduced to $62.50 per thousand, the increased demand, however, soon making their sale profitable again in each case. Mr. Brush took the audience into his confidence as to the profits from one of his patents, stating that the patent for copper-plating carbons had netted him $150,000.

Open Coil v. Closed Coil Dynamos.—In a Paper read before the Cleveland Convention by Mr. C. N. Black, of the Brush Company, it was maintained that the open coil dynamo is best for arc lighting for several reasons. One of the principal of these was stated to be the large amount of self-induction in the bobbins of these machines (apparently referring to the Brush machines), which Mr. Black considered essential in order to get the best results in arc lighting, as it prevented flashing around the commutator. Another advantage urged was the greater simplicity of the commutator, and the less rise of E.M.F. if the circuit was broken. It was stated that by trial the E.M.F., upon breaking the circuit of a 6,000-volt Brush machine, was found to rise only from 1,500 to 2,000 volts.; the only effect was to make the machine flash, and thus short circuit the armature, causing the E.M.F. to drop to zero. It was claimed that with a closed-coil machine the result under the same circumstances would have been to double the voltage, and injure the armature. The characteristic curve shown of a 125-light Brush machine was almost perpendicular beyond the bend, indicating the generation from that point of almost an absolutely constant current. The "electrical efficiency" of this machine was claimed to be 94 per cent., and its "commercial efficiency" 90 per cent. at full load. It was stated that the magnetic circuit was worked at a much lower density than in the older types of arc machines.

Arc Carbons.—In a Convention Paper read by Prof. L. B. Marks, data was given of tests on arc carbons in which the range of voltage was obtained between the hissing and flaming points of a large number of carbons. It was found that this range varies greatly with different varieties of carbons; a minimum of 11·4 was found with a squirted petroleum carbon and a maximum of 34 volts with a moulded carbon, and it was stated that the hissing point of cored carbons averages ten volts lower than that of solid ones.

A New Method of Measuring Illumination.—Messrs. Houston and Kennelly described, at the Cleveland Convention, an apparatus for measuring illumination based upon the principle that the illumination received, for example, on a printed page, must have a definite value in order to render the printed characters just legible, and that the intensity of illumination so required will, for a normal eye, depend upon the size and character of the print. To apply this, a small printed tablet is placed in a darkened box and exposed to illumination from a translucent plate of glass or porcelain which receives directly on its surface the illumination whose intensity is to be measured; the area of the translucent plate is then varied until the amount of light received by the test characters just renders them legible, and from a scale the illumination is read, being a function of the area of the plate exposed to the source.

CORRESPONDENCE.

PARALLEL RUNNING OF ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I observe from Mr. Raworth's letter that this is still an open question.

Before an elaborate correspondence is begun about it, I would venture to point out that the question is not one of the parallel running of alternators at all. Wilde first proved that, I believe, in 1868, and Dr. Hopkinson confirmed it, and gave the conditions, in 1884. Since then hundreds of alternators have been run in parallel.

The real question is, What is the margin of safety, or perhaps I may be permitted to say the "rectifying factor," in each type of alternator? That is, suppose we have an alternator of 100 kilowatts working in parallel at full load, what alteration in the driving power or in the pressure and phase of the current on the omnibus bars will be sufficient to throw it out of parallel? also, in such a case, what is the maximum current which can be forced through the armature?

It is quite conceivable that a machine which runs most perfectly in parallel with a good engine and heavy momentum, may at the same time have very little rectifying power if anything tends to pull up the engine or to alter the state of matters on the omnibus bar. On the other hand, a machine possessing an immense rectifying factor may have other undesirable characteristics, such as low efficiency, or a very drooping characteristic.

As I am presenting a Paper to the Institute, in which these matters are treated of, I will say no more.—Yours, &c.,

47, Holland-park, London, W., G. L. Addenbrooke.
March 5, 1895.

COATBRIDGE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have only just noticed Mr. Raworth's letter in your issue of February 22nd, and am greatly surprised by his statement that the gas engines at Coatbridge would not drive the alternators properly, either singly or in parallel. On the evening of Wednesday, the 27th, I happened to take my students to see this station, and during the whole time we were there, from a little before 9 till after 10 o'clock, the lights were run with wonderful steadiness. As the load at the time was a very light one, the conditions were certainly not favourable for the engines, although perhaps most favourable for the alternators. From what I saw I have not the slightest hesitation in saying that, with comparatively slight modifications in connection with both the engines and the alternators, it would be possible also to run them satisfactorily in parallel. To me it seems a great pity that this plant should have been so summarily condemned, especially in view of the fact that bitumenous coal can now be successfully used in gas producers.—Yours, &c., W. H. Watkinson.

Glasgow, March 6, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: My attention has been called to your issues of February 15th and 22nd. In the latter number I note a letter in which Mr. Raworth, in evident annoyance at your editorial criticism upon alternators, expresses himself strongly and very unfairly upon the Coatbridge gas engines. Of these he says: "The last engines supplied would not drive the alternators properly either singly or in parallel." Mr. Raworth says he speaks from an intimate acquaintance with both sets of gas engines. This must be only from hearsay, as Mr. Raworth has, I believe, upon one occasion only visited the electric station at Coatbridge, and his actual acquaintance is that of two hours, from 11 to one o'clock.

The first engines installed were underpowered through an error from which nearly all gas engine makers have suffered, that is, overestimating the actual working power of monoxide gas. The first engines drove the Mordey alternators in parallel on a number of occasions, but only upon comparatively light loads, rarely exceeding half the full output of the alternators. The replace gas engines have only been partially installed, and are, as the former ones, coupled double-acting gas engines, giving on full load 360 impulses per minute. The replace engines, about 140 I.H.P., were constructed, the designs and patterns made, and the engines fixed and started to work in about two and a-half months, and there is small wonder if some defects appeared under such hard conditions as were imposed by the Scottish House-to-House Company.

I endeavoured to obtain from several sources the relative values of impulse, interval, and momentum of flywheel necessary for parallel running; but, not being able to do so, I thought to save time by using upon the larger engines the existing flywheels. These were found insufficient, and they were replaced by heavier flywheels. In the presence of Mr. Geipel and Mr. Sellon (the writer also being present), a short trial was conducted of the two new pairs of gas engines driving in parallel, and this was declared extremely satisfactory, the load carried being from light load to two-thirds full load. Mr. Geipel's remark to the engineer in charge of the station (in my presence) was that he had never seen parallel running so good, and he congratulated me on the result. About a fortnight after the trial referred to, Mr. Raworth paid a short visit to the station, and after trying the engines up to the full output of the alternators, he reported that they would not drive satisfactorily in parallel. The uncompromising hostility which appeared to actuate the Scottish House-to-House Company, and their expressed determination that the gas engines should be removed, followed by Mr. Raworth's report, resulted in the decision that the gas engines should be taken out and replaced by steam engines.

The new gas engines, although not running in parallel, have been running steadily and well for several months past, and the users of the light in every case express themselves perfectly satisfied with them. The gas engines have not had a fair trial for parallel running, and in the interest of progress it is much to be regretted that the trial could not be carried to completion. Gas engines, it is well known, run with less variation of speed when on full load, and the same is true of the Coatbridge gas engines. I am not acquainted with the behaviour of steam engines when driving alternators, but upon several occasions I have regulated the governors to put in parallel, and have seen the synchronising lamp under full and steady glow for fully half a minute before the switches were closed, and on several occasions I have turned away, thinking the engines were in parallel, and then found that the switch had not been closed. I impute no blame to the alternators, but I think that in view of what has occurred at Sheffield and other places Mr. Raworth might have been more generous in his criticism. The failure of the gas engines to drive satisfactorily at full load, after the result of the first trial herein referred to, is very disappointing, and not easily accounted for.—Yours, &c.,

J. W. Hartley.

Messrs. Dick Kerr and Co., Kilmarnock, N.B.,
March 6, 1895.

STONEWARE INSULATORS AND GAS EXPLOSIONS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The interesting discovery of sodium and caustic soda on the stoneware insulators at St. Pancras, alluded to in your leaderette of March 1st, requires, for those who do not happen to know how this sodium comes there, the following explanation:—You hint at the decomposition of the stoneware in the presence of moisture; but this is not quite correct, and slightly misleading. The glaze on the surface of common stoneware articles is produced by means of common salt (sodium chloride). Moist salt is thrown into the firing kiln, and, owing to the high temperature, there decomposes in the presence of water, the following equation representing approximately what takes place:—

$$H_2O + 2NaCl + xSiO_2 = Na_2O.xSiO_2 + 2HCl,$$

the hydrochloric acid being disengaged. The leakage current and the moisture on the surface seem to decompose the glaze Na_2OxSiO_2, which is a soda glass, and forming pure sodium.

But now you say that glass insulators have been used in other places, and no explosions have resulted; nearly all qualities of glass, however, contain sodium to a considerable extent, and those glasses which do not contain sodium (namely, lead glass) contain potassium, the physical properties of which, as regards ignition in presence of water or ordinary atmosphere, are about the same as those of sodium. So there is still a little mystery about this very interesting and important subject, but about which we will, no doubt, know all in a very short time, seeing the attention which is being at present paid to these gas explosions.—Yours, &c.,

Fernwood-road, Newcastle-on-Tyne, H. W. Keiffenheim.
March 4, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In a Note in your issue of March 1st, a reference is made to the fact that an examination of the incrustation found on the insulators used at St. Pancras for the underground bare copper mains has shown that, under some conditions, this deposit may contain particles of metallic sodium. So long as gas is permitted to find access to underground conduits, the liberation of sodium—even though this may be possible only in minute quantities, and under exceptional conditions—must no doubt be attended with risk of explosions, and the subject is therefore one which demands the immediate investigation it is about to receive at the hands of the Board of Trade.

The writer of the article, however, assumes that the sodium is "electrolytically produced" by "decomposition of the stoneware." We feel that this assumption is made without adequate evidence, and although we did not supply the St. Pancras insulators, yet, as large manufacturers of both stoneware and porcelain, we may be allowed to make some comments thereon.

"Stoneware" is spoken of in the paragraph as though it were a material used indiscriminately for making insulators or "ginger-beer bottles." It, therefore, seems necessary to state that the word "stoneware" is a comprehensive term applying to a large *class* of pottery products, which, though distinct as a class, embraces materials possessing differing qualities, and applicable to very dissimilar purposes. The more highly vitreous forms of stoneware—among which insulators find a place—are largely used, to the exclusion of porcelain and other kinds of pottery, for vessels and apparatus for chemical manufacturing processes, the reason being that, of all available materials, stoneware possesses in the highest degree the quality of withstanding corrosive action. For such purposes, stoneware made in this country finds a market throughout the world, while as a material for insulators it has been satisfactorily used since the earliest days of telegraphy until the present time. We think, therefore, it will be admitted that, in adopting this substance, the engineers who have advocated bare copper systems have chosen a well-tried material, known to possess many qualities specially fitting it for their purpose.

With regard to the suggestion made in the article that glass should be in future substituted for stoneware, we may remark that glass insulators have been employed in connection with bare copper mains, but experience has led to their use being discontinued.

When considering the case to which *The Electrician* has referred, we think that the numerous schemes where stoneware insulators have been satisfactorily used should be kept in view. We could mention some interesting results of investigations we have made which confirm our view that the deposit is not derived from the stoneware; but we refrain from doing so, pending the reports of the experts who have the subject under consideration. We may say, however, that it is very difficult to reconcile a chemical analysis of the material of our stoneware insulators with the theory which assumes that an incrustation of sodium salts could arise therefrom. We therefore protest against what we consider a somewhat hasty criticism of a material which has proved in the past of good service in chemical and electrical industry; and we ask that, before the presence of the unwelcome sodium is attributed to "decomposition of stoneware," those interested in the result should wait to see whether the investigation may not prove that the source is to be found—not in the insulators, but in the cement, the brickwork, or the surrounding soil.—Yours, &c.,

Lambeth Pottery, London, S.E., Doulton and Co.
March 6, 1895.

THE SECOHMMETER.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have read with interest your article upon the measurement of inductance, capacity, and polarising resistances, and, following your precept that a refreshing of the memory is useful, I should be glad of this opportunity to point out that when in 1889 Prof. Ayrton described his secohmmeter before the Institution of Electrical Engineers, Mr. W. P. Granville mentioned that the late Mr. Willoughby Smith had described and used an identical instrument in 1882.

The instrument to which Mr. Granville referred was made by Messrs. Elliott Brothers, in 1881. It was described for the first time in a pamphlet issued in 1882, and again in January, 1883, at the Institution of Electrical Engineers—being actually shown there later in the same year—as well as at the Royal Institution in 1884.

In every essential the secohmmeter is identical with the double commutator designed by the late Mr. Willoughby Smith, which, to quote from the article in the last number of *The Electrician*, consists of "two rotary commutators, each with four stationary brushes. The two commutators are both on the same spindle, and the group of brushes can be adjusted relatively to each other until both sets of reversals are simultaneous, or until they lag one behind the other by a given amount." This description is perfectly correct for the original apparatus, except that the brushes were fixed, whilst the relative position of the two revolving commutators could be adjusted.—Yours, &c. WILLOUGHBY S. SMITH.

March 5, 1895.

[The secohmmeter was first described by Profs. Ayrton and Perry in April, 1887, in a Paper entitled "Modes of Measuring the Coefficients of Self and Mutual Induction," read before the Institution of Electrical Engineers. In the discussion which arose at the same Institution in March, 1889, on Profs. Ayrton and Perry's "Laboratory Notes on Alternate-Current Circuits," Mr. W. P. Granville, referring to Mr. Willoughby Smith's Paper on "Volta-Electric Induction," read before the Institution in November, 1883, said: "With those experiments I was to a certain extent connected as his assistant, and on that occasion a commutator was used very much of the same form as that adopted by Prof. Ayrton in his secohmmeter—viz., a double commutator mounted on one spindle, one part of the commutator reversing the battery, and the other part simultaneously reversing the galvanometer, so as to produce a steady deflection." In reply, Prof. Ayrton said: "I am very much interested to hear the remarks made by Mr. Granville. I can only say that, notwithstanding I heard Mr. Willoughby Smith's Paper, I was totally unaware of such a method having been employed, and I am quite sure also that MM. Ledeboer and Manœuvrier, who were engaged at the same time as Prof. Perry and myself in developing easy methods for the *absolute* measurement of the coefficients of self-induction, two years ago, were equally unaware that Mr. Willoughby Smith had employed a somewhat similar commutating device."—ED. *E.*]

LEGAL INTELLIGENCE.

Re Loftus John Barnacle.

This bankrupt attended at the Liverpool Bankruptcy Court last week for further public examination. It will be remembered that (in connection with the affairs of A. Hall and Co., under which style he had traded in South John-street, Liverpool), he had been ordered to file certain accounts, but had not done so; nor had he appeared upon the last appointment for public examination, and now said the reason was that he had been at home ill.

The OFFICIAL RECEIVER asked if the bankrupt had not been attending the meetings of directors of a company in which he had been interested, at which meetings resolutions had been passed for disposing of the stock and dividing the money?—I was there because I was obliged to go.

The REGISTRAR said the bankrupt was also obliged to attend at the Official Receiver's office when required, or risk imprisonment if he did not.

The OFFICIAL RECEIVER asked if the bankrupt and Mr. Hall and Mr. Baily had not divided the money obtained from the assets of the so-called company?—Yes.

The OFFICIAL RECEIVER: So that there is not a penny left for the creditors?—I cannot say. It is in the hands of Mr. Hardisty.

The OFFICIAL RECEIVER: You three undischarged bankrupts (Mr. Hall, Mr. Baily, and yourself) have met and divided the assets, have you not?—Yes, together with Mr. Wild; and some has been paid in wages.

The OFFICIAL RECEIVER said the case was a very bad one, and if there was any further difficulty he would apply to the Judge.

The matter was then adjourned to March 11th.

Clift v. Verity.

On Tuesday last the case of Clift v. Verity came on for hearing before the Master of the Rolls and Lords Justices Lopes and Rigby, sitting as a Court of Appeal. Messrs. Leslie Clift and Co., the plaintiffs, engravers and electrotypers, claimed as against Messrs. B. Verity and Sons, that the Divisional Court, consisting of Baron Pollock and Mr. Justice Grantham, should have entered judgment for the plaintiffs in the action instead of sending back certain items of account to the official referee, to be further considered. The action arose out of certain electrotypes supplied by the plaintiffs for the purposes of a trade catalogue, and counsel for the appellants asked that judgment should be entered for them on the ground that certain items had been deducted improperly by the official referee, and that the defendants should, therefore, have been condemned in costs. The defendants paid £200 into Court in full discharge of all claims, but the case was referred to the Official Referee, who made certain reductions, which, it was contended by the plaintiffs, were erroneous, and brought their claim below the sum paid into Court, thus saddling them with costs beyond £150.

Mr. Witt, Q.C., and Mr. Reginald Brown, for the defendant, were not called upon.

After hearing Counsel, the MASTER of the ROLLS said the case was not only confusing, but disgusting. The case ought not to have been brought there at all, and the appeal would be dismissed with costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.—At or before 12 o'clock noon of Monday, the 25th inst., the Llanelly Borough District Council will receive plans, designs, specifications, and estimates of cost of providing and fixing electrical plant and machinery, including street lamps and laying down mains for lighting certain portions of the town. Plans and all further particulars may be obtained on application to Mr. G. Watkeys, C.E., Borough Surveyor, Llanelly, and tenders have to be sent in on the day above mentioned to Mr. John Jennings, Clerk to the Llanelly Borough District Council, Town Hall, Llanelly. Some further particulars are given in our advertisement columns.

—— As will be seen from our advertisement columns, the Corporation of Bradford invite tenders for the construction and delivery of two steam dynamos for use at their electricity works, Bolton-road, Bradford. Specifications may be obtained of Mr. Baynes, electricity department, Town Hall, Bradford, and tenders must be sent in to the Town Clerk, Mr. W. T. McGowen, not later than Thursday, the 28th inst.

—— The Directors of the Electricity Supply Company for Spain require tenders for the supply and erection of machinery, &c., required for the extension of their electricity works in Madrid. Plans and particulars can be obtained at the offices of the Company, 15, St. Helen's-place, London, E.C., or of Mr. Robert Hammond, the Company's electrical engineer, Ormond House, Great Trinity-lane, E.C., after Wednesday next, the 13th inst. Sealed tenders must be sent in to Mr. P. A. Latham, Secretary of the Company, before 6 p.m. on Wednesday, March 27th. Some further particulars are given in our advertisement columns.

—— The Hastings and St. Leonards Electric Light and Power Company have decided to devote their entire attention to the generation and distribution of electricity, and, in consequence, invite tenders for their installation business, with useful stock and fittings, &c. Some particulars are given in our advertisment columns, and tenders must be sent in to the secretary, Mr. F. E. Burton, by Monday, the 19th inst.

—— Tenders are invited by the Eccles Corporation for the supply and erection of plant for an electric light installation at the sewage farm Works, Peel Green-road, Patricroft. Tenders must be in by the morning of the 16th instant.

—— The Manchester, Sheffield and Lincolnshire Railway Company invite tenders for (amongst other stores) copper and brass, iron and brass, wood screws, fog signals, signal stores, telegraph materials, tools, &c., &c. Tenders have to be in by 10 a.m. of the 19th instant.

—— The Stowmarket Urban District Council invite tenders for lighting the streets of Stowmarket and also the Post Office clock, but whether by electricity or otherwise is not stated. Mr. S. Prentice, Clerk to the Council, will supply particulars, and tenders have to be in by April 5th.

—— The Gas and Electric Lighting Committee of the Glasgow Corporation require tenders for excavating work. Tenders have to be sent in to Sir J. D. Marwick, Town Clerk, City Chambers, Glasgow, by the 12th instant.

TENDERS ACCEPTED.—The tender of Messrs. D. and G. Graham has been accepted by the House Committee of the Philosophical Society, Glasgow, for the work connected with the electric lighting of the large lecture hall of the society's buildings in Bath-street, Glasgow.

BANKRUPTCY.—A receiving order has been made against W. Arthur Jones, described as an electrical engineer and works manager, of 50, Albert-avenue, Newport, Mon.

LIQUIDATION.—In the Chancery Division, on Saturday, Mr. Justice North heard the case of Ross *v.* The Medical Electrical Institute (Limited), which was an action by debenture-holders, who had a charge upon all the property of the undertaking of the Company, asking for the usual decree and order for sale, which was granted. It was stated during the hearing that Mr. Harness, the landlord of the Company's premises, had issued a distress for rent.

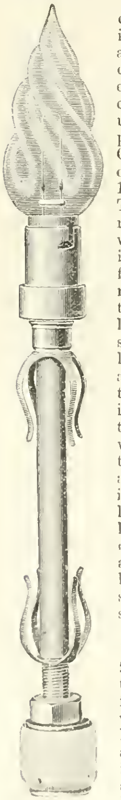
—— Mr. A. Grove, a creditor for £300, obtained a compulsory winding-up order against the Ford-Lloyd Manufacturing Company (Limited) on Wednesday. The Company was established June 7, 1893, with a capital of £10,000 in £1 shares, to carry on an electrical engineering and manufacturing concern at Phœnix-place, Clerkenwell, E.C.

PLANT FOR SALE.—The St. James' and Pall Mall Electric Light Company, Limited, owing to extension of supply from their supply stations, necessitating the use of larger units of plant, have for disposal by private tender a quantity of machinery guaranteed to be in full running order, Some particulars are given in our advertisement columns, and further information may be obtained of the general manager and secretary, at the Company's offices, Carnaby-street, Golden-square, London, W.

Appointment Vacant.—The Corporation of Walsall desire applications for the appointment of electrical engineer in connection with their electric lighting scheme, at a salary of £150 per annum. Applications must be sent to Mr. John R. Cooper, Town Clerk, Walsall, not later than Saturday, the 16th inst. Further particulars will be found in our advertisement columns.

Appointment.—There were 47 applications for the post of electrical engineer to the electric lighting department of the Aberdeen Corporation. This number was reduced to four—Mr. A. S. Blackman, assistant at Aberdeen; Mr. J. Christie, of Londonderry; Mr. W. H. Tittensor, of Dundee; and Mr. J. Williamson, of London. Finally, a vote was taken, which resulted in Mr. A. S. Blackman obtaining the appointment by 27 votes to 2. The salary is £200 per annum.

Removal.—The offices of Froggatt's Electric Lighting Company (Limited) have been removed to 2, Lorrimore-street, Walworth, London, S.E.



"Standard" Safety Candle Fittings.—In consequence of the great reduction in the price of incandescent lamps and lamp accessories, more attention has been paid to the adaptability of the electric light in cases where price has been an obstacle in the way of its adoption. Imitation candles, which form an ornamental method of utilising the old-fashioned chandeliers, have not previously been much used owing to their cost. Conical incandescent lamps can, however, now be obtained at a price little above that of the ordinary 16-c.p. standard, and are coming more into use. To avoid inconvenient short-circuits, improvements in the methods of fixing and connecting up were necessary, and one of these improvements is illustrated herewith. In the older style of candle fitting it was attempted to keep the inner brass tube rigid by rubber rings fixed round it, but frequently these were too small for the opal tube, and had a loose appearance, or the inner brass tube, being small, was used as the return circuit, with only one leading-in wire—a bad arrangement. Messrs. Mellier and Lowry, the patentees of the new fittings, claim to have made improvements, and, as shown in the illustration, a perfect fit is obtained in any size opal tube by means of the upper and lower metal springs, which can be bent in or out as desired, while the thickness of the rubber ring at the base is also adjustable by means of a small nut above it. The inner tube is of sufficient capacity to admit two leading-in wires, which can run right up to the holder. This also is small enough to slip in to the opal tube, and yet will screw on to the brass tube, and, of course, can be either Edison screw or bayonet joint as required. These fittings are supplied by Mr. T. G. Poole, of Queen Victoria-street, London, E.C.

Electric Construction Company (Limited).—We have received a copy of a pamphlet, reprinted from the *Machinery Market*, giving views of the turning and fitting shops, testing department, foundry, and dynamo-winding department of the works at Bushbury, together with several of the leading manufactures of the Company. The plates are accompanied by descriptive letterpress. The illustrations are not altogether a success, but give a good idea of the extensive range of works owned by the Company. A good view is shown of the large overhead travelling crane worked by one of the Company's own type of electric motors.

Swinburne and Company (Limited).—Mr. H. S. Holt, late Managing Director, has been appointed General Manager of this Company, with control of its affairs as from January 1, 1895. The Company report that they are extremely busy, having more orders and inquiries than at any previous time. A showroom has been opened at 66, Victoria street, Westminster.

Facilities for Small Consumers.—Some remarks which we recently made about the condition of the gas supply in Kensington produced so prompt and satisfactory a result that it may be worth while to call attention to a detail of the way in which the Gas Light and Coke Company serve their small consumers. Much fuss has been made about the abolition of meter rents, and about prepayment meters for small establishments; but a lady who took a flat in the Earl's Court district, in the middle of November, applied for a gas supply, and was asked to show her confidence in the Company by making a deposit of £2. Thinking this was mere payment in advance, she made the deposit, and when a gas bill for 4s. 2d. came in, she thought this would be debited to her account. Not a bit of it, the collector soon called again, and told her that a deposit is a deposit, and that the supply would be cut off if the money was not paid. We made some inquiries yesterday about the matter, and find that while householders are not annoyed in this way, the Company thus borrow money without interest from people who live in a small way in flats and apartments, and claim that they so borrow by Act of Parliament. We asked how the sum of £2 was arrived at, and learned that the deposit was intended to cover the highest quarter's gas bill, and that it has been a common practice for the last 30 years, and, we should imagine, a very lucrative one. We learned that the Gas Light and Coke Company are unable, even with their large experience, to estimate the probable consumption of gas by a lady living with one servant in a flat. The consumption, by their own showing, is at the rate of 8s. 4d. per quarter; but having induced the lady to sign an agreement, and having her at their mercy, the interest on her money will go as a bye product to their next dividend. The smallness of the sums in question make the meanness of the transaction the greater.

Smoking Concert.—The employés of Messrs. Drake and Gorham held their third annual smoking concert on Wednesday evening at Cloote's Restaurant, Victoria-street, S.W., under the presidency of Mr. B. Drake, who remarked that, if their company continued to grow in the future as in the past, their concerts would shortly have to be held in the Albert Hall. An excellent entertainment was provided.

Bangor.—At a meeting of the City Council on Wednesday, on the proposal for an application for borrowing powers for a further £10,000 for gas purposes, Dr. Edwards suggested that seeing the great improvements recently introduced into the district, the time had come for adopting the electric light, and he, therefore, proposed that the Water and Gas Committee report upon the expediency and cost of electric lighting before proceeding to expend any further sum on the gas works, a report to be made at the next meeting of the Council. After discussion the proposal of the Committee to obtain the borrowing powers referred to and Dr. Edwards' proposal were both agreed to.

Bath.—Major Cardew held an inquiry on Wednesday into an application for an Electric Lighting Provisional Order made by the City of Bath Electric Lighting and Engineering Company, who were represented by Mr. Morse. The Local Authority opposed the Company, and made an application for an Order on its own behalf. Mr. Morse stated that the electric light was introduced into Bath by Mr. Massingham in 1890, under a licence which would expire at the end of 1897. Mr. Massingham transferred the licence to the Bath Company, who now sought an Order giving them power to light the whole of the city instead of a restricted area. About £40,000 had been spent in the undertaking, and a further £15,000 would be required to complete the installation for the extended district. The Local Authority, in reply, stated they were dissatisfied with the Company's supply, and wished to have the control of the light in their own hands. The inquiry lasted till a late hour, and Major Cardew's report is awaited with interest.

Birmingham.—At the meeting of the City Council, on Tuesday, Mr. Martineau presented the report of the Technical School Committee respecting the proposed lighting by electricity and equipment of the new school, which was referred to in our last issue. With regard to the general equipment of the school, Mr. Martineau replied to a statement that "the new Technical Schools might come into competition with the Mason College" that anyone who entertained that fear might be referred to the members who formed the Technical School Committee, amongst whom were the Principal of Mason College and Prof. Poynting. While Mason College was for the teaching of science as science, the Technical School was for the teaching of science in relation to commerce. Mason College was for the training of professional experts, and the Technical School for the teaching of successful manufacturers. A proposal that £11,000 be expended upon fittings, &c., for the School, independent of the lighting contract, was agreed to. Mr. Martineau then moved that the Technical School Committee be empowered to expend £6,080. 11s. 2d. (the price quoted by a Glasgow house) in providing electric light fittings and motive power plant at the School. He said the Committee found there was an increasing use of electric motors for power purposes. They were cheaper in first cost, less expensive to keep up, and made less noise. They were safer, occupied less room, and there was an economy of power; but, perhaps, one of the greatest claims in their favour was that they were so very easily moved. Electric motors being provided for power purposes, it was also considered convenient to have the electric light. This would be effected by having the machinery larger than would be required for power purposes, and the installation of the electrical plant would prove one of the best possible means for a practical education in the science of electricity. The question then turned upon the tender to be accepted, and in this respect a proposal was made by Mr. Bradley that the lowest tender submitted on the specification originally issued be selected. He pointed out that a tender from Messrs. Fowler, Lancaster and Co., (Limited), of Birmingham, to do the work for £6,271, had been sent in; but they had been told that some of the work tendered for by that firm could not be done at the price quoted. Mr. Martineau pointed out that the whole of the firms who tendered under the first specifications had also tendered under the revised conditions, and he said that circumstances in connection with the tenders had come to the knowledge of the Committee which they could not state to the Council. If the confidence of the Council was not given them sufficiently to lead them to believe they would be trusted, the Technical Committee wished to place their resignation in the hands of the Council. The amendment by Mr. Bradley was subsequently put to the vote, and carried by 30 to 28, but upon being put to the Council as a substantive resolution was lost by 32 to 34. This, of course, leaves the matter to be again brought up at the next Council meeting, when it is expected that the recommendation of the Committee that the contract be given to Messrs. D. and G. Graham and Co., of Glasgow, for the sum above quoted, will be agreed to.

BOURNEMOUTH.—The Bournemouth and District Electric Supply Company announce a reduction in the price of electric current from 8d. to 7d. per unit. The sliding scale of discounts at present in use is to be abolished, and the "Wright" system is to be applied to those customers who may desire it, 5d. per unit being charged for all current consumed in excess of 300 hours' use per half-year of the maximum current taken, as shown by a maximum demand indicator. These changes are to come into effect from the 31st inst.

BURNLEY.—A recommendation of the Gas Committee that in future the charges for electric current be reduced from 6d. to 5d. per unit for lighting, and from 4d. to 3d. for power purposes, has been agreed to by the Town Council. The profit upon the past year's working, on an income of £2,215, was over £100, and it is expected that the reduction will create such an extra demand as to keep up the profit to this point. It has been decided to borrow £3,000 for additional plant at the electric lighting stations, and £2,500 for extension of the mains.

BURTON-ON-TRENT.—In moving the Gas and Electric Light Committee's report for the past year, Mr. Alderman Low informed the Town Council that the working of the electric light had resulted in a loss of £1,802. 9s. 3d. The consumption of gas had continued to increase, and it was decided to reduce the price from 3s. to 2s. 6d. per thousand.

CHELTENHAM.—The Chairman of the Electric Lighting Committee of the Corporation states that the electric light will be turned on by the contractors in the course of the present month, and that about the middle of April the station will be handed over to the Corporation.

COMMISSION OF SEWERS (LONDON, CITY).—At the last meeting of the Commission Mr. Berridge said that no report had been presented by the Committee who were considering the question of the use of the telephone tubes, because a delay had occurred owing to a doubt as to the legality of the Commission taking any part of the rental of the tubes. Reference was made to the report by Major Cardew on the subject of the presence of sodium in electric lighting mains, and Inspector Voysey said that in the City there were no bare metal conductors or hardware insulators, and, therefore, the question did not concern them.

THE COUNTY COUNCIL ELECTIONS.—Earl Russell, a candidate at the election on Saturday last for the London County Council, was returned at the head of the poll in the Newington West division. Mr. W. F. Bradshaw, secretary of Reuter's Telegram Company, has been returned a County Councillor for the West Wood Green division of the Middlesex County Council.

DERBY.—The report of the Electric Lighting Committee has been presented, in which it is stated that the total expenditure has reached £34,000, and liabilities have been undertaken for a further £9,000, or a total of £43,000, which is £8,000 in excess of the £35,000 originally granted. The additional expenditure is owing to the demand for electric current being largely in excess of the anticipated amount. It was originally thought that a period of about two years from the date of opening would elapse before the largest output capacity of the works would be reached, but this period arrived at the end of 15 months. In addition to the expenditure already made, Messrs. Bramwell and Harris, the consulting electrical engineers to the Corporation, recommend a further expenditure of about £5,000, and the Electric Lighting Committee therefore advise that powers to borrow £13,000 be applied for.

ECCLES.—With regard to the tenders now being asked for by the Corporation for an electric light installation plant at the sewage farm works and buildings, Dr. Smith, chairman of the Sanitary and Cleansing Committee of the Town Council, states that the necessary power for the installation will be provided at the farm, and that therefore the cost will not be great.

EDINBURGH.—At the meeting of the Town Council on Tuesday the following resolution was adopted:—"That, in view of the introduction of the electric light into the city, it be remitted to the Lord Provost's Committee to consider and report whether, and if so what, steps should be taken in the interests of public safety to secure that any faults in the gas mains and service pipes shall be detected and removed without delay, and to provide against any dangers likely to result from insufficient piping."

ELECTRICAL TESTING INSTRUMENTS.—In reference to a communication from Mr. R. W. Paul in our last issue, Messrs. Elliott Bros. write:—

> We notice a letter in your issue of 1st inst., under the above heading, evidently referring to our catalogue which you lately noticed. Our attention is particularly directed towards the last sentence of this letter, as to copying original designs of other makers. Mr. Paul has apparently forgotten the old saying advising people what not to do when living in glass houses. We have before us a list of his manufactures (List No. 5), in which we find but three illustrations besides those of the galvanometers he refers to. Two of these, Nos. 5 and 6, are practically copies of our original designs, and will be found in our catalogue of a quarter of a century ago; whilst the third, No. 4, bears a wonderful family likeness to an illustration given in a catalogue published many years ago by M. Carpentier, of Paris. For our own part we make no objection, believing imitation to be the sincerest form of flattery.

ELECTRO-CULTURE.—On Tuesday evening the members of the Wolverhampton Gardeners' Mutual Improvement Society listened to an interesting lecture upon "Electro-Culture," by Mr. G. W. Fairall. The lecturer stated that, so far back as ten years ago, he had made experiments upon lettuces, tomatoes, and other vegetables with the object of ascertaining the value of electricity as an agent in the cultivation of plant life. Although the results of his own experiments were eminently satisfactory, as also were those of other and more favoured investigators, it would be unwise to generalise too prematurely upon the value and extent of that form of assisted cultivation. His position with regard to electro-culture was one of hope for the future, although as yet sufficient data was not to hand to enable one to generalise with freedom.

ELECTRIC FIRE ALARMS.—A drunken compositor, named Gainsford, aged 25, was convicted at Clerkenwell (London) Police Court of breaking the glass of one of the street fire-alarms, and thereby making a false call. The fellow received a severe reprimand from the magistrate, and was fined £5, or in default a month's imprisonment. This exemplary sentence should serve as a severe warning.

FACTORIES AND WORKSHOPS BILL.—An important Bill was introduced into the House of Commons last week, entitled "The Factories and Workshops Bill." The Bill covers a wide area, and is intended to provide reasonable conditions of safety for life and health to all classes of workers. It is proposed that in all factories and workshops there should be a minimum of 250 cubic feet of space for each person, and 400 cubic feet for every person working overtime, with power to the Home Office to add to this minimum during hours when artificial light is used. Another clause extends to "young persons" the prohibition now existing against children cleaning machinery in motion. In all new factories where self-acting machines are used, no such machine shall be allowed to run out to within 18in. of any pillar or fixed structure. In the event of danger from fire, an inspector may apply to a summary court of jurisdiction to order movable fire escapes where workers, in the opinion of the court, are not sufficiently protected. An important clause refers to out-workers, and the Bill will provide for summary action in the event of work being given out to be done under insanitary conditions. This clause is expressly directed against what is not very comprehensibly described as "sweating." As to hours of working, the Bill prohibits the working of overtime by any person under 18 years of age. Docks, wharves and quays are to be brought under the supervision of the Act, as are also what are known as tenement factories, the owner in this case being made responsible under the Act. In a clause dealing with dangerous trades the Bill gives power to the Home Secretary to make rules limiting the period of, or prohibiting employment in lead, arsenic, and many other trades not included under existing enactments. The Bill is considered non-contentious, and, with small modifications in Committee, is expected to pass. It will have a serious effect upon many trades in the country, especially the printing, textile, and fancy trades.

FAREHAM.—In regard to the decision of the District Council to rescind the arrangement come to by its predecessor in the matter of the purchase of the Fareham Electric Lighting Company's undertaking, the Directors of the Company have taken legal advice, and threaten to bring proceedings against the Board for the carrying out of the arrangement come to. The Company are further advised that the action of the Council leaves them under no obligation to carry out the conditions of the arrangement previously existing, The action of the Council in the matter will be settled at the meeting this (Friday) evening.

HUDDERSFIELD.—The Corporation are about to open, in the central part of this town, a showroom for the purpose of exhibiting electrical appliances, and firms desirous of exhibiting their special apparatus or machinery should apply to Mr. A. B Mountain, Borough Electrical Engineer, St. Andrew's-road, Huddersfield.

HULL.—An important statement was made by Mr. Holder, the Chairman of the Electric Lighting Committee, at the last meeting of the Corporation, when the accounts of the Electric Lighting Department for the past year were presented. Mr. Holder considers that in every particular the accounts are satisfactory, and in moving their adoption, said that there was a profit balance shown of £1,053. 1s 3d. The accounts having been adopted, a report was presented by the Borough Engineer (Mr. A. H. Gibbings) as to estimated receipts and expenditure for the coming year. Expenditure is put down at £5,100, and sale of current (at the reduced figure of 6d. per unit) was estimated at £5,577. 10s., added to meter rents, £195. 12s., a total of £5,770. 2s., leaving a credit balance of £632, notwithstanding the reduction in the price of current of ½d. per unit, which represents a sum of £465 to the benefit of the consumer. The electrical engineer's statement was supplemented by one from the Chairman of the Committee, in which Mr. Holder stated that in regard to the efficiency of their electric lighting station the place it holds in the estimation of the electrical profession was an acknowledgment of its success. With their total works and management costs of 2·8849d. per unit, they would compare favourably with any station of equal output in Great Britain. This economy was not procured either by cheap labour, material, or want of provision for future advancement. They could not expect to come out at coal cost as cheap as Newcastle; but even in this item they compared well with other stations. Their unit production cost had for the past year been reduced over 50 per cent., and they were thus enabled to pay all charges, a twenty-fifth part of the sinking fund, and still show a handsome profit. The following statement of facts was the best evidence of past success and promise of future progress:—

	Year 1894.	Year 1893.
Engines	860 H.P.	560 H.P.
Dynamos	4,200 amperes	2,600 amperes
Condensers	560 H.P.	—
Battery	920 amp. hours	920 amp. hours
Street conduits	5¼ miles	2¼ miles
Cables laid	21½ miles	9¾ miles
Lamps attached	14,208 8 c.p.	8,035 - 8 c.p.
Units delivered	163,357	74,600
Users	271	148
Price per unit	6½d. lighting 5½d. places of worship 5d. power	7d. for lighting 6d. for power
Expenditure	£39,031 13 9	£22,818
Income	£4,948 0 11	£2,462

With regard to the question of the reduction in the price per unit. This, of course, must be founded partly on their last year's profits, and with some relation to the estimated expenditure for the coming year. These latter would require to be larger, as their plant needed extension, and, of course, their machinery got year by year the worse for wear. This required that provision should be made for increased up-keep charges, but the success of their past year's working justified them in reducing the charge for current. It had been estimated than an increase of 63,100 units would be added to their last year's output, which seemed a reasonable estimate. Adding this to what had been disposed of for the year, a reduction of ½d. per unit, left them, according to calculations made, with a surplus of £632. A reduction of 1d. per unit (that is to 5½d.) would leave them a margin of £167. They had already been approached by one of the largest hotel companies in Hull for a supply of electric current, and the Committee, therefore, proposed to offer current at 5½d. per unit, instead of 6½d. as at present charged, leaving the charges for places of worship and power as at present. An objection had been made that if the area of electric supply is afterwards extended, consumers in the outlying districts would expect to be supplied with current at the same rate as that within the present area. That, however, would not be possible, as a considerable initial expenditure would have to be incurred, which must first of all be reduced by sinking-fund charges. The Committee proposed that the Corporation should supply the current at the lower charge of 5½d. per unit, commencing with the quarter for September. A discussion followed, and the report was adopted, with an amendment that the reduction should take place from July 1st next.

INDIA.—The Bill providing for the electric lighting of the streets in the Presidency towns of Calcutta, Madras, Bombay and Rangoon, will, it is stated, not be passed until quite the end of the year.

INDIAN TELEGRAPHS. As the Secretary for India has decided against the extension of the period of service of Mr. W. R. Brooke, C.I.E., Director-General of Indian Telegraphs, the post is now vacant. Mr. Brooke's successor is Mr. C. H. Reynolds, Deputy-Director-General. Mr. Brookes has served the Indian Telegraph Department for over 37 years.

ISLINGTON (LONDON, N.). On March 1st the Islington Vestry received a report from the Electric Lighting Committee, stating that, having considered a report from the electrical engineer (Mr. Albert Gay), calling attention to the fact that electric lighting enterprise is being prejudiced by the explosions of gas occurring from time to time in electrical conduits, and to the possible danger to life resulting from such explosions, it recommends that a memorial be presented to the Board of Trade urging that steps should be taken by legislation or otherwise to obtain greater control over the gas companies as regards any escape of gas from their mains, and that a copy of such memorial be forwarded to the other metropolitan vestries and district boards, and to the several metropolitan electric lighting authorities, with a request that they will make similar representations.

KENDAL —It has been decided by the Town Council to oppose the Windermere Company's application for a Provisional Order, the Council having decided to themselves supply electric current "as the demand for it develops." Mr. Deacon has been requested to prepare plans and specifications "so as to make provision for pipes of sufficient size and strength to render the power available for generating electricity, if the Corporation should so determine." The result of a circular-canvas of probable users of the electric light has been the receipt of 64 promises and 254 negatives.

KENSINGTON (LONDON, S.W.).—The Vestry agreed to an application from the Notting Hill Company to extend their mains to Holland Park, the conditions being that the plans be approved by the Vestry's surveyor and the lighting engineer, and the works carried out under their supervision and to their satisfaction. The works are to be completed within three months, and the boxes are to be "sufficiently protected against accumulation of gas and water." Similar sanction was given to a proposal from the House-to-House Company to extend their mains in Kensington High-street and some of the adjoining thoroughfares.

LECTURE.—Mr. A. P. Trotter's third lecture to the pupils and staff of Messrs. Crompton and Co., at Chelmsford, on Monday last concluded the subject of "Royal Roads to Calculation." Sixteen different examples of slide rules—straight, circular, cylindrical, gridiron, and compound—were shown, and the use of the ordinary rule was demonstrated by a slide rule 10ft. long. Slide rules were lent for exhibition by Messrs. Elliott Bros., Mr. J. Mactear, Mr. Ravenshaw, and others. Mr. Trotter's last lecture will be on "Photometry of Candle-Power and of Illumination."

LEEDS.—Mr. W. S. Graff Baker has found it necessary, in connection with the Leeds tramways, to again confute the statement that the overhead electric system precludes the possibility of outside seats on tramcars. In Mr. Hewson's report to the Corporation on the tramway subject, as the City Engineer he recommends a quicker service of cars, and makes a comparison of cost between the system now in use and the electric system. For the former, he arrives at the figure of £265,884, and for the overhead electric system £378,499. The annual cost of working the two systems on an improved 7½-minute service he estimates at £117,292 for the present system, and £90,072 for the electric system, an estimated saving of over £27,000. A third set of figures, prepared by Mr. Hewson, referred to the cable system, and here again the figures, both for capital and annual charges, are greatly in excess of those set out for electric traction. In addition, the cable system could only be adopted on the condition that it is extended to the whole of the tramways. Therefore, the proposal that the working of the tramways in the central district should be by cable, and those of the outskirts by electricity, is declared by Mr. Hewson to be impracticable with an improved and much more rapid service, and taking into account the improvements likely to be introduced in the overhead electric service, Mr. Hewson favours electricity as being certainly the cheapest and the best for the use of the city of Leeds. A lengthy communication has been sent by Mr. R. W. Blackwell to the *Leeds Mercury* on the subject of tramway haulage for Leeds, in which the advantages of the electric system are dealt with.

LIVERPOOL. At a meeting of the Special Lighting Committee of the City Council, held on Tuesday, the terms upon which the Liverpool Electric Supply Company are prepared to transfer their undertaking to the Corporation were discussed. Although the negotiations have been in progress for several weeks this is the first meeting at which the Committee have discussed the terms and conditions referred to. It is understood that the Company have offered to sell the undertaking to the Corporation for a sum approaching £500,000, payable in instalments. The subject was to have been discussed at the meeting of the City Council, on Wednesday, but was not reached at the time of a "count out" being effected.

MONMOUTH.—The Town Council, on Monday, after discussing the plans and conditions for a combined scheme of drainage and electric light prepared by Messrs. Bramwell and Harris and Mr. Lailey, also considered a proposal by Messrs. Bramwell and Harris to take over the work scheme of drainage and electric lighting, and to carry out the whole at the original cost of £18,000. It was decided to accept the offer, subject to the approval of the Local Government Board.

"Noiseless" Lamps.—In the City of London Court, on Tuesday, an action was brought by Mr. D. F. Adamson, of Finsbury-pavement, London, E.C., to recover £7. 14s., the price of an arc lamp supplied to Messrs. Horne Bros. The defence set up was that the plaintiff agreed to supply a noiseless lamp; but the plaintiff's solicitor explained that it was impossible to supply such a lamp, as no arc lamp could be perfectly noiseless. Mr. Commissioner Kerr pointed out that this was what the plaintiff agreed to do, and therefore he must give a verdict for the defendants with costs.

Pontypool.—At the last meeting of the District Council the report of the Committee appointed to negotiate for the electric light company's undertaking was adopted.

Presentation.—Mr. Harold W. Kolle, who has resigned his position as head of the staff of Messrs. S. Z. de Ferranti, (Limited), to take an important engagement with the Babcock and Wilcox Company, was presented with a handsome silver salver by the Directors and employés of his late firm "as a mark of the esteem and respect in which he has been held by them during the last seven years." The presentation was made by Mr. Ferranti, who expressed the great regret of all concerned at losing Mr. Kolle, and their united wishes for his success and prosperity in his new work. Mr. Kolle joined the original Ferranti Company in 1883, and was manager of the Eastbourne Electric Lighting Company from 1885 to 1888. Since rejoining Mr. Ferranti in 1888 Mr. Kolle has had a varied experience at the Grosvenor and Deptford stations of the London Electric Company, and in the central station and general engineering work of the firm.

Printing Office Lighting.—The new printing works of the Geraldine Press in Whitefriars-street, Fleet-street, London, and the block of offices occupied by *Answers*, have been lighted throughout by electricity, Mr. E. R. Dolby acting as consulting engineer. A compound-wound direct-current Crompton dynamo, driven direct by a Belliss engine, supplies current for about 270 lamps. The lighting is extended to the rotary machines, very considerably facilitating the work. It frequently happens in printing that the easy manipulation of a light in a required spot will save considerable time, especially in rotary working, and this has proved to be the case in the installation under review. The wiring has been carried out by the Electrical and General Engineering Company under Mr. Dolby's supervision.

Rhondda Valley.—At a meeting of the Ystradyfodwg District Council a deputation from the Rhondda Valley Chamber of Trade presented a proposal to light the public buildings and streets of the district by electricity. One member of the deputation complained that they were being very badly treated by the local gas company. He had been charged for two quarters' gas, although not a match had been struck. The deputation said that the Chamber had decided to offer a premium of £50 for a scheme to light the valley by electricity, but before doing so approached the Council with a view to their taking further steps. Gas in this district is 4s. 3d. per thousand. The Chairman of the Council assured the deputation that investigation was proceeding, and that they might rely upon the Board making every effort to supply them with electric light if their scheme was successful. The Council's meeting concluded with an instruction to the Clerk to make complaint to the gas company of the "wretched quality of the gas."

Sunderland.—The public electric lighting was formally inaugurated on Wednesday evening by the Mayor. About 20 installations are now completed.

The Telephone Agitation.—At a meeting of the Greenock Town Council, on Tuesday, a motion that the Town Council be recommended to support the Corporation of Glasgow in their representation that the Government should assume the working of the telephones, and, if the Government are not prepared to do this, that municipal authorities should, in all cases where they are willing to undertake the duty, obtain from the Government the necessary licences to supply telephonic communication in the areas under their charge, was negatived in favour of a motion that telephonic communication throughout the country should be left to the administration of the national authorities.

Worcester.—The City Council, in considering the report of the Electricity Committee, endorsed the severe criticisms of the Committee upon the charge of about £5,000 for extras upon the construction of the generating station at Powick. In reply to the complaint that the City Engineer had not consulted the Committee on the subject, Mr. Caink pointed out that his certificate was in the nature of an award, and that it would have been improper and irregular to have informed either of the contracting parties before the certificates were signed which bound them both.

COMPANIES' MEETINGS AND REPORTS.

Chelsea Electricity Supply Company (Limited).

The annual ordinary general meeting of this Company was held at their central station, Draycott-place, Chelsea, on Tuesday, under the presidency of Mr. J. Irving Courtenay.

The SECRETARY (Mr. S. J. Cluer) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, you have all had before you copies of the Directors' report and the audited accounts for 1894, and I will therefore presume that they may be taken as read. I will now touch upon the principal features, and give any further elucidation of them that may be necessary. I think that any difference which exists between the accounts for 1893 and those for 1894 is a matter on which the shareholders are to be congratulated. On the accounts for 1893 a dividend of 5 per cent. was paid to the ordinary shareholders; we had then no Preference capital. As a result of the business done in 1894 we recommend a dividend of 6 per cent. on the Preference capital, and 5 per cent. on the Ordinary. But we have also taken care to consolidate the position of the Company by placing £1,500 of the profits to the renewals and depreciation fund, and extinguishing the preliminary expense account by writing off £2,174. 3s. This result has been attained partly by a reduction on all the items of expenditure relating to the manufacture of the electricity; it is also partly due to increased volume of business. Although we have had to pay a larger price per ton for coal (an average of 9 per cent. higher than in 1893), the coal used to produce each unit comes out at a lower cost; wages, stores, and maintenance are also less. This is very satisfactory, and we are sanguine of making further improvement in that direction; much credit is due to the managing engineer, Mr. Frank King, and also to our resident engineer, Mr. Percy Still, who has ably seconded him, for the persevering manner in which they have continuously and successfully worked, and are still working, at the problem of economy in production. The capital expenditure in 1894 has amounted to a little over £20,000, and the heads under which this has occurred are clearly set out in the Board of Trade form. The building operations (£2,425) have taken place chiefly in such improvements in Cheyne-walk station as will enable us to take advantage of the best arrangement of the machinery, and in the construction of a new and commodious sub-station in Pavilion-road capable of meeting the rapidly-growing demand of the northern part of our area. The generating plant purchased and fixed (£9,186) has been mainly for the further equipment of the Cheyne-walk station. This plant is now in full work, and the advantages of having the latest improvements both in the design and in the arrangement of the plant will be beneficially felt during the current year. The item of accumulators and transformers (£3.018) is for the equipment of accumulators at Cheyne-walk and of accumulators and continuous-current transformers at Pavilion-road sub-station. We have found the accumulators to be not only of value in maintaining a steady and unflickering light, but also productive of economy by reason of their being able to supply small or sudden demands, and thus obviating the wasteful working of the engines at a light load. The amount of £4,979 for mains is for extensions arising out of the increased demand. The mains laid are capable of taking a supply for a large number of lamps with little or no additional expenditure; and as the erection of new buildings as leases fall in is likely to continue, we may hope for a larger return on the capital already spent. There is no question that an important element to be considered when estimating in any given residential district the probable annual increase of lamps is: What is the amount of rebuilding actually in progress or in view? No company has better prospects in this respect than the Chelsea, as in no part of the metropolis are more important alterations and improvements in progress than in its district, while the houses are mostly wired when building. The capital expenditure per lamp (£2. 9s. 4d.) fixed is, I think, as low as that of any other company in the metropolis, and what I have just mentioned points rather to our retaining that advantage. During the year, as I have said, the re-organisation and re-equipment of the generating station at Cheyne-walk have been steadily proceeded with. A substantial brick chimney shaft, sufficient for all the requirements of this station, has been completed. Five boilers, having a capacity for supplying steam for about 10,000 lamps, have been erected and are ready for work. There are also installed and in working order six engines and dynamos, having a total generating capacity of 200,000 watts. A storage battery, forming an efficient stand-by, and enabling the machinery to be shut down about sixteen hours a day, is also installed. The premises at Cheyne-walk will be able to contain plant sufficient, when fully equipped, to supply the needs of 50,000 or 60,000 lamps. The new Pavilion-road sub-station has a battery capable of discharging at 60,000 watts, and will have, when fully equipped, continuous-current transformer capacity for about 3,000 amperes. It will then be, I believe, the largest continuous-current transformer station in existence. I think it is worthy of remark that these continuous-current transformers were originally introduced into the practical work of public electricity supply by this Company, and they were manufactured by the Electric Construction Company. Their working has given absolute satisfaction, the cost of repairs being very slight. Draycott-place station is fully occupied and continues to work satisfactorily. With respect to the mains, during the year Callender-Webber cases have been laid for a distance of over 4,250 yards, and have a capacity for accommodating nearly 20,000 yards of conductor, the cable actually drawn in being over 17,000 yards in length. Before moving the adoption of the report and accounts, I have a few words to say on the matter which forms the second portion of our business to-day, namely, the resolution to authorise an extension of our borrowing powers. In the early days, before the operations of the Company were of sufficient magnitude to command financial success, and at a time when the public looked with some distrust at what was then an entirely new field of enterprise, we had to obtain capital on somewhat onerous terms. The debentures then issued carried interest at 6 per cent., and it was not an easy matter to place them even at that rate. £30,000 was, however, obtained on First Mortgage Debentures, and these fall due in September this year. A short time afterwards a further small issue of £6,900 Second Debentures was made, this latter class being redeemable at six months' notice. I am glad to say that the present condition of the electric lighting industry, and our own vastly improved position, enables us now to obtain capital on more reasonable terms. I now move—

"That the report of the Directors and statement of accounts for the year 1894, now before the meeting, be, and they are hereby, adopted, and the payment of a dividend of 6 per cent. on the Preference share capital and of 5 per cent. on the Ordinary share capital, for the year 1894, be, and is hereby, approved payable forthwith."

The DEPUTY-CHAIRMAN (Major-General Webber, C.B.): It is my pleasure to second the resolution which the Chairman has just laid before the meeting, and I would ask the gentlemen present to allow me to supplement what he has said by a few remarks. As regards the new transformer station which has been established during the year in Pavilion-road, Mr. Courtenay did not tell you that not only will it be the largest station of that kind in existence, but that it is two or three times the size of the former one there, which up to that time had fully supplied the wants of that neighbourhood. Owing, however, to the extreme demands on us at the north end of our district, it was imperatively necessary to construct this larger station. There is a point which Mr. Courtenay did not tell you about, although I think it is a very important one—I refer to the discussions which are always arising regarding the relative merits of the alternating and continuous-current systems. The Chelsea Company's is the continuous-current system, and here we have all the advantages of the alternating system in one sense —that our transformer station is more than a mile distant from the generating point. The cables for conducting high-tension continuous current are far less expensive than those used for conducting high-tension alternating current a corresponding distance, and in these respects we are quite on a level with all the advantages of the alternating system, while we have also the great advantage—which they, too, could have, but not without great expense—of the power of storing electricity at our transformer stations, and thus relieving our generating plant during daylight hours, when it is most convenient and economical to do so. We may also congratulate ourselves—although we must not boast so as to let you imagine that we are quite out of the wood—on an absence of any of those serious explosions that have taken place in the streets of London. The investigation going on as to their cause has shown it was shown at a meeting yesterday of very scientific men who consulted on the subject—that these explosions may arise out of spontaneous combustion of metallic sodium, which comes into existence in the street boxes through the electrolytic action caused by some leak in the cables passing through the chlorate of sodium that exists, and is supposed to exude from surrounding brickwork, or from the surroundings of the cables. In our case their surroundings are made of casing of bitumen concrete, which contains no chlorate of sodium, and although we have bricks in our boxes, it is very probable that any of those substances that would cause spontaneous combustion would not approach the conductors. There is no doubt that gas is the first offender, but whether its ignition arises from the cause already mentioned, or from a spark in the electricity, is not yet certain. I may say that we are on excellent terms with our neighbours, the Gas Company, in this district. Whenever there is an escape of gas I am told by Mr. Still that they take due precautions to allay it, and, moreover, the Chairman of the Gas Company, Colonel Makins, often assures me that so far from being a cause of loss to their revenue, we are a cause of saving and an increase to it. I have nothing more to say, but to second the proposal which has been laid before you by our Chairman.

The CHAIRMAN, in answer to Mr. Andrew, stated that they had not heard of any lamp having been given up after it had been used. They had no complaints from their employés. He then put the motion, which was unanimously agreed to.

The retiring Directors—Major-Gen. Webber and Mr. George N. Marten —were re-elected, great regret being incidentally expressed, both by the Chairman and Mr. Marten, at the death of Sir George R. Prescott, and the loss which the Company had thus sustained.

The auditors, Messrs. Cooper Brothers and Co., were also re-elected.

The CHAIRMAN then proposed the following resolution:—

"That the power to borrow or raise money, conferred on the Directors by Clause 43 of the Company's Articles of Association, be extended so that they may be at liberty to borrow or raise money to such an extent as they may from time to time think expedient, provided that the amount at any one time owing in respect of money so borrowed or raised shall not, without the sanction of a General Meeting of the Company, exceed the amount of the subscribed capital for the time being and from time to time of the Company."

He said: The necessity for this resolution is stated in the Directors' report. The Company has to make provision for the debentures falling due in September, and it is most desirable not to have two classes of debentures, especially when the amount outstanding of the Second Debentures £6,900 is so small. It is, therefore, our intention to call in and pay off this amount. Further capital as I have previously pointed out, is required to meet the growing demand in our district for electric light, and we have to look ahead and put the Company in a position to deal with the demand as it arises to the best advantage. The present issue will be £60,000 of Four and a Half Debenture Stock at the price of £103 per cent., and so well is it thought of, that practically one half of the total amount it is now intended to issue has been already applied for.

The DEPUTY CHAIRMAN seconded the motion, and expressed his belief that the proposal was entirely in the interests of the Company.

The resolution was unanimously agreed to.

On the motion of Sir D. COOPER, seconded by Mr. ANDREW, a cordial vote of thanks was passed to the Chairman, Directors, and officers of the Company, and the proceedings then terminated.

Cambridge Electric Supply Company (Limited).

The third annual general meeting of this Company was held at the offices, Thompson's-lane, Cambridge, last week. Mr. D. Munsey presided.

In moving the adoption of the report the CHAIRMAN said he would first call their attention to the capital which had been raised by shares. In the year 1893 they issued 2,775 shares, which gave them a capital of £22,200; last year they issued 807 shares, which added to their capital £6,456; and this year they had had applications for 450 shares, making their total share capital £32,256. With regard to their Debenture Stock, in 1893 it stood at £7,000, in 1894, £4,000, and to-day it was £400 only. They only owed £400 on Debenture Stock; they had a balance at the bank of £500, so practically they were £100 to the good. For the greater part of the past year they had paid only 4 per cent. interest on their Debenture Stock. Only one company in the Kingdom, as far as he knew, paid only 4 per cent. on Debenture Stock, and that was the St. James' and Pall Mall Company, London, all the others paying from 4½ to 6 per cent. The number of consumers of current had increased from 176 to 263, and the number of units sold had been about 44 per cent. more than in 1893, which had only cost an extra 5 per cent. in the working expenses. The number of lamps had increased about 29 per cent., and there was a good prospect of a further increase during the present year. The Directors were fully aware that the day load was very small, and they had decided to put down a small machine, and they anticipated a great saving, which would soon pay the extra expense they were put to and give them a very good return. They had also decided to put down a new boiler. That they felt to be necessary to carry on the work of the Company with safety and success. The Directors were glad they could see their way to advise the payment of a dividend of 2½ per cent.

A SHAREHOLDER asked whether the Directors proposed to have a reserve fund. He thought all electric light companies, as well as other companies, had a reserve fund.

The CHAIRMAN said they must bear in mind that theirs was a young company, and they thought from information they possessed that they would be able at the end of this year not only to declare a better dividend, but also to lay something by to form that fund.

The report having been adopted, the Hon. C. A. PARSONS (Managing Director) said they had just turned the corner and were commencing to make good profits. Looking at the state of their finances, he did not see up to the present they ought to put money by for reserve or for depreciation. All the machinery was new, and they thought they were justified in paying a dividend nearly equivalent to the earnings of the Company during the year. He proposed the payment of the 2½ per cent. dividend.

Dr. LATHAM seconded, and said he thought the Company was to be congratulated upon its success. The dividend might be small, but considering the age of the Company he thought it was a very good one.

The motion was agreed to, and the retiring Directors re-elected. £100 was voted for Directors' remuneration, and after a vote of thanks to the Directors and staff the proceedings terminated.

Hove Electric Lighting Company (Limited).

The third annual general meeting of this Company will take place at Cannon-street Hotel, London, E.C., on Tuesday next, at three o'clock, when the Directors' report will be presented. The statement of accounts accompanying the report shows that the total share capital paid up is £22,255, with £255 in arrear. The loan capital (comprising £10,000 of banker's loan and £12,500 debentures) amounts to £22,500. The revenue for the year shows a balance profit of £1,243. 0s. 5d., against £77. 5s. 8d. for 1893. The Company have sold 107,218 units of current for private lighting, and public lighting, rental of meters, &c., and installations have realised £339. 4s. 4d., against £214. 9s. 3d. for 1893.

The report states that the progress of the Company continues in every way satisfactory: the supply of current to consumers has been carried on without a single hitch; whilst the machinery, batteries, and mains supplied and laid by Messrs. Crompton and Co. have given perfect satisfaction to the Board during the whole year. The number of lamps attached to the Company's mains has increased from the equivalent of 6,915 8-c.p. lamps at the date of the last report to 16,473 at the present time, whilst the number of consumers has increased from 105 to 233. The sale of current per meter, which realised £1,265. 18s. 10d. during 1893, shows an increase to £3,508. 6s. 9d. for 1894. After deducting £563. 17s. 11d. for interest accrued on loans and debentures, a net balance to the credit of revenue account remains of £679. 2s. 6d., as compared with a corresponding figure of £1. 2s. 8d. at close of 1893. In dealing with the £680. 5s. 2d. thus available for division, the Directors propose to write off £73 from the suspense account, to declare a dividend for the year at the rate of 3 per cent. per annum upon the Ordinary shares of the Company (absorbing £594. 10s. 2d.), and to carry the balance, £12. 15s., forward. The Debentures offered to the public in March last were readily subscribed; but the shares were not so taken, and in consequence further capital is required to discharge the bankers' loan, and to meet the liabilities to the contractors and the cost of the additional machinery, which the Directors foresee will be required to supply the demand for current next autumn. The Directors invite subscriptions from the shareholders. Mr. John Wilkes has resigned his seat as a Director, and the Directors do not propose to fill up the vacancy. Mr. Harold A. Hoare retires by rotation, and offers himself for re-election, and Mr. Robert Payne, F.C.A., the auditor of the Company also offers himself for re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

GENERAL ELECTRIC TRAMWAYS COMPANY (LIMITED).—This Company was registered on February 28th, with a capital of £50,000, in £1 shares, to acquire tramways, tramway concessions, Acts of Parliament, or Provisional Orders for the construction of tramways or tramway plant, and in particular to acquire certain interests in tramways at Hartlepool and West Hartlepool, in the county of Durham, to construct tramways to be operated by electric, horse, steam, cable, or other power, to manufacture tramway plant and appurtenances, to convert tramways operated by one kind of power into tramways operated by some other power, to carry on the business of and dealers in machinery, materials, stores, appliances and apparatus of every description applicable for or in connection with the supply or use of electricity or magnetism for any purpose, and to generate, accumulate, distribute and supply electricity or electric, magnetic, or other force. The subscribers with one share share each are :—Sir Daniel Cooper, Bart., James W. Barclay, Philip F. Beachcroft, Sir Henry C. Mance, C.I.E., J. Irving Courtenay, James Pender, J.P., Alexander B. Blackburn, M.Inst.C.E. The first Directors are to be appointed by the signatories.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The annual return of this Company, made up to February 8th, has been filed. The nominal capital is £1,300,000, in £20 shares, and 60,710 of these have been taken up, and all have been issued as fully paid.

EUROPE AND AZORES TELEGRAPH COMPANY (LIMITED).—The annual return of this Company, made up to December 27th, has been filed. 16,700 shares have been taken up, out of a capital of £200,000 in £10 shares. Of these 5,568 have been issued as fully-paid to the Telegraph Construction and Maintenance Company (Limited). The full amount on the remainder of the shares (£111,320) has been paid.

JULIUS SAX AND CO. (LIMITED).—The annual return of this undertaking, made up to January 3rd, has been filed. The whole nominal capital of £20,000, in £10 shares, has been taken up, and, with the exception of seven shares, has been issued as fully paid. No amounts have been received in connection with the signatories' shares.

CITY NOTES.

BARCELONA TRAMWAYS COMPANY (LIMITED).—Under the presidency of Mr. E. M. Underdown, Q.C., a meeting of the shareholders in this Company was held at Winchester House, London, on Wednesday, at which the Chairman referred to the important question of the introduction of electricity to their lines of tramways. He referred to the paragraph in the Directors' report, which stated that the Directors having become aware of the advantages both to companies and the public to be derived from the substitution of electric for animal traction, are taking steps towards obtaining powers to adopt electricity as motive power, and during the intervening period before finally obtaining the necessary permission, he stated that the Directors were diligently inquiring into the respective merits of the various systems now in use. They had studied with great attention the electric system, had seen it at work on the Continent and in America, and were convinced that the adoption of electric traction would be of great advantage to them. At the same time, before finally deciding upon the matter, they had to take great care that the conditions under which they worked would not be made in any way onerous to them. They had between 17 and 18 miles of line at work, and if they could save anything like a large percentage in their working expenses they were quite safe in adopting the electric system. Such a saving in working expenses was not likely to require any serious modification of their fares, as these were most moderate. The Company have at present 800 mules, which are worked to their full power. The traffic receipts for the year 1894 were £70,087. The number of passengers carried was 17,392,276

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend of 3s. per share, equal to 6 per cent. per annum, for the quarter ended December 31st last. The transfer books of the Company will be closed from the 15th to the 21st instant inclusive.

BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend for the six months ended December 31st last, at the rate of 5 per cent. per annum on the Ordinary shares of the Company. Half-yearly interest is also declared on the Six per Cent. Preference shares of the Company. The dividends are payable on the 18th inst., and the transfer books of the Company will be closed till the morning of the 20th inst.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended March 3rd were £950, as against £934 in the corresponding period of 1894, being an increase of £19. The total receipts for the half-year amount to £8,940, as against £8,544 for the corresponding period of 1894, an increase of £396.

COMMERCIAL CABLE COMPANY.—At the annual meeting of this Company, held in New York on Tuesday, accounts were presented showing gross earnings in 1894 of $1,773,434, and working expenses of $762,995, being respectively $68,912 and $21,604 less than in the preceding year. After deducting the dividends paid, amounting to 7 per cent., $310,438 was carried to the reserve fund. The regular quarterly dividend of $1\frac{3}{4}$ per cent. is now declared, payable on the 1st prox. The transfer books will be closed from 2.30 p.m., 21st March to 2nd April.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of February are £4,000, as compared with £3,639 in the corresponding month of last year.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts for the month of February, 1895, amounted to £1,690, as against £1.698 in the corresponding period of last year.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of February, 1895, amounted to £34,213, and to £35,187 in the corresponding period of 1894.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the month of February, 1895, amounted to £62,342, as against £54,904 in the corresponding period last year, or an increase of £7,438.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).—The Directors of this Company announce the payment, on account of the dividend of the current year, at the rate of 5 per cent. per annum, less income tax, on the "A" shares of the Company, for the half-year ended December 31st last. This will work out as follows:—On the 89,261 Ordinary shares, £3 paid, 1s. 6d. per share; on the 5,000 shares, £5 paid, allotted to the Edison Electric Light Company (Limited), 2s. 6d. per share; on the 12,139 shares, £5 paid, allotted to the Swan United Electric Light Company (Limited), 2s. 6d. per share, less income tax. Dividend warrants will be issued on the 20th instant.

EVERSHED AND VIGNOLES (LIMITED).—We are asked to state, in connection with the recent formation of this Company, that letters of allotment and regret have been posted.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company for the month of February, 1895, amount to £21.200. In the corresponding months of 1893 and 1894, the amounts were £41,200 and £41,000 respectively. Total receipts from January 1 to February 28, 1895, £44.400.

HOBART ELECTRIC TRAMWAY COMPANY (LIMITED).—A meeting of the holders of the Second Mortgage Debentures of this Company will be held at College Hill Chambers, College Hill, London, E.C., on Wednesday, at 2:20 p.m., for the purpose of considering and passing a resolution authorising the Company to charge the property included in the Trust Deed, securing the First and Second Mortgage Debentures of the Company with £5.000, further Mortgage Debentures ranking with the present Second Mortgage. Previous to this meeting an extraordinary general meeting of the Company will be held at the same place, when the following resolution will be proposed :—"That inasmuch as the amounts of the £30,000 First Mortgage Debentures and the £15.000 Second Mortgage Debentures, issued by the Company, are together equal to the nominal amount of the share capital of the Company issued, the Directors be, and they are hereby, authorised pursuant to Article 194 of the Articles of Association of the Company, to create and issue £5,000 further Mortgage Debentures, ranking *pari passu* with the existing Second Mortgage Debentures of the Company, or subject thereto, and to the First Debentures of the Company, as the Directors think fit."

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 3rd inst. amounted to £934, against, in the corresponding week of last year, £635.

MERSEY RAILWAY COMPANY.—At a meeting of this Company, held on Wednesday, Mr. A. G. Kitching, who presided, said that from letters received by the Directors it was evident that there was a widespread belief that they had absolutely determined to employ electricity as motive power for their railway; but this was not so, as no decision had been come to in the matter. Some of the Directors were strongly in favour of this step being taken, and they had that day received a report from two eminent engineers on the subject. Personally, all he required was to be shown that their working expenses would be materially reduced by adopting electricity. A shareholder said it had always been the intention of the Company to run through trains with the great railways at each end of the tunnel—he understood that the adoption of electricity as their motive power would prevent this idea being carried out. The meeting was too busily engaged discussing questions of ways and means and the important decision of Mr. Justice Stirling as to the priority of the Company's Debenture stock to discuss the introduction of electricity. The question will doubtless have more attention given to it at an early date.

NORTHAMPTON ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual meeting of this Company was held last week, when Councillor W. Tomes (the Mayor) presided. A brief statement was made by the Chairman, and after the re-election of the retiring Directors, a resolution was passed for payment of a dividend on the Preference shares.

REDUCTION OF CAPITAL.—A petition has been presented to the High Court of Justice for confirming a resolution of the shareholders of the British Electro-Chemical Agency (Limited) for reducing the capital of the Company from £75,000 to £50,000. A list of the persons admitted to have been creditors of the Company on February 1st may be inspected at the offices of the Company, Queen-street Chambers, Queen-street, London, E.C., on payment of 1s. Messrs. Spreat and Bullivant, of 27, Nicholas-lane, E.C., are solicitors for the Company.

A. AND J. STEWART AND CLYDESDALE (LIMITED).—A dividend at the rate of $3\frac{1}{2}$ per cent. per annum for the half-year ended December 31st has been declared by the Directors of this Company, £10,000 being placed to depreciation, and £4,490 carried forward.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended March 1st, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,073.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the two weeks ended February 28th were £1,925, as compared with £2,333 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Feb. 27.		Price Wednesday, Mar. 6.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Mar. 6.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	14 0	Anglo-American	40	41	40	41	4 17 7	Jan., Apr., July, Oct.	..	..
£2,993,560	Stock	28 0	Do. Preferred	75½	76½	75½	76½	5 4 7	,, ,,	76½	75¾
£2,993,560	Stock	5/0	Do. Deferred	6½	6¾	6	6½	..	..	6½	6
£181,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 17 4	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	11¾	12¼	11¾	12¼	5 6 1	Mar., June, Oct., Dec.	12¼	11 15/16
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1903)	109	113	109	113	4 9 1	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	148	152	148	152	4 12 1	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	,, ,,	..	..
12,931	5	1/8	Direct Spanish (fully paid)	4	4½	4	4½	4 8 11	April and October ..	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9½	10	9½	10	5 0 0	,, ,,	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8½	9	8½	9	5 0 0	Jan., Apr., July, Oct.	9	..
400,000	10	2/6	Eastern	16¼	16½	16¼	16½	3 18 9	,, ,,	16½	16¼
70,000	10	6%	Do. 6 per Cent. Preference	17½	18	17½	18	3 6 8	,, ,,	17½	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	124	127	124	127	3 3 0	May and November	125½	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	108	105	108	4 13 0	February & August	..	..
250,000	10	2/6	Eastern Extension	17½	17¾	17½	17¾	4 0 8	Jan., Apr., July, Oct.	17¾	17½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	123	126	123	126	3 3 6	February & August	123½	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	107	104	107	4 13 11	January and July	106½	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	104	107	4 13 11	,, ,,	..	—
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106	109	106	109	3 13 7	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 4	May and November	..	..
180,227	10	1/6	Globe Telegraph and Trust	9⅝	9⅞	9½	10	4 10 0	Jan., Apr., July, Oct.	10	9⅞
180,042	10	6%	Do. 6 per Cent. Preference	16⅝	16⅞	16⅝	16⅞	3 11 3	,, ,,	16⅞	16⅝
150,000	10	5 0	Great Northern	22	22½	21¾	22¼	3 16 7	Jan., April, and July	21 15/16	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	106	109	104	107	4 13 6	March & September	106	..
17,000	25	12 6	Indo-European	53	55	53	55	4 10 11	May and November	54	53½
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures xd	105	109	105	109	5 10 1	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	105	108	3 14 5	..	..	—
11,839	8	4/0	Reuter's	3½	4½	4	5	..	April and October .	4 7/16	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	118	123	119	124	4 16 9	,, ,,	123	122
15,609	10	5/0	West African Telegraph	4	5	4	5	..	January and July	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.) xd	101	106	101	104	4 16 2	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	98	103	7 15 4	June and December	..	..
88,321	10	6d.	West India and Panama	1	1½	⅞	1⅜	..	..	1	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	5 6 8	May and November	11½	11
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 10 8	June and December	..	..
64,242	15	3/0	Western and Brazilian	10	10½	10¼	10¾	4 17 3	May and November	10¾	10 7/16
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	..	6 9/16	6⅜
33,129	7½	4/6	Do. 5 per Cent. Deferred	4	4½	4¼	4¾	..	..	..	—
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 14 10	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 14 10	,, ,,	..	—
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115	120	115	120	5 18 11	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.) xd	104	106	101	103	5 16 6	March & September	..	—
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	—	..	..	..
224,850	10/0	2⅞d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	—
171,504	£1	..	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	..	..
484,597	5	2/6	National xd	5¼	5¾	5¼	5½	..	June and December	5½	5¼
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref. xd	15½	16½	15	16	..	,, ,,	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid) xd	15	16	14½	15½	..	,, ,,	15	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref. xd	6	6½	5¾	6	..	—	5 15/16	5 11/16
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	104	106	3 6 0	January and July	105¼	104¼
58,000	5	1/0	United River Plate	1	2	1	2	..	,, ,,	..	—
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.) xd	86	91	85	90	5 9 11	,, ,,	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid) xd	13½	14½	13	14	3 11 5	—	13¾	13⅜
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid) xd	16¼	16¾	15	15½	3 17 5	..	15⅝	15 7/16
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2 6	Charing Cross and Strand Electricity Supply Corp. xd	5	5½	5	5½	3 17 9	—	5¼	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	—
8,322	£5	..	House-to-House Electric	..		..		—	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		—	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		—	January and July	..	—
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7¼	7¾	7 1/16	7 7/16	—	—	..	—
111,000	5	..	London Electric Supply	¼	½	¼	½	..	..	..	—
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	9¾	10¼	10¼	11¼	2 4 5	..	11	10¼
£150,000	Stock	4½%	* Do. 4½% Debs.	118	120	118	120	3 15 6	June and December	119¼	118
6,452	£10	2/0	Notting Hill Electric xd	7	7½	7¼	7¾	..	..	7½	7¼
19,980	£5	4 6	St. James and Pall Mall	7½	8	7½	8	..	..	7½	7⅜
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8½	9	3 17 9	..	..	..
59,900	5	..	Westminster Electric Supply (fully paid)	..		..		2 16 3	..	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅝	2⅞	2½	2¾	5 9 3	..	2 11/16	2 9/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2⅝	2¼	2½	4 11 5	.	2⅜	
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures xd	115	118	113	116	3 17 7	March & September	115½	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	3	3½	3	3½	—	January and July	..	..
12,139	5	..	Edison and Swan United	—		—		—	—	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		..	—	—	..
120,000	2	..	Electric Construction	½	¾	½	¾	..	—	..	..
12,845	2	2 9½	Do. 7 per Cent. Cumulative Pref.	1¼	1½	1¼	1¾	—	—	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1¼	1¼	1⅜	1½	..	—	..	..
20,000	5		Fowler-Waring Cables (fully paid)	⅞	1½	⅞	1½	—	—	1½	1 7/16
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works xd	23½	24½	23	24	5 5 4	February & August	23½	23
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1890	102	104	102	104	4 8 5	March & September	..	—
15,995	£10	..	International Okonite Ordinary	..		..		—	—	..	—
16,000	£10	..	Do. 8 per Cent. Preference	—		—		—	December and June	..	—
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid) xd	—	¼	—	⅜	..	..	..	..
37,350	12	3/0	Telegraph Construction and Maintenance	45	47	39	41	8 15 7	March and July	41½	39½
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 13 6	January and July .	..	..
37,611	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	—		—		..	—	..	..
41,098	£5	..	Do. Preference (fully paid)	..		—		..	—	..	..
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	10	11	10	11	4 10 11	..	10⅜	..
£30,000	10	..	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1½%	City and South London Railway xd	40	48	45	47	2 13 2	May and November	..	..
7,000	10	5%	Do. 5% Perpetual Preference xd	14	15	14	15	3 6 8	..	—	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	130	133	130	133	3 0 2	May and November	130¾	..
37,600	£10	2%	Liverpool Overhead Railway	8 1/16	8 11/16	8½	8⅝	2 6 4	..	—	—
6,295	10	5%	Do. 5% Preference	13	13½	13	13½	3 16 6	..	—	—
125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July ..	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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NOTES.

The names of the members who are to decide as to the adequacy or inadequacy of the telephone service of Great Britain and Ireland will be found in another column; it cannot be said that they inspire much confidence. The majority of this parliamentary jury have, at one time or the other, conspicuously shown not merely their ignorance of fundamental facts connected with telephony generally, but of those connected with the very case they were discoursing about. However, as we remarked last week, if the members of the Committee thereby learn the elements of telephony, this belated agitation will not have been in vain.

◆

Pursued by no less a personage than Her Gracious Majesty's Attorney-General, it is not perhaps surprising that the St. James's Company entered on Tuesday last into the following formidable undertaking. It was agreed that if, in the opinion of an engineer to be appointed by the Board of Trade, or by agreement, the works in Mason's-yard now caused, or should hereafter cause, any nuisance by vibration or noise, or by permitting to escape from the chimney shaft of the works black smoke, soot, ashes, or dust, or effluvia offensive and injurious to health, or by discharging into the sewers of the Vestry hot water or steam; the defendants would forthwith, at their own expense, make and execute all such works necessary for remedying the nuisance as the engineer should direct. Perhaps also the fact that the Carnaby-street station can alone almost take the entire load may have had something to do with this sudden surrender at discretion. No one who has not town nerves, and a residence in close proximity to a central station, should dogmatise overmuch on the reality, or otherwise, of the nuisance said to be caused by the working of a modern central station. At the same time, so far as own casual experience goes, so unobtrusive to nose, ear, and sight are most London generating stations, that *the* difficulty is to detect them. Whether the dead-set made against one or two stations is due to the peculiarly vibratory nature of the subsoil, to defects of design or mechanical engineering, or to the exceeding selectness of the surrounding householders, is a matter of some little doubt. One thing, at any rate, stands out clearly: that alternate-current stations, unless exceedingly "eccentric," have no special exemption from legal indictments. Deptford may after all justify its founders.

The long controversy upon "Labour-saving Apparatus as an Instrument of Education," which has been carried on in our Correspondence columns, receives a remarkable addition this week from the pen of M. Cornu, who may fitly be taken to represent French physical science. He begins by calling attention to the number of independent questions which have been successively raised during this discussion, and, if for no other reason, the time has now come when it must be brought to a close, and we hope that Prof. Ayrton will conclude it by a reply.

◆

Messrs. Doulton and Co.'s statement in our Correspondence columns last week, that experience with glass insulators in connection with bare copper mains has led to their use being discontinued, in certain instances, is confirmed by information which we have received in reply to inquiries from the Kensington and Knightsbridge Company; but the cause of the difficulty which has arisen is not at all clear. The positive and the middle conductor quickly dry off any dampness, and the insulation resistance of the glass insulators is good. But on the negative side this drying off does not occur, or occurs to so small an extent that where the concrete sweats, owing to moisture of the surrounding soil, or to other local conditions, the condensation which is facilitated, and perhaps to some extent induced, by the so-called hygroscopic nature of the surface of the glass, may exceed the dissipation; and it is found that low insulation results. This selective action is not, as we have already remarked, very clear. The sealing up of a fault on a telegraph cable is, of course, due to the formation of insoluble salts, but no corrosion worth mentioning is found in the present case. When the earthing of the middle conductor was advocated, some years ago, the reply by experienced engineers was: We can get good insulation on the positive and middle; they mend themselves up, but the negative *will* earth itself if it can, and won't mend. It seems possible that there may be a surface tension effect, as in the Lipmann electrometer, which causes the film of moisture near the positive to retract.

◆

A curious experiment of Lord Armstrong, which only awaits correlation to be admitted into some branch of electrical science, may be recalled in connection with glass insulators. Two glasses full of water are placed nearly touching, and a wetted cotton thread forms a connection. A powerful induction coil is arranged with a spark-gap, allowing only the "break" spark to pass. If the water is perfectly pure and clean it will rapidly travel across the thread connection *with* the current, while the thread will move in the opposite direction.

It is possible that the rapid rise of insulation resistance between two conductors, when supported on glass or stoneware or glazed pottery, is not due to electrolysis of the moisture, or to its dissipation by heat, so much as to this unexplained withdrawal from the positive, and that this increase of resistance may indeed be unaccompanied by any material rise of insulation between the negative and the earth. A very interesting Paper on stoneware for chemical purposes was read before the Society of Chemical Industry some years ago, and the author, whose name we forget, but who was of course a manufacturer, made some useful remarks upon practicable and impracticable forms and uses of stoneware. A good Paper on insulators—glass, stoneware, pottery, and the popular but sometimes very unsatisfactory white "china," commonly miscalled porcelain—would be very interesting. Cannot the Institution of Electrical Engineers beat up a competent author for such a Paper?

"Diamond," Sir Isaac Newton's little dog, won for itself undying notoriety in the annals of science, and shall not that Chicago nigger achieve not only notoriety but fame, who burned Prof. Ayrton's Chicago Paper on the electric arc, and thus induced Mrs. Ayrton to rewrite and amplify the lost work? Her extremely interesting and important articles started with numerous diagrams in which were embodied a large number of experimental results, and which were not only new and unexpected, but contain a vast amount of practical information. We remarked at the time that Mrs. Ayrton's comments on these curves were much too brief, and many of our readers, we are sure, are highly appreciating the completeness with which the work is being continued, though at the expense of time which would otherwise have been spent on further research. How much of the present articles are based upon the original Chicago Congress Paper, and how much upon recent confirmatory experiments which have been conducted since the articles began, the authoress herself would perhaps find it difficult to decide; but that is of small importance compared with the value of the whole. Many attempts have been made to illustrate the normal arc, and one well-known woodcut of French origin has been borrowed or copied into scores of books. This week we publish a large number of views of the arc under different conditions, some in outline and some from large sepia drawings, which, owing to the great difficulty of obtaining photographs, is the only way of securing any record of the features of the carbons and of the surrounding flames. No photograph that we have yet seen has succeeded in giving a fraction of the information that is apparent on these drawings. The only hope of securing a useful photograph would be to use a screen allowing only red light to pass; there would even then, probably, be too much light from the crater, and too little from the rest of the carbons, and the faint but highly interesting details of the arc would be lost. Some such spectroscopic arrangement as is used for photographing solar prominences might be feasible, but further optical difficulties would be introduced.

When we recently drew up a brief comparison between the initial cost of gasworks and that of electric light works, we did not seek to do so in any controversial spirit, nor with the intention of doing more than make a simple deduction from the data ready to our hand. We regret that Mr. Newbigging's pocket-book was not in our hand at the time; but our gas data were taken from an electrical pocket-book which had evidently originally obtained the information from that source. Mr. Newbigging has written to the *Journal of Gas Lighting* to complain that we have "exhibited a marked disingenuousness" in our comparison, inasmuch as we included "the cost of land, law, parliamentary and other expenditure" in the gas estimate. It is quite true that we did this thing; but our reason for doing so was that these items were also included in our electric light estimate. So far as we were able to ascertain, the comparisons were strictly on the same lines. However, we now have Mr. Newbigging's own statement that the mere cost of plant for manufacturing and distributing gas would amount to £490, exclusive of the items just referred to; so that we are still entitled to consider electric light works cheap as compared with gas works of equal capacity.

Power for "Nothing."—Over £220,000 has been expended in running the tunnel which forms the tail race of the Niagara Falls Power Company's turbine station.

Electrical Bills in Parliament.—The North London Railway Company has withdrawn its opposition to the London, Walthamstow, and Epping Forest Railway Bill.

British Association.—The Council of the British Association have resolved to nominate Sir Joseph Lister, For. Sec. R.S., president for the annual meeting, which will be held at Liverpool in 1896.

"John Forrest" Lecture.—Prof. W. C. Unwin will deliver the "John Forrest" Lecture on Thursday, May 2nd, at the Institution of Civil Engineers. The lecture will be a complete monograph on "The Development of the Experimental Study of Heat Motors."

The Indo-Chinese Telegraph Line.—The Chinese Director-General of Telegraphs has arrived in Yunnan, and there seems every prospect of the Indian-Chinese telegraph lines being linked up by the end of March.

Royal Society Soirée.—The Council of the Royal Society have fixed Wednesday, May 1st, for the first Soirée of the session. The Ladies' Conversazione will be held on some convenient day in June, probably the 12th.

Electricity: An Unenumerated Article.—The Canadian Customs Department has decided that electricity generated on the American side of Niagara Falls, and conducted to the Canadian side, must pay a duty of 20 per cent. as an unenumerated article.

Electrical Wires.—A Bill has been introduced into the Missouri Senate requiring all electrical wires, except trolley wires, in cities of more than 200,000 inhabitants to be placed underground. It would be interesting to learn how many such "cities" there are in the State of Missouri.

Finsbury Technical College.—In consequence of the severe illness of Prof. Perry, his course of lectures at the Technical College, Finsbury, upon Reciprocating Machinery is postponed till after the Easter holidays. Mr. Miles Walker will give (on Thursdays) a short course of five lectures as an introduction to Vector Calculus.

Electrical Communication with Lighthouses.—It is impossible, says *The Times*, at present to state when the Earl of Mount-Edgcumbe's Commission on Electrical Communication with Lighthouses will finish their work, but it is scarcely probable that they will be able to do so before the close of the year.

The Telephone Committee.—The following names are proposed to form this Committee:—Capt. Bagot, Mr. Baird, Mr. Benn, Sir Charles Cameron, Mr. John Ellis, Sir James Ferguson, Sir Julian Goldsmid, Sir John Gorst, Mr. Grant Lawson, Mr. Solicitor-General, Mr. Arnold Morley, Mr. Moulton, Mr. Snape, Lord Stanley, and Mr. Tully.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
Constantinople—Odessa	Feb. 25, 1895.	Mar. 12, 1895.
Alexandria—Port Said	Mar. 2, 1895.	Mar. 13, 1895.
Latakia—Cyprus	Nov. 27, 1894.	—
Martinique—Paramaribo	Feb. 21, 1895.	—
Cadiz—Teneriffe	Feb. 23, 1895.	—
St. Louis—Noronha	Mar. 12, 1895.	—

United States Patents.—Mr. J. G. Lorrain writes us that it may interest our readers who apply for United States patents to know that on and after April 15th next the time for answering examiner's questions will be six months, instead of two years, as has formerly been the case. This change will prevent the repetition of cases in which patent applications have been kept from issue for many years, in order to prolong monopoly. This alteration in the United States rules of practice is a result of the Government suit against the American Bell Telephone Company, which was reported in our columns at the time.

The Sayers Armature.—On p. 569 of our last issue there was an obvious printer's error. Mr. Sayers' formula was written—

$$N = \frac{\text{Machine constant}}{1} \times 1{,}350{,}000.$$

It should have been—

$$N = \sqrt{\text{Machine constant}} \times 1{,}350{,}000.$$

The figure 1,350,000, we may add, represents what Mr. Sayers has been doing, but recent calculations show that it may with advantage be greatly reduced.

Units of Electrical Measurement.—An American technical, but non-electrical, contemporary has given publicity to the following "nice derangement of epitaphs":—"During the Electrical Congress held at the Chicago Exposition a committee was appointed to consider the establishment of a system of units of electrical measurement, and the work, in the main, was left with the German physicist, Helmholtz. His death delayed the conclusion of the work. Now the matter is in the hands of Prof. O. C. Marsh, of Yale, and he will forward his report to Washington." It would be an interesting exercise for our junior readers to enumerate the errors in the above paragraph.

Electric Car Speeds in Brooklyn.—An inquiry has been held by the United States Railroad Commissioners into the speeds at which electric cars are run in Brooklyn, about which complaints have been made. One speaker stated that he had frequently timed cars at 18 miles an hour, and an average of 57 cars timed showed a speed of 13½ miles per hour, the legal limit being 10 miles. The presidents of four roads declared that their schedules do not call for speeds in excess of the legal rate, but the employés are understood to claim that the schedules are cut so close that any detentions by frequent stops, &c., render it necessary to use high speed in order to keep time.

Ironless Mathematics.—"Much time and energy is expended, especially by mathematicians," says Mr. F. G. Baily, in a Paper recently read before the Northern Society of Electrical Engineers, "in elaborating hypothetical problems, the conditions being chosen to suit their method of analysis, and the desirability, and even the possibility, of realising those conditions being disregarded. This has been especially the case with alternating current problems. It seems a field so evidently made for mathematical treatment of an interesting nature, and so impossible to attack by any less rigid method of reasoning, that one almost feels called upon to give up the use of such an unreasonable material as soft iron, and even to abjure the use of most dielectrics, in order to rest in the security of an analytical demonstration."

Electric Heating and Cooking.—It is in a way satisfactory to find that electric heating and cooking has attained a sufficient vogue to warrant the drawing up by the Technical Adviser to the Phœnix Fire Office of a special set of rules and regulations. Generally speaking, the work is to be done to the satisfaction of the Technical Adviser, and the same general precautions are to be taken as are required in ordinary electric lighting work. Specifically we note that electric radiators are not to be heated to a higher temperature than any others; the radiators are to be fixed at a safe distance from woodwork and other combustible substances; no radiators are to be fixed in roofs; all radiators to be placed on fireproof insulators; floor sockets are deprecated; every socket to be so constructed that the contacts are automatically covered when the plug is removed, &c.

Portsmouth Telephone Troubles.—The Electric Light Committee has reported that the question of the alleged disturbance of the telephone service has been discussed with the representatives of the National Telephone Company, and it was arranged that certain experiments should be made by the Committee. As a result, the following report has been submitted by Mr. Dane Sinclair, the engineer of the latter Company:—"With reference to the disturbance on our wires, caused by the circuits of the arc lighting at Portsmouth, I have now the result of the test made on Saturday, and it proves conclusively that, if the Corporation so arrange their circuits as to balance the amount of work done by each conductor, the trouble caused to our subscribers will disappear; and as this means that it would only be necessary to put an equal number of lamps, arranged alternately, on each of the two conductors forming the cable, the work, in my opinion, ought to be done at comparatively little cost."

Electrical Exhibition at Karlsruhe.—In this Exhibition, which is to be opened in September, many of the principal electrical firms of Germany are to take part. Special importance is being given to small industries. Some 17,000 incandescent, and 450 arc lamps, are to be connected up for the opening; some 66 motors, with a total output of 306 H.P., will also be connected up. It is specially wished that motors used for a variety of purposes should be exhibited, and the following is a list of motor exhibits already announced by different trades:—

	Motors.	Total H.P.
(1) Military equipment, saddlery, &c.	4	10½
(2) Printing and lithographic establishments	9	61
(3) Joinery, upholstery, cabinet making	7	32½
(4) Machinery, locksmith and iron work	5	35
(5) Butcher and sausage making	4	11
(6) Colonial produce	7	11
(7) Copper and tin smiths	4	10½
(8) Turnery	2	5
(9) Miscellaneous	24	129½

Applications for programmes, &c., should be addressed to the Secretary, Gewerbevereins, 3, Friedrichsplatz, Karlsruhe.

The Dublin-Dalkey Electric Tramway.—Operations were commenced last Monday for the construction of the new electric tramway from Haddington Road, Dublin, to Dalkey. The works are to be constructed under the supervision of Mr. J. Clifton Robinson, electrical engineer and manager director of the company, and Mr. Mossop, who represents the contractors—the British Thomson-Houston Company. The estimated cost of the line is over £100,000. The first section, from Dublin to Blackrock, is three and a-half miles in length, and has at present a single line of rails, but will be double tracked throughout. The whole work is to be completed and the road ready for operation within three months. Ornamental steel standards will be erected on the kerbstones of the footpaths on both sides of the road, opposite to each other, and 24ft. above the ground level will be suspended the span wires. These standards will be placed at a distance of 125ft. apart along the whole line. Each car will be fitted with electric motors in duplicate. The line, when completed, will be worked with 20 motor cars, in addition to which there will be an equal number of "trailer" cars.

A Carbon-Consuming Battery.—The following communication, made by Mr. Carl Hering to the *Electrical World* of New York, may interest our readers:—

"In connection with the recent experiments of Dr. Borchers, which have been attracting so much attention, the following simple little experiment made in 1883 by Mr. von Dobrowolsky and myself, at the suggestion of the former, may be of interest, as it seems to show conclusively that a cell *can* readily be made in which the cold combustion of coal gas (or at least some constituent part of it) with atmospheric air will take place, yielding its energy in the form of an electric current. Two carbons, such as used in Leclanché cells, were carefully cleaned and platinised with platinum black; they were then placed in dilute sulphuric acid, and kept short-circuited for some time in order to discharge them, should there be anything different in the two causing a difference of potential. One was then placed in a jar containing ordinary illuminating gas from the street mains and the other was held in the air. After a while they were inserted in the dilute sulphuric acid, and connected to a crude galvanometer made of a small coil of wire around a pocket compass. The current obtained, when started and stopped at proper time intervals, caused the needle to spin around on its pivot with considerable speed. It may, therefore, be said that a motor, although only an infinitely small one, was run with the energy thus obtained. No further measurements were made, as it was considered to be of no practical interest, and as we had no suitable measuring instruments at the time. I believe that the problem of the conversion of the energy of coal into electrical energy, without the aid of that frightfully wasteful converter, the steam engine and boiler, will be solved first by some of the numerous possible indirect ways. If scientists and inventors would direct their attention to these, rather than to the direct methods, we would, I think, be relieved much sooner from the necessity of using the wasteful steam engine and boiler, which, although very useful in the absence of something better, must still be regarded as merely a temporary, unsatisfactory makeshift. The efficiency of the engine boiler converter is so very low that it will require but a very poor and inefficient electrical converter to relegate it to the museums."

French Provincial Central Stations.—Our esteemed contemporary *L'Industrie Electrique* has been good enough to digest its own central station table, recently published, and the results of this comforting process we give below. On January 1, 1895, the number of central stations at work in France *outside* Paris was 328, against 301 on January 1, 1894. Classified according to motive power the stations work out as follows:—

	No. of stations.	H.P.	Power %
Hydraulic	151	9,650	24·5
Hydraulic and steam	39	6,000	15·0
Steam	119	22,000	56·0
Producer gas	5	220	0·55
Town gas	14	1,550	3·95
	328	39,420	—

According to the system of electrical distribution the stations classify out as follows:—

	No. of stations.	H.P.	Power %
Continuous	260	27,895	70·75
Alternate	73	10,645	27·00
Polyphase	3	880	2·25
	336	39,420	—

The difference in the totals of 336 and 328 is due to the fact that eight stations are at once continuous-current and alternating-current stations. Out of the 328 stations 29 are worked by municipalities and 20 by gas companies. On New Year's day 34 stations were building, and 74 were projected. Although the number of the French provincial stations is large their capacity only averages 120 H.P.

The Srinagar-Gilgit Telegraph Line.—The telegraph line between Srinagar and Gilgit is now undergoing a severe ordeal, as the winter in Cashmere has been marked, says the *Times of India*, by tremendous snowstorms, some of which have lasted for six days on end. The wire has been broken in several places, but between the Burzil and Tragbal Passes are stationed two repairing parties, who sally out to make the necessary repairs whenever opportunity offers. These men are at Gurais and Minimerg, absolutely cut off from the outside world for several months; but they are comfortably housed, and the most has been done to make life bearable to them during their isolation. They are in touch by the wire only with their fellow-men, though now and again an adventurous postal runner appears to claim their hospitality. These runners have a dangerous duty to fulfil in crossing the passes, and one or two have already lost their lives by the fall of avalanches. The telegraph linemen have been fitted out with snow shoes, but they find that after a fall of snow 5ft. or 6ft. in depth they cannot move over the soft surface. The snow lies so lightly that they sink deeply into it, and they have to wait until it has "set" before making their inspections. The wire has stood well in spite of the exceptionally heavy storms, and communication is kept up in a really wonderful manner. It is, of course, impossible to guard against avalanches, but valuable experience is being gained as to the most dangerous parts of the route, and the wire can be relaid in the summer wherever breakages have shown that a new alignment is desirable. Gilgit must have its telegraph all the year round, and each winter brings us nearer the solution of the problem which Mr. Olphert and his staff have been grappling with during the past two years.

Sodium in Electric Conduits.—The Rev. H. Marchant, of Stonyhurst College, Blackburn, has kindly sent us a copy of the *Scientific American Supplement*, of August 31, 1889, which contains the following note, which is of some interest at the present moment:—

> A PECULIAR GROUND.—A short while ago an incident happened in connection with the Edison three-wire system under Boylston-street, Boston, which is interesting both to the electrician and the chemist. It was noticed that the horses were very uneasy and somewhat scared when passing over an area of, say, 10ft. square in the granite pavement of the street. An investigation by the Edison people seemed to show no trouble, and everything went right for ten days or more, when, during a rainstorm, the same action of the horses was noticed. Upon digging down to the wooden box which contained the three wires of the system, embedded in some kind of tar or bitumen compound, a spot was found where the box was eaten through, and a large mass of sticky stuff was found around the negative wire. The insulation of the wire was destroyed, and, as the neutral is dead grounded in the station, there was a leakage, causing a fall of potential in the earth about the leak which was sufficient to affect horses as well as men. The leak was a small one, and did not shown at the station. Chemical examination of the lump showed that it was originally concentrated lye, which had become partly converted into caustic soda by water, and that the action of the currents had, by electrolysis, formed a considerable quantity of metallic sodium throughout the mass. There was sodium enough present to make a fair display of fireworks when thrown into a pool of water, and it is fortunate the workmen did not get into trouble in handling it. My theory of the affair is this: In some way a piece of lye tumbled into the kettle in which the insulating compound was made, and was not noticed when the box was filled. In time surface water got at this lump, and converted a part into caustic soda, which destroyed the box and insulation of the wire (it only came in contact with one wire, the negative). The escaping current caused a difference of potential at the surface of the ground, which disturbed the horses. Metallic sodium was set free and would tend to collect at the negative wire. The voltage at the escape was in the neighbourhood of 105 volts, and it was estimated by the touch that there was over 50 volts within the space that a man could reach with both hands.

The above communication was originally made to the *Electrical World* of July 6th, by W. L. P.

The South African Cable Rates.—After protracted negotiations, we are able to announce that it has been finally arranged that in consideration of certain subsidies payable to the Telegraph Company, the tariffs between Europe on the one side and various places in South Africa, as well as to Zanzibar, on the other, will on and after April 1st next be reduced to the following figures:—

	Public.		Press.	
	s.	d.	s.	d.
Cape Colony, Cape Town	5	0	1	6
" Other places	5	2	1	6½
Natal, Durban	5	0	1	6
" Other places	5	2	1	6½
British South Africa Company	5	5	1	7¼
British Bechuanaland	5	2	1	6½
Orange Free State	5	2	1	6½
South African Republic	5	2	1	6½
Zanzibar	5	0	1	6

The negotiations have been carried on ever since last October, and we have no doubt that Sir John Pender, the Chairman of the Eastern and South African Telegraph Company, who has been acting for the various Telegraph Companies concerned, considers that he has been met in a fair and businesslike spirit by the representatives of the various Governments with whom he has been negotiating. It has always been Sir John Pender's policy to favour reduced rates for telegraphic messages wherever possible upon fair and equitable terms, and he considers that an important concession has been made by all concerned to the mercantile community by this reduction of the tariffs between Europe and South Africa. The following gentlemen represented the various Governments:—For the Imperial British Government, Mr. J. C. Lamb, C.B., C.M.G., Mr. Ardron; for the Colony Cape of Good Hope, Sir Chas. Mills, K.C.M.G., C.B., Mr. S. R. French; for the Colony of Natal, Mr. Walter Peace, C.M.G. The negotiations with the Transvaal have been carried on by Sir James Sivewright, K.C.M.G.

ELECTROMAGNETIC THEORY.—LXIV.*

BY OLIVER HEAVISIDE.

(Continued from page 357.)

§ 246. Let us now pass to some simple cases concerning effects produced at a distance. I remarked before that the solutions concerning the effects produced on the spot by an impressed force were the easiest to investigate. This is true when the constraint on the spot (or terminal condition) is not too complicated. But some cases of the effects produced at a distance are quite easily examined operationally, provided the terminal conditions are of the simplest kind.

Go back to § 240. To find V at x due to V_0 at $x=0$, we have the operational solution

$$V=\epsilon^{-qx}V_0. \tag{1}$$

This expands to

$$V=\left(1-qx+\frac{(qx)^2}{\lfloor\!\underline{2}}-\frac{(qx)^3}{\lfloor\!\underline{3}}+\ \dots\right)V_0$$
$$=(\cosh qx-\text{shin}\, qx)\,V_0. \tag{2}$$

Here we have even and odd powers of q, so there is nothing new in the way of operations. Taking $V_0=e$, constant, beginning when $t=0$, we may discard the even powers of q, and write

$$V=(1-\text{shin}\, qx)e$$
$$=e-\left(1+\frac{(qx)^2}{\lfloor\!\underline{3}}+\frac{(qx)^4}{\lfloor\!\underline{5}}+\ \dots\right)qxe, \tag{3}$$

and since this involves complete differentiations performed upon $q1$, which is known, the full algebraical result follows at once:—

$$\frac{V}{e}=1-\left(\frac{\text{RS}x^2}{\pi t}\right)^{\frac{1}{2}}\left\{1-\frac{1}{3}\left(\frac{\text{RS}x^2}{4t}\right)+\frac{1}{5\lfloor\!\underline{2}}\left(\frac{\text{RS}x^2}{4t}\right)^2-\ \dots\right\} \tag{4}$$

This is an exceedingly important formula in diffusion, both in itself and as the basis of other formulæ, so we may as well give some details about it.

If we differentiate to x we shall obtain the formula for the current. Thus

$$\frac{\text{RC}}{e}=\left(\frac{\text{RS}}{\pi t}\right)^{\frac{1}{2}}\left\{1-\left(\frac{\text{RS}x^2}{4t}\right)+\frac{1}{\lfloor\!\underline{2}}\left(\frac{\text{RS}x^2}{4t}\right)^2-\ \dots\right\} \tag{5}$$

Here we recognise the exponential formula, so we may write it finitely, thus,

$$\frac{\text{RC}}{e}=\left(\frac{\text{RS}}{\pi t}\right)^{\frac{1}{2}}\epsilon^{-\text{RS}x^2/4t}, \tag{6}$$

which is another important formula in diffusion.

We got (5) by differentiating (4) to x. But if we please we may get it in the same way from any of the previous operational forms. For example, from (3) we obtain

$$\text{RC}=\left(1+\frac{(qx)^2}{\lfloor\!\underline{2}}+\frac{(qx)^4}{\lfloor\!\underline{4}}+\ \dots\right)qe, \tag{7}$$

which gives rise to (5) or (6) on development.

Or we may start from the initial operational solution for C, viz.,

$$\text{RC}=\epsilon^{-qx}\text{RC}_0=\epsilon^{-qx}qe. \tag{8}$$

On expansion, this makes

$$\text{RC}=(\cosh qx-\text{shin}\, qx)qe. \tag{9}$$

In developing V we rejected the cosh function, excepting the constant term 1. But now we must reject the shin function, because (on account of the q factor) the even powers of q go with it. So we get

$$\text{RC}=\cosh qx\,.\,qe, \tag{9A}$$

which is equivalent to (7). I give these variations to let the reader see that the solutions do not arise by fortuitous accident, but that there is a consistent fitting together.

That these solutions for V and C are *the* solutions may be tested by their satisfying the necessary conditions: (1), the characteristic; (2), the terminal condition; (3), the time condition, that V and C are zero initially everywhere except at the origin. The last, however, is troublesome numerically, on account of the very slow convergence when t is small. But the functions are well known, so there is no need to be frightened.

The V/e formula (4), observe, is a function of $\text{RS}x^2/4t=y$, say. So we may write it

$$\frac{V}{e}=1-\frac{2}{\pi^{\frac{1}{2}}}\left\{y-\frac{y^3}{3}+\frac{y^5}{5\lfloor\!\underline{2}}-\frac{y^7}{7\lfloor\!\underline{3}}+\ \dots\right\}, \tag{10}$$

which is the same as

$$\frac{V}{e}=1-\frac{2}{\pi^{\frac{1}{2}}}\int_0^y\epsilon^{-y^2}dy \tag{11}$$
$$=1-\text{erf}\, y. \tag{12}$$

A comparison of (11) and (12) defines the function which is sometimes called the error function, and denoted by erf y. A pretty full table was given by De Morgan in the *Ency. Met.*, "Theory of Probabilities," going by steps of 0·01 from $y=0$ to 2. This table is reproduced by Lord Kelvin in his "Physical Papers," Vol. III., p. 434. But a much briefer table is all that is needed for general purposes, and for curve tracing, say with step 0·05. Perhaps even step 0·1 would be enough.

y.	erf y.	Δ.	y.	erf y.	Δ.
0·05	05637	5637	1·05	86243	1973
0·10	11246	5609	1·10	88020	1777
0·15	16799	5553	1·15	89612	1592
0·20	22270	5471	1·20	91031	1419
0·25	27632	5362	1·25	92290	1259
0·30	32862	5230	1·30	93400	1110
0·35	37938	5076	1·35	94376	976
0·40	42839	4901	1·40	95228	852
0·45	47548	4709	1·45	95969	741
0·50	52049	4501	1·50	96610	641
0·55	56332	4283	1·55	97162	552
0·60	60385	4053	1·60	97634	472
0·65	64202	3817	1·65	98037	403
0·70	67780	3578	1·70	98379	342
0·75	71115	3335	1·75	98667	288
0·80	74210	3095	1·80	98909	242
0·85	77066	2856	1·85	99111	202
0·90	79690	2624	1·90	99279	168
0·95	82089	2399	1·95	99417	138
1·00	84270	2181	2·00	99532	115

We see that the error function rises from 0 to 1, as y goes from 0 to ∞; but as it reaches 0·995 when $y=2$ only, the subsequent rise to the full 1 is very slow work. The values are very easily calculated by formula (10), and without great labour; but the table is useful for reference. The Δ column shows the differences or steps in erf y, corresponding to the equal steps 0·05 in y itself. They therefore serve to plot the curve of the derivative, that is, the curve of current, represented by formula (6), which may also be used directly.

In Fig. 1 is represented the way the potential (or the charge) extends itself into the cable when the potential at its beginning is raised to and maintained at a steady value. The abscissa is length from the beginning, and the ordinate is the potential. The curve 1 is got by making $\text{RS}=4t$, and varying x. Or if $t'=4t/\text{RS}$, then curve 1 represents the state of things when $t'=1$. We may use any unit of length we please, so that the base line may be 2 centim. or 2 kilom., or 2,000 kilom. if we like.

Now V/e is unchanged by altering x^2 in the same ratio as t'. So when $t'=4$ we have the same values as before with doubled values of x. This is shown by curve 4, representing the potential distribution when $t'=4$. Doubling x again for the same values of V/e, we get the curve 16, showing the potential when $t'=16$. Similarly, by halving x in the curve 1, we obtain the curve $\frac{1}{4}$, showing the potential when $t'=\frac{1}{4}$; and halving x again brings us to the curve $\frac{1}{16}$, showing the potential when $t'=\frac{1}{16}$. The initial potential curve is simply the vertical line $0V_0$ (up and down) and the base line 012. The final potential curve is the vertical $0V_0$ and the horizontal line V_0A.

We may imagine the curves to represent the shapes assumed by a rope resting initially on the base, when the end of it is lifted from 0 to V_0, there being enough friction or as little inertia as will stop oscillations. But the exact mechanical analogy before employed requires an elastic massless string, moving in a medium which resists its transverse motion with

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a force varying as its velocity. The string should be fixed at 0, and be initially along 012. Then a force applied close to the fixed end should stretch it (like a piece of "elastic") to V_0. The string will then move through the different forms shown.

On removing the impressed force, we have the shape given by $0V_0A$, and the shapes which follow are to be seen by inverting the diagram and looking at it from behind.

The curves of current may be got by plotting the Δ's in the table. When $t' = 1$, 4, and 16, we have the curves marked with these numbers in Fig. 2. It will be seen by (6) that by doubling x and quadrupling t we get a halved C. So curve 4 is got from curve 1 by halving the ordinates and doubling the abscissæ. Similarly as regards the other curves. The unnumbered one, with the top cut off, belongs to $t' = \frac{1}{4}$. These curves all bound the same area, that is, the area bounded by the curve and the vertical and horizontal axes is constant. In another form, the line-integral of the current is constant, the reason being that

$$V_0 - V = \int_0^x RC\,dx \qquad (13)$$

by Ohm's law, and $V = 0$ at $x = \infty$. That is, when we apply the impressed force we generate instantly a definite amount of magnetic momentum at the beginning of the cable, which then diffuses itself along the cable and attenuates to zero density without alteration of total amount. It is true that the magnetic momentum is zero in amount, because we have assumed $L = 0$ in the theory. But that is nothing in the way of the use of the idea of magnetic momentum, because we may suppose L to be finite, although so small that the diffusion law of propagation is followed practically.

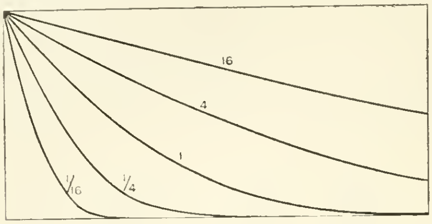

FIG. 1

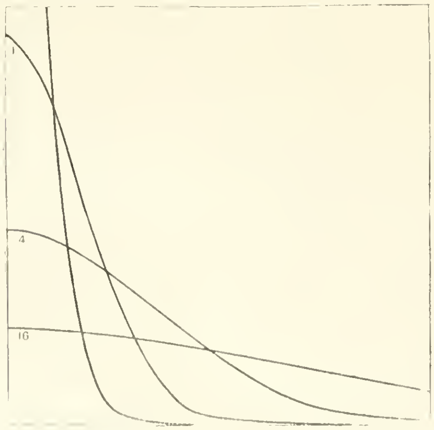

FIG. 2.

247. An exceedingly interesting and instructive case arises when the impressed force at the beginning of the cable, inserted between it and earth, is variable with the time in a certain way. For a purpose to be seen presently, let the impressed force be given by

$$e = Q\left(\frac{R}{S\pi t}\right)^{\frac{1}{2}}, \qquad (14)$$

where Q is a constant. Before $t = 0$ the cable is to be understood to be uncharged. The potential V_0 is raised to the value e, of course. It is the same as

$$V_0 = qQ/S, \qquad (15)$$

by (A), § 241.

Now find the current entering the cable due to the impressed force. By (5), § 240, it is

$$C_0 = \frac{q}{R}V_0 = \frac{q^2}{RS}Q = pQ, \qquad (16)$$

where the second equation arises by (15), and the third by the definition of q^2. Since Q is constant for any finite value of time, the result is zero. That is, there is no current entering the cable under the action of the continuously-present impressed force at any finite value of the time.

Is this nonsense? Is it an absurd result indicating the untrustworthy nature of the operational mathematics, or at least indicative of some modification of treatment being desirable? Not at all. It is the fact under the circumstances stated, and the principal remarkability is the instantaneous arrival at the result. For the above details concerning (14), (15), (16) are not wanted by an experienced worker; the operational solution $RC_0 = qV_0$ of § 240 being sufficient to show that if V_0 is $q1$, then C_0 vanishes.

We have to note that if Q is any function of the time, then pQ is its rate of increase. If, then, as in the present case, Q is zero before and constant after $t = 0$, pQ is zero except when $t = 0$. It is then infinite. But its total amount is Q. That is to say, $p1$ means a function of t which is wholly concentrated at the moment $t = 0$, of total amount 1. It is an impulsive function, so to speak. The idea of an impulse is well known in mechanics, and it is essentially the same here. Unlike the function $p^{\frac{1}{2}}1$, the function $p1$ does not involve appeal either to experiment or to generalised differentiation, but involves only the ordinary ideas of differentiation and integration pushed to their limit. Our result $C_0 = pQ$ therefore means that an impulsive current, that is a charge, is generated by the impressed force at the first moment of its application; that the amount of the charge is Q, and that there is no subsequent current. It is the same as saying that the charge Q is instantaneously given to the cable at its beginning, which charge then spreads itself.

Next work out the solutions for V and C anywhere in the cable. We have, by (15),

$$V = \epsilon^{-qx}V_0 = \epsilon^{-qx}q(Q/S). \qquad (17)$$

This was algebrized before, equations (8) and (6), so the result is

$$V = Q\left(\frac{R}{S\pi t}\right)^{\frac{1}{2}}\epsilon^{-RSx^2/4t}. \qquad (18)$$

By differentiation to x, the current is

$$C = -\frac{1}{R}\frac{dV}{dx} = \frac{Qx}{2t}\left(\frac{RS}{\pi t}\right)^{\frac{1}{2}}\epsilon^{-RSx^2/4t}. \qquad (19)$$

It will also be useful to obtain the current formula directly. We have, by (16),

$$C = \epsilon^{-qx}C_0 = \epsilon^{-qx}pQ. \qquad (20)$$

Here reject the even powers of q, and we get

$$C = -p\,\mathrm{shin}\,qx\,Q \qquad (21)$$

which expands to

$$C = -p\left(1 + \frac{(qx)^2}{\lfloor 3} + \frac{(qx)^4}{\lfloor 5} + \dots\right)qxQ \qquad (22)$$

involving only complete differentiations upon $q1$. Thus

$$C = -xQ\left(p + \frac{RSx^2p^2}{\lfloor 3} + \frac{(RSx^2)^2p^3}{\lfloor 5} + \dots\right)\left(\frac{RS}{\pi t}\right)^{\frac{1}{2}},$$

which leads directly to the formula (19) above or, rather, its full expansion.

We may also note that (20) or (21) gives C by a time differentiation upon the function $\epsilon^{-qx}1$, already obtained, (1) and (4) above. This again leads to the result (19).

That the previous special results for V_0 and C_0 are contained in the general formulæ for V and C anywhere is clear enough; that is, they make $V_0 = e$ and $C_0 = 0$ at $x = 0$. We have now only to explain why there is no current after the initial charge. It is for the same reason as why there is no current in the galvanometer in Poggendorff's way of comparing two battery voltages. If there be current in a network of conductors, and two points A and B thereof be joined through an external conductor, there will be a derived current in the new wire usually—that is, if there be any voltage between A and B due to the original arrangement. But if we introduce in the new wire an impressed voltage equal to and acting against the former voltage, there will be no current, and everything will be the same as if A and B remained insulated.

Applying this to the cable, we see that the impressed force in the above case is so artfully graduated in its strength as to be exactly equal to the potential at the beginning of the cable due to the charge Q when redistributing itself without terminal loss—that is to say, if we remove e and insulate the beginning of the cable, everything will go on as before. Of course, the removal must be done after its initial effect in charging the cable.

So, dismissing the impressed force altogether, we see that if we suddenly communicate a charge Q to the beginning of a cable, and then immediately insulate it, the potential and current which result will be given by (18) and (19) above. The potential (or the charge) redistributes itself in the same way as the current in the previous problem of a steady impressed force, that is, according to the curves in Fig. 2. It has been mentioned already that areas are conserved in that diagram. In the present case this means that the electrification is conserved.

If the cable be infinitely long both way, and have a charge 2Q suddenly introduced at $x=0$, the resulting V and C will still be given by (18) and (19) on the right side of the origin, where x is positive, because the charge 2Q will split into two equal charges, one of which will go to the right and the other to the left, and obviously in a symmetrical manner, so that there is no current at the origin. On the left side, V will be the same, and C the same negatived as at the corresponding points on the right side. We shall also obtain these results in another way, without the use of e. Thus, let a doubly infinite cable have an auxiliary wire attached at the point $x=0$, through which current is artificially sent into the cable. Let $2h$ be this current. It is equivalent to a source of electrification of strength $2h$; that is, electrification is generated at $x=0$ at the rate $2h$ per second. This splits equally right and left, so that $C_0=h$ may be taken to be the terminal datum for the positive half of the cable. Consequently

$$C=\epsilon^{-qx}h \qquad (23)$$

gives the current at distance x, and since $RC=qV$,

$$V=\frac{R}{q}\epsilon^{-qx}h \qquad (24)$$

is the corresponding V. Here h may be any function of the time.

Now, if h is impulsive, acting only at the moment $t=0$, we shall have

$$h=pQ \qquad (25)$$

when Q is the time-integral of h. Putting this in (23) and (24) we obtain the expressions (17) and (20) for V and C. This proves formally the previous statements about the behaviour of e, so far as the general electrical property of balancing voltages entered into the explanation.

Corrections.—§ 243, equation (36). Multiply the second line by π. § 244, for "mesh" read "net" or "network" generally.

(To be continued.)

ON PROF. NIPHER'S VIEWS ON CAPACITY.

BY SILVANUS P. THOMPSON.

In the views which Professor Nipher has put forward in his paper on the electrical capacity of bodies, he has given expression in a simple and direct way to ideas which have more or less vaguely been suggested from time to time, though never so succinctly. His presentation of them is all the more valuable in that it is all his own.

The notion that the processes of statical induction follow a circuit-law is one of those notions which, like the law of the magnetic circuit, have been much neglected; and by none neglected more than by those eminent teachers who always follow the stereotyped classical lines. It has been left for the pioneers and the unorthodox to suggest heretical notions; the orthodox always adopt them in the end, so soon as they have won their way by sheer force of utility. Time was when Ohm's law was sneered at as nonsense. Within our own epoch, Faraday's notions about specific inductive capacity, and induction taking place along curved lines, were deemed speculations inconsistent with the orthodox mathematical views. Indeed, until Maxwell gave to Faraday's notions an appropriate mathematical dress, they were ignored by nearly every continental electrician.

So far back as 1861 Gaugain, a true experimental genius, whose isolation from other French electricians was their loss, pointed out how the problems of the induced charges on conductors separated by a dielectric might be treated mathematically on the general lines of Ohm's law. In his Papers in the *Philosophical Magazine* of June, 1861, and March, 1862, he calculates the effects in a simple inductive circuit, introducing under the name of "resistance to excitation" the same conception as that for which Prof. Nipher now suggests the name of "diviance."

About the same time, and in entire independence, Mr. F. C. Webb was writing in the columns of *The Electrician* (the short-lived predecessor of the present journal of that name) a series of articles which in 1862 were republished in book form by Messrs. E. and F. N. Spon, under the title, "A Treatise on the Principles of Electrical Accumulation and Conduction. Part I." Of this work the second part, on conduction, was never published, but the first part is a work to be prized by every student of electricity. It abounds in illustrations of the author's ideas about induction taking place in a circuit, some of which are worked out not only pictorially but algebraically and numerically. Three brief quotations are admissible. "Considering the two opposite states as two fluids, these invariably exhibit a strong tendency . . . to accumulate themselves most on those parts of the surfaces to which they are connected, which are *separated by the least inductive resistance*" (p. 9). "Whenever electricity is generated at a source, and accumulated on the conducting surfaces connected to the two sides of that source, there exists of necessity, as it were, a chain extending from one of these primary conducting surfaces round to the other, which chain consists in some cases simply of a dielectric, separating one of the primary conducting surfaces from a conducting surface, in conductive connection with another conducting surface, which, again, is separated by another dielectric from another conducting surface, and so on until the other prime conducting surface forms one of these surfaces, thus completing the chain" (p. 32). "Such a chain will be found to exist in every case of accumulation, and is as necessary for that accumulation as a continuous chain of conductive matter, joining the two sides of the source, and termed the *conductive circuit*, is necessary for permanent conduction. I shall, therefore, term such chain the *inductive circuit*" (p. 33). Further on Webb considers the resistance to induction offered by a shell of dielectric, and the part it plays in the total resistance of an inductive circuit. The quantity of charge that can be "accumulated" from a given source (*i.e.*, using a given voltage) was regulated by the total resistance to induction. This idea is worked out in detail in Webb's fourth chapter.

When, ten years later, Maxwell's treatise appeared, though no clear statement stood out in it upon the circuital nature of electrostatic induction, it became evident that Maxwell enunciated principles that involved equivalent ideas. His conception of electric "displacement," and of displacement currents as occurring in dielectrics during the growth or decay of the charges, implied a circuital—or, as he termed it, a solenoidal—distribution of the displacement. His general equation of displacement is, with little variation, what Prof. Nipher now regards as an Ohm's law for induction. Never since Maxwell's ideas gained general acceptance have the nonsensical distinctions between closed and unclosed circuits been seriously revived. There are no unclosed circuits. If not closed by conducting matter, they are closed by dielectric chains (as Webb called them) along which displacement can take place.

More recently Mr. Oliver Heaviside has written all too briefly on the same lines. On page 28 of his work on "Electromagnetic Theory" (which also first appeared in *The Electrician* in a series of Papers) he deals with "permittance" and "elastance" in their circuital relations. Need one remark that by the term "permittance" Heaviside means the electrostatic conductance along the field of an electrostatic circuit? It is precisely the same thing as that for which Prof. Nipher now suggests the name "perviance." Whilst its reciprocal "elastance" (which Lord Rayleigh has called "the stiffness" of a condenser) is precisely the same thing as the resistance to induction, which now Prof. Nipher asks us to call "diviance." For this quantity a name is clearly wanted. But are any of them satisfactory? Diviance is not a handy word. Neither, for that matter, is elastance; and to the Philistine the idea attaching to the word elasticity is that of stretchability, whereas the scientific term elasticity is more nearly synonymous with rigidity or unstretchability. The substances which (like hard steel) have the highest moduli of elasticity are the most rigid. Would not "rigidity" express all that Prof. Nipher desires to connote in his word "diviability"? In that case "rigidance" would be the natural form of the noun corresponding to the idea of resistance to electrostatic displacement. Heaviside's equation $D = S\,V$, where D is the displacement, V the voltage which produces it, and S the permittance or perviance of the inductive circuit, is, of course, merely one form of the law analogous to that of Ohm, of which Maxwell's equation, $D = \frac{1}{4\pi} K\,E$ is another, in which E stands for the voltage, and $K/4\pi$ for the permittance or perviance.

Returning to Prof. Nipher's Paper, two small points present themselves for criticism, but these in no way affect its substantial value as a whole. We have now become so used to the term *flux* as applied to magnetic lines to signify the total number crossing any orthogonal section of the magnetic circuit, that it would surely be useful to retain the same expression for the analogous term in the electrostatic circuit. Why, then, return to the less acceptable phrases "total flow of force" and "flow of force or induction"? The other point concerns the verb used in Prof. Nipher's first sentence. What *does* he mean when he says that the lines of force distribute? I feel inclined to say (as I once said to Prof. Lodge about one of his philosophical Papers) that to make it intelligible it must be translated out of English into Greek. Then there could be no mistake as to the mood or voice of the verb. What are the lines of force to distribute? Or does he mean that they distribute themselves? Or does he mean that they are themselves distributed? Is the verb, in fact, to be understood as active, middle, or passive? The phrase reminds me of another which puzzled me greatly when first I heard it on arriving at an American hotel. After I had been some time comfortably esconced, I was asked "Have you *registered!*" At first I supposed the question had something to do with my baggage, and I promptly replied: "Oh, the transfer man is bringing my baggage." The question was repeated with greater emphasis. I cast about to try and think what it was that I ought to have registered, and which I had not registered. So I replied again that I did not expect any letters, either registered or unregistered. The third time the question came, this time with the accent on the pronoun, "have *you* registered?" Then it dawned upon me that the verb was being used in the middle voice, as an inquiry whether I had registered *myself* upon the books of the hotel. Had the inquiry been in Greek (or, indeed, in French) there would have been no ambiguity. And scientific writers ought not to be ambiguous.

Central Station Practice in Germany.—During 1894 the *Elektrotechnische Zeitschrift* states that the use of accumulators in central stations in Germany has greatly progressed. Alternating current stations have also been extended, and the four principles—moderate periodicity, large units, slower speed, and direct coupling—have throughout been introduced in German works. The rotatory current system, it seems, bids fair to be adopted in new stations in preference to the ordinary alternating system.

NOTES ON RECENT ELECTRICAL ENGINEERING DEVELOPMENTS IN FRANCE AND ENGLAND.*

BY H. WARD LEONARD.

Introduction.—As a result of inspecting some of the most interesting of the developments in the field of electrical engineering, during a recent trip to France and England, and as a result also of having met many of the engineers responsible for these recent developments, I find it difficult to reach a conclusion as to whether we or our contemporaries across the water are ahead in the electrical engineering race. Of course, when one attempts to compare the electric developments of the respective countries commercially, we are in the same position as the "America" was in the historic yacht race, "there is no second;" but, considering the recent electrical development from an engineering standpoint, we are rapidly losing the lead we have thus far held. Although I have always felt that so-called fundamental patents, and the resulting enormous aggregations of capital and engineering talent under one management, was a millstone around the neck of our profession, I have never before had the opportunity of seeing positive and unmistakable evidence of it such as this visit abroad showed me.

In the beginning of electric lighting, both arc and incandescent, we led the world from an engineering standpoint, and were years ahead of any other country. But what has been done in this country in the way of a remarkable electric engineering development since Edison started his first three-wire system at Sunbury, Pa., in July, 1883, and Westinghouse established his alternating system with 1,000-volt primary and 50-volt secondary a few years later, and Sprague started the Richmond electric road? A moment's thought will, I think, make you all realise that the practical development of electrical engineering improvements is almost impossible against the opposition of the gigantic corporations in that field, and that corporations having such a large portion of their capital represented by patents will not wish to see the practical trial of a promising improvement which they do not control, and which may depreciate the value of the methods they control or claim to control. It is in just this way that we are losing ground when compared with England and France. We undoubtedly have the best three-wire central station plants in the world, also the best alternating system converting from 1,000 to 50 volts. But what other kind of central stations have we to point to? Practically none.

We have 500-volt continuous-current electric railways galore, and we operate such railways at distances for which 2,000 volts should be used instead of 500, and after investing more money in copper per car than the entire cost of the electrical equipment, we still lose twice as much energy as is commercial in the line. Is there a large electric railway system in this country which, as an electrical transmission of power, is a credit to our profession? Not one.

In France, and even more in England, one is forcibly impressed by the many kinds of central stations being tried. Many of them may seem almost sure to prove commercially unsuccessful; but who can say which one may not prove the "Sunbury" of an enormous electrical engineering development? No capital or patents can prevent the slow development of evolution; but I fear that under the existing conditions we shall have to content ourselves with drawing pictures of what might be done, and watch the continued introduction of the three-wire system of 1883, the 1,000 to 50-volt alternating system of about 1887, and the continuous-current 500-volt railway system of 1887; while our engineering friends abroad keep trying not only their own ideas, but the ideas of many of us from this side, because they have the necessary encouragement and opportunity to do so, while we have not. I have learned, on this hurried trip abroad, of many applications of inventions of American engineers which have proven very successful, and which, although patented, described, and advertised in this country, were taken up first by English or French engineers, notwithstanding their well-known prejudice against American inventions.

Alternating Current Practice.—In England one of the first things which impresses an engineer is the total absence practically of a 50-volt secondary for alternating systems. It is the general practice in England of late to use a three-wire secondary, with 100 volts on each side. I believe that every engineer who has ever given the subject a thought knows that there was no excuse, except patents, for a 50-volt two-wire secondary originally, and no excuse, except the inertia and prejudice of large corporations, for continuing to put in the two-wire 50-volt secondary to-day.

Manufacturing and Engineering.—In England there is a multitude of medium-size concerns manufacturing electrical apparatus, and the competition is mainly on ideas, and not the cost of dynamos per kilowatt. It is surprising to find that generators and motors

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[*] A Paper read before the American Institute of Electrical Engineers, New York and Chicago, February 27th.

are much cheaper in the United States than in either England or France, notwithstanding their advantages over us as to cheaper raw materials and labour. The manufacturers abroad generally consider the consulting electrical engineers as entirely unnecessary in view of the multiplicity of schemes which every plant brings forth from the various manufacturers, but I believe that a great deal of benefit has been and is being accomplished in England by virtue of the custom of placing in the hands of good consulting electrical engineers the design, for instance, of a large central station plant to be built by a city itself.

Has a central station of this kind ever been built in this country? I think not; that is, a central station built according to advice from a good consulting engineer who was free to select the good features and eliminate the bad features of the various systems known to the art. Imagine a central station combining apparatus and methods of the General Electric, Westinghouse, and Siemens and Halske all in one system, also taking advantage of other good ideas from the United States and abroad. Who can doubt that it would be better than could be built by using only the patents and apparatus controlled by some one company? Many will answer that all the best engineers are in the employ of the leading companies, and the consulting engineers available are incompetent commercially, and there is a great deal of force in this argument, but even if true it certainly merely emphasises the difficulty of getting a practical trial in this country of promising ideas in the electrical field unless they be controlled by one of the would-be monopolists.

Rotary Transformers.—Rotary transformers are used in several stations in England for a continuous-current high-potential multiple arc distribution, the secondary being a three-wire system as usual. Such a plant is in use at Oxford. At Brighton and several other places the standard 220-volt continuous-current three-wire system is supplemented for distant lighting and in newly-occupied territory by the alternating system, using about 2,000 volts in the primary and a 220-volt three-wire secondary. This alternating plant supplies the distant and scattered lighting during the period of heavy load, and during the period of light load (about three-quarters of the whole time) this distant lighting is supplied directly from the 220-volt three-wire system by switching the secondary circuit from the converter to the regular three-wire system.

Mr. Arthur J. Wright, who installed this system first at Brighton, spoke of it to me as an American invention not patented in England, a description of which he had read in the American electrical journals, and was much surprised to learn that none of the central-station companies had made use of it in the United States, as it was proving of the greatest value to him in his plant.

Steam Engines.—I believe we are ahead of England and France in the designing of dynamos and engines. Their workmanship leaves nothing to be desired, but giving consideration to amount of material used, efficiency and design, I think we are in advance of them.

One of the most surprising things to me was to see the almost universal use of engines which we would consider had practically no governor. That is, engines using slow-acting throttling governors instead of the triumphs of engineering skill which are so common in this country. Not since 1883 have I seen such poor governors as I found generally used abroad in the finest and most recent stations, and upon engines which are almost perfection itself as regards manufacture.

The Parsons Steam Turbine.—The Parsons Steam Turbine was one of the most interesting things I saw in England. These steam turbines are direct coupled to dynamos, and in sizes of 350 kilowatts revolve at 3,000 revolutions per minute and, of course, run at higher speed in smaller sizes. The space occupied by a 350-kilowatt outfit is over all about 25ft. long, 5ft. wide, and including governor about 7ft. high. These turbine plants, when running at these high speeds, are entirely free from vibration, and are not even bolted down, but are supported by three pedestals, one near each end and one at the middle. There are some seven or eight bearings all in line, and a continuous stream of oil is forced through the bearings by a small pump driven by a worm on the main shaft.

The bearings used are extremely simple and very ingenious. The shaft runs in a gun-metal sleeve of about the usual dimensions; but between this sleeve and the surface of the pillow-block are three cylinders of thin sheet brass concentric with the shaft, and sliding loosely over the gun-metal sleeve. The gun-metal sleeve is prevented from turning by a lug projecting down at one end into a hole in the pillow-block. The entire box being filled with oil, it will be seen that the shaft is free to vibrate slightly in every direction as it revolves, and that the viscosity of the oil tends to damp any such vibration. The three thin surrounding sleeves are perforated by a hole of about ¼in. at about every two inches, so that the oil can work freely between these sleeves. The Parsons steam turbine uses the steam expansively as a reciprocating engine does. The steam, at about 125lb., and preferably superheated, is led into the centre of a cylindrical chamber in which the moving parts revolve. There are three of these chambers. In the first chamber the steam is expanded down partially, and thence goes to a second similar chamber and finally to a third one, which last chamber leads to the condenser. In each of these chambers the steam in its passage from the admission to the exhaust has to pass some thousands of small blades or teeth which project from the surface of the discs a fraction of an inch. The amount of steam used and its expansion will depend upon the clearance and the number of these turbine discs it has to pass in getting to its exhaust. It will be evident that the friction of the engine is less than that of a reciprocating engine, and that the condensation losses should be less. Also full advantage can be taken of high pressure, and especially of superheated steam, for the difficulties of proper lubrication and packing in the presence of high temperature steam in a reciprocating engine do not apply to this engine.

Tests by Profs. Ewing and Kennedy indicate that this turbine when in perfect condition has an efficiency of one kilowatt hour in electrical energy produced by 28lb. of feed water, the turbine being operated condensing. This is equivalent to about 15·7 pounds of water per indicated horse-power per hour, and I understood that in a recent competition a guarantee was made by Mr. Parsons which was equivalent to about 13 pounds per indicated horse-power per hour, and that his guarantee was lower than that of the best triple compound condensing engines of the reciprocating type which were in the competition. At Newcastle-on-Tyne I saw a central station of about 25,000 lights operated solely by these steam turbines, and which has been in operation since 1890 and has been earning and declaring dividends ever since it started. An interesting fact as to this Newcastle station is that all of these conductors are laid underground, and consist of vulcanised rubber cables drawn into cast-iron pipes which are gas and water tight, and through which chemically dried air is forced from the station by a blower. There are over six miles of piping and over 25 miles of cable, and after five years operation Mr. Parsons states that they have not had a single instance of failure of insulation, explosion, or other trouble with the underground system.

The Laval Steam Turbine.—Before leaving the subject of steam turbines, I will describe the Laval steam turbine, of which I saw a number in the works of the manufacturers, Breguet and Co., of Paris. This steam turbine differs radically from the Parsons. The power is derived from the momentum of a jet of steam impinging upon buckets near the periphery of a disc, so that the machine is somewhat comparable to the Pelton water wheel. The steam, which is preferably used at a high pressure, and exhausting into a vacuum, is expanded in a nozzle before reaching the disc, and reaches the buckets of the disc fully expanded, and hence moving at a very high velocity, which the inventor claims is 3,000ft. per second for steam at 85lb. per square inch, exhausting into the air, and 3,700ft. exhausting into vacuum. The nozzle makes a very slight angle with the plane of the disc. The admission of steam is controlled by a centrifugal throttling governor. The number of revolutions of the disc per minute varies from about 30,000 to 15,000 in sizes from 5 H.P. to 50 H.P. The buckets are milled out of a solid disc of steel just inside of the periphery, so as to leave a solid band on the circumference. The edges of the buckets are quite sharp. The disc in a case of a 50-H.P. turbine is about ½in. thick. This disc is mounted on a small steel flexible shaft at a point about one-third from one end. At the high speeds in question, a body tends to revolve about an axis through the centre of gravity, and since it is impracticable to make the centre of gravity absolutely coincident with a straight line joining the bearings, Mr. Laval has used a flexible shaft so that the disc is free to assume such a position as to revolve practically around an axis through the centre of gravity, and consequently the disc revolves with perfect smoothness and without any trouble at the bearings at these enormous speeds.

No successful way has been perfected as yet for operating a dynamo directly at these speeds, and so Mr. Laval gears from his turbine shaft to two dynamo shafts, one on each side of the turbine shaft, by means of double helical gears beautifully cut, which reduce 10 to 1, and upon these two driven shafts are placed the dynamo armatures, two driven shafts being used so as to balance the side thrust on the bearing of the turbine shaft. The Laval people claim as high efficiency as that of any steam engine of the same horse-power, and there seems no good reason to doubt their ability to secure such an efficiency, which they guarantee fully and specifically.

A careful test made at Stockholm in 1893 showed an efficiency of 20lb. of water per horse-power hour, with steam at 113lb. initial pressure and used condensing. The weight of this turbine is about 30lb. per horse-power in a size of about 30 H.P. The simplicity of this steam engine, also its theory and practical design in detail, are most beautiful, and it seems likely to become an important factor in the electrical field. What is needed is a generator of electricity directly driven by, or preferably constituting a part of, the revolving disc, and here is food for considerable thought.

Five-Wire System.—At Manchester I saw the five-wire plant designed by Dr. Hopkinson and recently installed. I inspected the central station for a few minutes only, as, unfortunately, those most familiar with the principal features of the system were absent at the time of my visit. The dynamos were bipolar machines driven from vertical engines by means of link belts with idlers. I cannot say that I was favorably impressed with the generating plans or distribution system, as far as I could judge of them in such a brief observation.

Liverpool Electric Railway.—At Liverpool I investigated the overhead electric railway. The overhead structure, the motors, methods of collecting the current, &c., were exceedingly well designed and constructed, and gave evidence of good working. The central station apparatus and design was not, however, up to the standard of work here in recent electric railways.

The series parallel control is used, but no rheostat, the designer seeming to realise that it might just as well be left out, and the equivalent resistance secured in the windings of the motors themselves with less apparatus and no appreciable difference in economy or control.

English Central Stations.—In London I visited several central stations, of which I will mention two. The first is that of the Metropolitan Electrical Supply Company. This company has an enormous area allotted to it. I will explain right here that both in London and Paris the authorities follow the plan of granting to several different central station companies—supply companies as they term them—the exclusive right to a certain section of the city. No such company can run into any other company's section. At the central station of the Metropolitan Company I found four Parsons steam turbine units of 350 kilowatts each, running at 3,000 revolutions per minute. These steam turbines had been in operation only a short time I saw them, and had been installed for the reason that the central station had been enjoined by the Courts from operating the reciprocating engines formerly in use because of the vibration they caused. I was informed that the vibration was particularly troublesome and difficult to overcome, because the central station was built upon made land, above the bed of a former river, and that the ground was boggy and transmitted any vibration in the most surprising manner. I enquired as to the working of the steam turbines, and was informed that they were not able to detect any difference in their coal consumption compared with the compound condensing reciprocating engines formerly in use. I found that an accident had happened to one of the steam turbines by which it had lost all of the blades in one of the three chambers, which reduced its capacity and efficiency considerably, but did not put it out of service entirely.

The other London central station I shall refer to is that of the City of London Company. This company supplies the heart of London, that is the old "City of London," which is without doubt the best central station territory in the world, on account of the wealthy nature of the customers, the substantial character of the buildings, and especially because of the peculiarly dismal foggy weather in London. While I was there, artificial light was required almost as much by day as by night. This central station is beautifully located on the south bank of the Thames, near the centre of lighting, and is a fine example of the best that can be done to-day with the alternating system under such conditions. I do not believe it would be possible to find less excuse for the use of the alternating system than in this station, and yet I expect it will pay, for it can hardly fail to earn money under such extraordinarily favourable conditions for lighting.

But I need hardly say that they have no motors except toys, and but few of them ; and when I remember that in Chicago 40 per cent. of the connecting load is motors, and that this percentage is rising all the time, it seems evident that the City of London Company is terribly handicapped by the use of the alternating current. However, they have a 2,000-volt three-wire secondary, and operate the dynamos all on multiple-arc, which is certainly using the alternating current to the best advantage. Aside from the use of the alternating current under these conditions, it is difficult to say anything in criticism of the central station.

The plant is arranged on the panel system, which Mr. Mordey says originated with him, and which is thoroughly carried out in this station, for each panel or section across the building comprises an independent unit, including a boiler, engine, dynamo, and switchboard for 500 kilowatts. The engines are vertical and direct-coupled to the Mordey alternators. The switchboards are entirely novel in design, being cast iron pyramids about 10ft. high, standing clear from the wall and having all of the conductors inside, with the instruments, &c., mounted on the front face. While very finely finished and ornamental, I could not but think that the vital parts would be more difficult to inspect and repair in case of emergency than in our recent switchboard practice. One detail of electrical construction in which the foreign practice seems very backward is the rheostats. In this magnificent station in the City of London, for instance, and in many other places, I saw rheostats made by winding german silver wire on a slab of slate, which was then mounted on insulators horizontally on a table, and a slider arranged to move over the surface of the resistance wire itself, which was thoroughly exposed.

Another detail in which we are certainly in advance of foreign practice is our instrument work, for which we must thank Mr. Weston solely. I saw many fine instruments while abroad, but they seemed to be more suited for a physical laboratory than a central station, the substantial compact, permanent features of the Weston instrument, with its readable scale and dead-beat index, were conspicuous to me by their absence.

French Central Stations.—In France the most interesting central station I saw was in Paris, where I visited a sub-station designed for a capacity of 30,000 lights. The sub-station was supplied from a distant central station by means of a constant current of 250 amperes, all devices on this current being in series and the total E.M.F. running as high as 6,000 volts at times.

In the sub-station were rotary transformers, the primary ends of which were series-wound motors, and all being in series. The secondaries of these rotary transformers as generators fed a five-wire system of conductors, and in multiple-arc with these generators across the five-wire system was a bank of storage batteries. The lamps used were 110 volts ; some of the rotary transformers had 110-volt secondaries, four of such secondaries being in series so as to make the five-wire system complete independently of the batteries. Other of the rotary transformers had 440-volt secondaries and fed the outside conductors only. On each rotary transformer was a rheostat which was in multiple with the series-wound field, and which, by a step-by-step movement similar to that of the old U.S. automatic regulator, controlled the strength of the series field so as to keep the E.M.F. in the secondary constant, the controlling magnet of the automatic being across the secondary of constant E.M.F.

The storage battery plant was well designed, and seemed to be in good order. It was as clumsy and seemed as full of troublesome possibilities as those we have on this side of the water. It had capacity for 8,000 10-c.p. lamps for three hours and cost about $30,000, weighed about 400,000lb., and occupied a space about 32ft. by 50ft. This cost means about $107 per kilowatt of output, which seems a pretty high price to pay for a plant to generate electrical energy to-day, especially when it probably has an efficiency at three hours' discharge not above 60 per cent. Such a storage battery must be compared in cost with the cost of boilers, engines and dynamos per kilowatt, which would cost perhaps $50 kilowatt, and whose efficiency would be 100 per cent. as compared with the 60 per cent. efficiency of the storage battery, since the storage battery must derive its energy from a steam plant first. The craze for storage batteries as the universal panacea for electrical troubles, which we have all read so much about in connection with European practice, seems to be on the wane, if I may judge from the statements of the engineers rather than the storage battery manufacturers ; but when we remember that in France and England they do not know what a healthy motor load means, we need not be surprised at the claims of inefficiency for stations which do not use batteries, and hence run their boiler, engine, and dynamo for most of the 24 hours practically without load.

Importance of the Load Factor in Central Stations.—All central station people have known for years that the most profitable consumers were those who used their lamps for the greatest number of hours.

In other words, that the net profit due to the consumer was largely dependent upon the relation between his average load and his maximum load, which Mr. Crompton in England has aptly called the "load factor." Yet, while appreciating this fact, central station companies make their rates dependent upon the kilowatt hours used, and independent of the maximum kilowatts used.

Mr. Arthur Wright, at Brighton, in England, deserves the credit, as far as I know, for having first given commercial recognition to this load factor of the consumer. Mr. Wright supplies each consumer, not only with a meter which registers the kilowatt hours used, but also a second meter of simple construction, which registers the maximum kilowatts used at any time during the month, and the discount which the consumer gets is very largely due to the relation between his average and his maximum kilowatts.

Suppose that there are two customers connected to a central station, and that the monthly readings show that each has used 900 kilowatt hours. By the usual practice in this country the bill would be the same, yet one bill may be due to the use of 1¼ kilowatts for 24 hours per day, and for 30 days per month, and the second bill may be due to the use of 30 kilowatts, an average of one hour per day for 30 days per month. That is, the first bill may be due to a steady load, such as a few lamps in a basement of a hotel or a ventilating fan, while the second bill may be due to a larger load of lamps used only occasionally, as in an office building or an electric elevator requiring 30 kilowatts for a few seconds to start it up, and after starting requiring only 15 kilowatts.

With the same 900 kilowatt hours per month for the two cases the central station company should charge at least five times as much for the case having the elevator and small load factor, as in the other case.

It is a fact not generally appreciated that in any central station the cost of producing a kilowatt hour can be divided into two portions, one of which, such as interest on cost, depreciation, salaries, a small part of the labour and coal, vary with the kilowatt capacity of the plant, that is, proportionately to the maximum load, and are independent of the number of kilowatt hours produced; and the other portion of the cost of producing 1 kilowatt hour represented by the larger portion of the coal, labour, water, &c., is dependent upon the number of kilowatt hours produced, and is independent of the maximum load. The fact about this matter which is best appreciated is, that the portion of the total cost of 1 kilowatt hour produced, which depends upon the maximum load, is about two-thirds of the total cost, and the part dependent upon the output is only about one-third.

In a modern central station 1 kilowatt of its capacity represents about $300 invested. Consider the two consumers cited above. Both loads are in use at the time of maximum daily load. For the elevator, the central station has to provide an investment of $9,000, for the ventilator fan $375. Assuming interest, depreciation, and similar charges, and at 10 per cent. we have $900 to deduct from our gross earnings in the elevator case, before we reach net profits, and $37.50 in the other case. Suppose we get 10 cents per kilowatt hour in each case, and that the cost of production independent of general expenses, interest, depreciation, &c., is 50 per cent. of the gross receipts, &c. This would mean that if we get 10 cents for each kilowatt hour in both cases, our gross revenue would be $90 per month in each case, and our gross profit $45.00 per month, or $540 per year in each case. But in the elevator case we have interest and depreciation charges of $900 a year, and hence have actually lost considerable money in supplying this customer, while in the other case we have made a net profit of over $500 per annum.

We would have to charge more than ten times the rate per kilowatt hour to the elevator that we charge to the ventilating fan to make the same net profit on $1 of capital invested.

This load factor is a most vital question, and it is the difference in load factors in English and American central stations which makes storage batteries commercially possible there and impossible here. The average load factor of an English central station is less than 15 per cent., and even in London in December it is only 33 per cent., while in most American cities the load factor, which is 40 per cent. in December, will in many cases be above 50 per cent.

This difference is due almost wholly to our motor load, which is an almost unknown quantity abroad. With a 15 per cent. load factor a storage battery may pay, but not with a load factor of 40 per cent., especially when the load factor in our central stations is rising each year.

If central-station companies would offer such a discount due to load factor as to warrant their individual customers in installing at his own expense a storage plant which he would charge at the minimum rate per kilowatt hour by a steady current for twenty-four hours per day, and then used this stored energy to supply his occasional demands for an occasionally very large rate of energy, I believe it is possible that the central-station companies, the storage-battery companies and the consumers might all derive a profit from the arrangement. I have no doubt that a central-station company could afford to make a rate of four cents per kilowatt hour for a continuous service night and day and make a satisfactory profit, while it would surely lose money in supplying an elevator, such as described above, even at 15 cents per kilowatt hour.

I believe that the following schedule of rates fairly represents the charges per kilowatt hour that should be made to customers of various load factors.

Load factor.	Rate per kw. hour in cents.	Resultant gross income per annum per kw. of plant.
5	30·0	$131.40
10	20·0	175.20
15	16·0	210.24
20	13·0	227.76
25	11·2	245.28
30	10·0	262.80
35	9·2	281.07
40	8·5	297.84
50	7·0	306.60
60	6·0	315.36
70	5·3	325.00
80	4·8	336.38
90	4·4	346.89
100	4·0	350.40

It must be noticed that this argument would lose most of its force if the maximum load of the consumer did not occur at the time of day when the maximum load was upon the central station, but in elevators, and similar loads which call for their maximum load in starting up every few seconds, then maximum loads will not only occur together occasionally, but this will sometimes occur at the time of maximum load on the central station, and when this accumulated load is put upon the central station the kilowatts must be there to meet the demand.

Electric Heating.—I saw evidences of a very healthy demand for electrically-heated devices while abroad. In London the principal central station company is running at its own expense a show room for the education of the public in this line, and several manufacturers of electric heaters told me the demand was very satisfactory, and promised a good future.

The Heilmann Locomotive.—In France I examined what I considered the most important electrical engineering development of all that I saw. It was the Heilmann electric locomotive. Having been for some years past a firm believer in the merit of this machine, and having been in correspondence with Mr. Brown, Mr. Heilmann's electrical engineer, as to an invention of mine used in this locomotive for the first time on a large scale, I was especially interested in it, and my hearers will please discount as they may think necessary my description of the advantages of a locomotive using my system of control. The locomotive I saw was the first one built, and was not in service when I was there. It had run 2,200 miles commercially, however, and as a result of the performance of this first locomotive, which was 600 H.P., there are now building two locomotives of 1,500 H.P. each, which, it is expected, will go into commercial service about June next.

This electric locomotive carries its own central station with it. It is really a complete central station on wheels, with its power used for propelling itself. Speaking from memory, I should say the length over all was about 50ft. The locomotive is mounted upon two bogies each having four axles, so that the weight of the locomotive is borne by 16 wheels, each of which is about 45in. in diameter. A platform made of heavy iron girders runs the whole length of the locomotive, and is supported upon two pivots, one at the centre of each bogie. Upon this platform is mounted the coal, water, boiler, engine, dynamo, &c., so that it will be noticed every pound of material is used upon the drivers and therefore becomes effective for tractive purposes.

The entire weight of the locomotive is 114 long tons; that is, about 15,500 pounds per driving wheel, which is about the same as our standard practice in this country. With a tractive coefficient of 0·2, this means a draw-bar pull of 50,000 pounds, and assuming friction at six pounds per ton, we find that 50,000 draw-bar pull would enable us to pull 1,900 tons on a 1 per cent. grade at a low speed, say 15 miles per hour, and would give us ample draw-bar pull for handling a 200-ton train at any speed thus far seriously discussed.

Most engineers who have heard of the Heilmann locomotive have derisively dismissed it from their minds as a ridiculous monstrosity of a crazy Frenchman, but I have for some time believed, and am now convinced, that you will in the immediate future be bound to give this machine the most respectful consideration. I find that the impression prevails generally, that the modern steam locomotive is really a very perfect and efficient machine. This I think is far from being true. The efficiency of a boiler depends largely upon how perfect the combustion is, and with forced draft we can realise an efficiency of 80 per cent. with very perfectly-designed boilers, provided we do not attempt to burn more than about 40lb. of coal per square foot of grate surface per hour. But the maximum duty of boilers in locomotive practice, such as for the highest speed service, involves the use of nearly 200lb. of coal per square foot of grate surface, and I need hardly say that forcing the boiler in this way results in a terrible inefficiency. To produce an indicated horse-power in a steam locomotive at highest speeds to-day probably requires at least twice as much coal as is required in first-class stationary or marine boilers. This is the first place where Mr. Heilmann is able to show an economy; he is able to carry a larger boiler, and hence does not have to crowd it to such a wasteful point.

But, regardless of an abundant supply of steam from the boiler, we find ourselves greatly limited in power for steam locomotive practice at high speed, because of the wire-drawing of the steam and difficulty of properly exhausting when we run our locomotive at its highest speed. The maximum draw-bar pull obtainable when running at the highest speed is only about half that obtainable at slow speed, no matter how much steam we have at command, or at what cut-off we work. Heilmann avoids this difficulty, as we shall see presently.

Another matter of most serious importance is the tremendously destructive effect upon the roadbed, and upon the locomotive itself, of the unbalanced vertical component of the motion of the counter-balance weight of the steam locomotive, and also the shouldering effect of the locomotive tending to spread the rails. Probably at least one-third of the cost of maintenance of the roadbed and the locomotive for high-speed service could be traced directly to this destructive "hammer blow" and side thrust. Both of these effects, which become very troublesome as we go to the higher speeds, are entirely absent in the electric locomotive.

Having now pointed out the weaknesses of the steam locomotive, which develop most forcibly as we increase in speed, I will describe the construction of the Heilmann locomotive and point out how those difficulties are obviated by the electric locomotive. The steam engine is compound, well balanced, and directly coupled on its shaft is the electric generator. A four-pole single reduction motor of the iron-clad type is geared to each of the eight axles, and the motors, which are series wound, are multiple with each other across the brushes of the generator armature. As the motor-field must have a fair degree of saturation to prevent sparking when the locomotive is running light and pulling no train, it will be evident that under all operating conditions the motor-fields are constant and fully saturated, which makes them entirely sparkless. The field of the generator is separately excited by means of a small auxiliary engine and constant potential dynamo, which also supplies the electric lights needed. The engine has a fixed cut-off at the most economical point, say one-quarter stroke, and its speed is adjusted by the throttle.

The engine in practice is varied in speed from perhaps 50 to 500 revolutions, and the strength of the generator field from zero to its maximum strength. It will be noticed that all steam used is used expansively at a fixed cut-off, and Mr. Heilmann lays great stress on this, although I myself would prefer an automatic engine running at a constant speed, and I believe that he would, if he could get as good ones abroad as we can in this country. For starting, an almost unlimited torque is secured by gradually increasing the generator field strength and speed, which sends a current through the motors, rising smoothly from zero to that current sufficient to start the motor armature. If we leave the field controller and throttle in this initial position, our train will start smoothly, and will continue to move slowly, using the full current, but producing the current with about 50 volts, or one-tenth of the full voltage, and we will be producing this power, about one-tenth of that required at full speed, by a steam engine using steam expansively instead of, as in the steam locomotive, full stroke. But, of course, we desire to accelerate the train rapidly, so we keep on manipulating the field controller and throttle, until we finally have the engine driving the generator at full speed in a field of full strength, which will, of course, represent the full power of the locomotive. When we reach a grade requiring three times the torque required on the level, we weaken the field to one-third of its full strength. We will then move up the grade at about one-third of the speed on the level, while using the same power as was required on the level.

It will be noticed that under the electrical arrangement on this locomotive, the electric energy is used in such a manner that its voltage is varied in proportion to the speed desired, and the amperes are in proportion to the torque required, so that the electrical energy produced is utilised in the most efficient manner possible.

Since this method of control of mine has been repeatedly criticised before this Institute on the score that a generator of such size and type when used as described would spark disastrously, I beg leave to say that I scrutinised most carefully the commutator of the generator which had supplied the current during the locomotive's 2,200 miles service, and I never saw a commutator and brushes in more perfect condition, and the engineer assured me that under no circumstances had there been any sparking whatever. I regret that my method of control does not fit the generally accepted self-induction theory of sparking, but am forced to conclude that, as something is evidently wrong, it must be the theory which fails to agree with the facts.

An electric locomotive of this kind would probably cost for the first few about $30,000, each being equipped with a 1,500-H.P. boiler of our best marine type, and one of our best automatic cut-off compound engines directly coupled to a modern multipolar generator. I believe that a locomotive of this type could be built which would be able to pull 50 per cent. more weight than any of the present steam locomotives, and that it could pull the same weight at 50 per cent. higher speed. I think this type of electric locomotive is the stepping stone between the steam locomotive and the electric locomotive operated from a distant central station.

To properly try the experment of operating a high-speed locomotive of 1,500-H.P. from a central station would undoubtedly cost nearly a million dollars. To try it with a locomotive of the Heilmann type would cost not more than $50,000 and if it proves successful it is not much of a step to replace the boiler and constant-speed steam engine with the moving contact and constant speed electric motor for driving the generator already tested and proven satisfactory.

The German Electro-Chemical Society.—The annual gathering of this Society will be held this year at Frankfort-on-the-Main on June 6th—8th, under the presidency of Prof. Ostwald.

A METHOD OF DEDUCING EXPRESSIONS FOR ELECTROMAGNETIC FORCE.*

BY C. T. HUTCHINSON AND E. R. CARICHOFF.

Biot and Savart and Maxwell have shown experimentally that the force due to a current in an unlimited rectilinear conductor on a pole of unit strength at a distance r from the current is $\frac{K\,C}{r}$, where K is a constant to be determined, so that the expression for work done shall be equal numerically to N C.

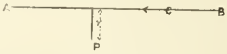

Fig. 1.

To determine this constant:

Imagine unit pole at P (Fig. 1); let the conductor, A B, revolve uniformly about P, describing a cylinder of radius, r. The conductor cuts the entire 4π lines which radiate from the unit pole; the work done is, therefore, 4π C. The distance that the conductor moves is $2\pi\,r$, and the uniform force is $\frac{K\,C}{r}$.

The work then is :—

$$W = \frac{K\,C}{r} 2\pi\,r = 2\pi\,K\,C.$$

This must equal 4π C, and therefore $K = \frac{1}{2}$. This is the usual electromagnetic definition of current, but obtained in a different way. With this definition of unit current the expression for work becomes numerically equal to N C. Using this we shall deduce the expression for the force in other cases.

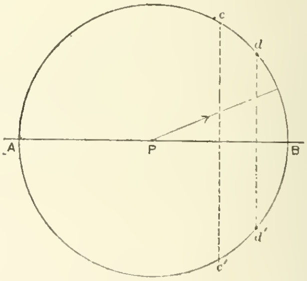

Fig. 2.

I. To find the expression for the force at the centre of a circle (Fig. 2) of radius, r, due to current, C, flowing around the circumference. Imagine unit pole at the centre, P. Revolve the circular conductor about a diameter, A B, through 180deg.; then all the 4π lines from the unit pole will be cut, and the total work done will be 4π C.

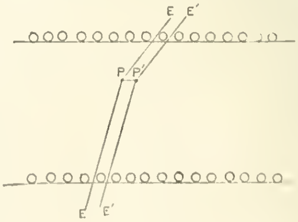

Fig. 3

Each element of the conductor, as $c\,d$, contributes a part to the work proportional to its length and to the distance it moves through. The sum of all these products of length and distance, however taken, is equal to the surface of the sphere, or $4\pi\,r^2$. If then F be the force due to unit length

$$F \times 4\pi\,r^2 = 4\pi\,C.$$

$$F = C\ r^2.$$

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* Abstract of an article in the *Electrical World* of New York.

The force due to the entire circumference is

$$F' = 2\pi r \times F = 2\pi C/r.$$

II. To find the force at a point within an indefinitely long solenoid (Fig. 3):

Let there be n turns per centimetre. Assume unit pole at P to move parallel to the axis to P′ where $PP' = (1/n)\,C\,m$. Every line of force will cut one spire of the circuit, for any line that was at E moves to E′ and $EE' = PP'$.

The entire circuit will then be cut by all 4π lines of force; the work will then be $4\pi C$, and the uniform force between P and P′ will be $4\pi C/1/n = 4\pi C$. This is irrespective of the position of P within the solenoid.

CHERRY'S "FORGET-ME-NOT" CALCULATOR.

This ingenious calculator consists of a logarithmic scale 100in. long, cut up into 20 equal parts, and printed in the space of 5in. by 2in. It is used in the same manner as the Fuller cylindrical rule, that is to say, by means of the relative position of two marks, which may be moved together over the scale. In the Fuller rule, these marks are carried by long brass arms or pointers and form part of the instrument, but in the Cherry calculator they are made upon sheets of tracing paper which are laid upon the printed card. The scale is practically the same as that of a Fuller cylinder unrolled, and as the space between the 5 and the 5·01 divisions is almost $\frac{1}{10}$in., this may be read to one-fifth, that is, four parts in 10,000, or about $\frac{1}{25}$ of 1 per cent. The accuracy of the instrument would be greatly increased by further subdivision of the first part of the scale, the divisions on the first line being about $\frac{4}{10}$in. apart. Sheets of tracing paper, ruled in lines spaced as on the calculator, are supplied with it. These lines are inclosed in a rectangle the same size as that of the scale, viz., about 5in. by 5in. To multiply two numbers together, one of the corners of the rectangle on the tracing paper is placed over one of the numbers, and a pencil mark is made at whichever corner of the rectangle or the card is available. This mark is then brought over the other number, and the product is found under whichever corner of the tracing paper rectangle is found on the divided scale. In general, any two marks made upon the tracing paper will always lie over two numbers in the same ratio, as in the Fuller cylindrical rule or the Borcher calculating circle, but by the use of the corners of the rectangle the difficulty of the discontinuity of the scale in the present calculator is ingeniously surmounted. Varnished tracing paper for pen and ink is provided, and slips with a number of conversion constants are supplied. Many such slips have been prepared, one giving weights of iron bars and rods, another converting metric into English weights and measures. Continuous multiplication and division may be carried on without stopping to read the successive quotients and products, and many other uses are explained in the printed instructions accompanying the calculator. Like all slide rules, a little practice is necessary before it can be used to advantage, but we think that for many purposes such a calculator should prove useful. It is made by Mr. Cherry, 21, Festing-road, Putney, London, S.W.

A STRAIGHT-LINE ACCUMULATOR CHARACTERISTIC.*

BY CARL HERING.

In plotting the results of a recent set of accumulator tests, a number of different curves were obtained, depending on the choice of the quantities used as co-ordinates, one of which, and a very important one, was found to be practically a straight line. Not having seen this result published before, I thought it might be new and of interest to those working with accumulators, as it enables one to find, by a very simple calculation, the capacities for different rates of discharge. The result will probably be different for different types of accumulators, and each maker will, therefore, have to determine for his particular type of cell whether this relation is a straight-line function, and if not, then whether it approximates sufficiently close to it for the calculations occurring in practice. It should be stated here that this accumulator differed somewhat from the usual types, it being specially suited for rapid discharges.

In the tests referred to, the same cell was fully charged for each test, and was then discharged at each of a number of different rates, from a very rapid to a very slow one, the discharge being considered ended when the difference of potential had fallen a certain fixed percentage of that at a few minutes after the beginning; the current was kept constant by adjusting the external resistance. As the cell was intended for power purposes, it would have been more correct to have kept the watts constant instead of the current, but this involves difficulties, besides introduces errors; the differences in the results are probably quite negligible.

The curve usually constructed is the one connecting the capacity with the *time* of discharge, but as this is far from being a straight line, it is at first sight discouraging to try to reduce it to a convenient formula for calculations. But if, instead of making the abscissas represent the *time*, they are made to show the rates in *watts*, the ordinates being the capacities in *watt hours*, then the curve for this particular cell approximated within 2 per cent. to a straight line having the general form:

$$\text{watt hours} = a - b \text{ watts},$$

the values of the constants for this particular accumulator being $a = 228.$, and $b = .272$ (or $\frac{3}{11}$). This enables the output for any particular rate of discharge to be calculated very easily, and as the results were obtained between a very rapid and a relatively slow discharge, they include practically all the cases occurring in practice.

For a theoretically perfect accumulator, having a constant capacity and no internal resistance, this line should not only be straight, but also horizontal. The inclination of this line, therefore, also shows how nearly it approaches to the theoretically perfect conditions.

From the above equation it is also very easy to calculate how long the discharge will contine at any desired rate in watts, even though the curve connecting the watts and the time is by no means a straight line. Dividing by the watts gives

$$\text{Time in hours} = \frac{a}{\text{watts}} - b.$$

The curve connecting the capacity in ampere hours with the rate in amperes is somewhat similar, but for this accumulator it is not so close an approximation to a straight line; perhaps it may be for other types, but if it is not, it may be sufficiently so for many practical purposes.

As it is often required to know the capacity at a certain rate, or perhaps the rate for a certain capacity or time, the above simple relation may be of use to those working with accumulators. The desired information can, of course, be obtained even without calculation from the curve itself, but it may often happen that the curve is not at hand while the constants are easily remembered or noted.

The constants must, of course, be determined for each type of cell, as they will probably differ considerably, depending mainly on the thickness of the active material, and on its porosity.

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* From the *Electrical World*.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, March 15th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Rarer Metals and their Alloys," by Prof. Roberts-Austen, F.R.S.

SATURDAY, March 16th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture (III.):—"Waves and Vibrations," by the Rt. Hon. Lord Rayleigh, F.R.S.

MONDAY, March 18th.

LONDON CHAMBER OF COMMERCE.

12 noon. Meeting of the Electrical Trade Section at Botolph House, Eastcheap. The most important item on the Agenda is to consider the proposed Telephone Agreement between H.M. Post Office and the National Telephone Company.

TUESDAY, March 19th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be further discussed: (I.) "The Kidderpur Docks, Calcutta," by William Duff Bruce; (II.) "Note on the Movement of the Walls of the Kidderpur Docks," by James Henry Apjohn. The following Paper will be read, time permitting: "Steam Engine Economy: Condensing Engines," by Henry Davey.

WEDNESDAY March 20th,

ROYAL METEOROLOGICAL SOCIETY.

7:30 p.m. Ordinary Meeting at 25, Great George-street.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Meeting at 20, Hanover-square.

FRIDAY, March 22nd.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Royal College of Science. The following Papers will be read: (1) "The Objective Reality of Composition Tones," by Prof. A. W. Rucker, F.R.S., and Mr. Edser; (2) "Some Acoustical Experiments," by Dr. C. V. Burton; (3) "The Use of an Iodine Voltameter," by E. T. Herroun.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting at 28, Victoria-street. The following Paper will be read: "Lead Covered Cables," by Mervyn O'Gorman.

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AS OTHERS SEE US.

"O wad some Pow'r the giftie gie us"—; the American Institute of Electrical Engineers has been good enough to undertake the task, and enable us to see oursel's as Mr. H. WARD LEONARD sees us. Whether it wad frae monie a blunder free us, and foolish notion, may be judged by a perusal of his Paper on "Notes on Recent Electrical Engineering Developments in France and England," which we reprint elsewhere. There is, we understand, in the United States a Society for the Discouragement of Lynching, or something of the kind, and to such we commend Mr. WARD LEONARD, for surely his plain speaking will get him into trouble with his countrymen. He begins by paying them a half-hearted compliment in saying that from the commercial point of view America wins easily, but at once goes on to observe that "considering the recent electrical development, from an engineering standpoint, we"—that is Americans—"are rapidly losing the lead we have thus far held." To discriminate between a commercial and a scientific standpoint is generally easy; but to set up a distinction between a commercial and an engineering standpoint, when a practical industrial matter is to be examined, is rather difficult; and that any marked distinction should exist is highly complimentary to the profession of engineering. We suppose that from a commercial point of view, an electric supply system exists for the purpose of earning dividends upon the shareholders' capital, and that these earnings are the only solid measure of success. The purely scientific point of view is the consideration of the ratio of the calorific energy of the fuel to the radiant energy of the lamps, having regard also to continuity and constancy of difference of potential. The engineer, taking the load factor as he finds it—unless, like Mr. WRIGHT, he can manage to humour it—taking his coal as he can get it, strives to turn out a kilowatt-hour for the smallest possible expenditure in fuel and labour, and this with the most economical equipment of plant and mains. Define it how you will, though he may be engaged on a number of scientific problems, the aim of the engineer is almost identical with that of the mere commercial man, though his methods of going to work may differ widely. It is probably with the methods in view that Mr. Ward Leonard makes this distinction.

It is a pity that Mr. Ward Leonard does not record any impressions of visits to continuous-current supply stations other than Manchester, for then we should be better able to appreciate the value of his opinion that "the best three-wire central station plants in the world" are to be found on his side of the Atlantic. He evidently has a leaning towards a common-sense selection of alternating or of continuous current supply according to the conditions of each case, and his views on the use of batteries, methods of maintaining uniform pressure, and upon main laying, would have been interesting. He appears to think that batteries only continue to exist because we have no day load of motors. Competition in England, we learn, "is mainly on ideas, and not on the cost of dynamos per kilowatt. It is surprising to find," he continues, "that generators and motors are much cheaper in the United States than in either England or France, notwithstanding their advantages over us as to cheaper raw materials and labour." Here we have a little glimpse of the difference between the commercial and the engineering standpoint. The commercial man is satisfied with a cheap dynamo that will give its stipulated output, and one that will last for a few years until it is superseded by inevitable improvements. He is thus satisfied, because he knows no better. The true engineer, however, wants good regulation, no sparking, noise, or heating, high efficiency, both in working and in materials. Mr. Ward Leonard does not say a word about the comparative efficiencies of American and of English dynamos. He believes that his countrymen are ahead of England and France in designing dynamos and engines, but gives no grounds for his belief. He runs away, as usual with engineers who have not given close attention to the matter, with the idea that a choice and elegant governor chock-full of scientific jim-cracks, and in fact one of those "triumphs of engineering skill which are so common" in the United States, is better than a throttle-valve governor for electric supply work. We commend Capt. Sankey's recent Paper to the attention of those who hold similar views. If we are not mistaken, the much over-rated Corliss engine is fast giving way in American stations to direct-coupled high-speed engines. We do not claim to have taught this to our cousins, because they sent over Edison's "steam dynamo" in 1883. This possibly gave so severe a shock to the feelings of English engineers that the first supply station—viz., at Kensington Court—did not open until 1886. The three-wire system was no doubt started at Sunbury, Pa., in July, 1883, and the Westinghouse 1,000 to 50-volt alternating system in about 1887; but it must be remembered that the Gaulard and Gibbs demonstration at Edgware-road, and other stations on the Metropolitan Railway, was made in 1884, and was followed in the same year by the establishment of the Grosvenor Gallery plant, which grew to supply nearly 10,000 lamps. We in this country know so little of the "gigantic corporations" which seem to impede improvements in the United States, that we cannot judge to what extent such a cause could have induced the repetition of 1,000 to 50-volt distributions, instead of 2,000 to 100 volts, as with us. We are inclined to think that the difficulty of making a good 100-volt 8-c.p. lamp has had a good deal to do with it.

While it is a great pleasure to find an American who can assume any other attitude than that of the graceful spread eagle when he condescends to turn his attention to European engineering, it is a still greater pleasure to find one who can give such an interesting, critical, and appreciative account of what we, according to our lights, venture to think is the most satisfactory way of going to work. In more than one place, as if with the fear of his fate before his eyes, if he should dare to disparage time-honoured American customs, Mr. Ward Leonard veils his remarks in language almost too subtle for his immediate audience—as, for example, where he observes that the designer of the Liverpool Electric Railway seemed to realize that the rheostat might just as well be left out. Another remark, put so nicely as hardly likely to wound the feelings even of the most susceptible, is to be found at the end of the first paragraph on the City of London Company. We hope that those concerned will take properly to heart Mr. Ward Leonard's indictment of the measuring instruments in our supply stations. The fault lies as much with the consulting engineer as with the contractor. The former dares not specify two or three makers only, and leaves the item open, specifying for as many ammeters and voltmeters as can be supplied for £50, or as many as the switchboard will comfortably hold; the contractor, of course, fills the bill with German trash. To save himself from ridiculous mistakes, the engineer in charge has to get at least one really good instrument to check the others by; these, probably, are Mr. Ward Leonard's "fine instruments" which "seemed to be more suited for a physical laboratory than a central station." The Weston instrument, of which the author is so justly proud, is a first-rate criterion; but if he had been better informed, he would have written that the English can make ammeters and voltmeters equal to Weston's for accuracy, legibility, and dead-beatness, but that for some reason they do not use them on their switchboards. The acute appreciation of the different conditions of supply makes this Paper particularly interesting, and the section on the load factor is more closely reasoned than anything that has been presented to an American audience for some time past.

REVIEWS.

Electrical Engineering. By W. Slingo and A. Brooker. New and Revised Edition. (London: Longmans, Green and Co. 1895.)

In the new edition of this excellent work a considerable number of additions have been made and several parts re-written. This is undoubtedly the only book which attempts to cover the whole field of electric lighting, and it is one which we have often recommended and can continue to recommend.

In future editions the authors ought to severely prune certain sections. Future developments will infallibly make demands on their space, and there is no room in a thoroughly practical book of this kind for antiquated machinery and apparatus. The description of the De Meritens alternator is useful as an introduction to modern machines, but the Forbes hot-air meter hardly serves the same purpose to the very scant section on this subject. Secondary batteries are well done, but transformers do not receive much attention.

Electric Light Installations. Vol. III. By Sir David Salomons. (London: Whittaker and Co. 1894.)

It is hardly possible to treat this volume seriously as a practical handbook. The original book out of which these three volumes have grown served a very useful purpose as a guide to the use of accumulators, and as far as we know remains, as the first volume of the present edition, the best one that exists. We were led by the second volume, which was profusely illustrated, to expect a practical third volume. In one sense it is practical, for it consists of a collection of notes of the author's experience. But as this experience must necessarily differ very greatly from that of ordinary engineering or laboratory practice, it cannot appeal to a large circle of readers. The chief defect, and the only one to which we will call attention, is the complete want of arrangement of the contents. The titles of the chapters are very vague; nothing but these titles appear at the head of the alternate pages; there are no sub-sections, and successive paragraphs deal with totally different and disconnected subjects. The index, by which this fault might have been partially remedied, is very meagre.

Practical Electric Bell Fitting. By F. C. Allsop. Fifth Edition, revised and enlarged. (London: E. and F. N. Spon.)

Electric bell fitting, although not a branch of electrical engineering but of electric "plumbing," is an extremely important domestic application of electricity. A doleful experience of the vagaries of the trembler bell is often brought forward as an argument against the adoption of the electric light; the logic is, of course, painful, and so is the consequence of it to the would-be supplier of electric energy. The proper fitting of electric bells is not, therefore, altogether beneath the notice of the "heavy" engineer. In a purely practical craft, however, next to nothing can be learned from books, but if they must be written it would be well if they were always as good of their kind as Mr. Allsop's little volume. A practical book written by a practical man for practical men is, as a general rule, about the dreariest reading imaginable, a defect which could, however, be endured with cheerful resignation by the reviewer if he could see any probability of those for whom such lucubrations are ostensibly intended benefiting by them ever so little. It is, therefore, particularly refreshing to occasionally come across a book like the one under consideration, which is at once lucid and well arranged, and withal thoroughly practical. A volume which has gone through five editions in as many years needs no bush.

Laxton's Price Book. 1895. (London: Kelly and Co.)

The electrical section of this compilation is the only one which requires review in the columns of an electrical journal. It cannot be said that this portion grows better as it grows older. There is, for instance, an indefinably prehistoric tone about the whole of the seven-and-twenty pages devoted to electric lighting, and the information supplied is neither particularly correct nor particularly useful. The prominence given to the names of two or three firms may be good business, but it cannot fail to prove rather misleading to the "architects, builders, engineers, and contractors" for whom the book has been prepared.

Lockwood's Price Book. 1895. Edited by Francis T. W. Miller. (London: Crosby, Lockwood and Son.)

The electric lighting section of this now well-known annual publication covers some seven-and-thirty pages, and is at once as accurate and up-to-date as is to be expected in a volume covering ground ranging from fireproof construction to road-making.

Hilfsbuch für die Elektrotechnik. By C. Grawinkel and K. Strecker. Fourth Edition, enlarged and corrected. (Berlin: Julius Springer.)

This volume is a truly comprehensive production. It is something between a text-book and an engineer's work of reference. The whole field of applied electricity from transmission of power to electro-plating is dealt with in some 650 pages. A book like this, obviously intended for practical men, might, if restricted to tables, curves and data, cover such a wide ground and yet prove of real use; but one which professes to do more than this cannot do justice to any and every subject treated of in its pages.

THE ELECTRIC ARC.

BY HERTHA AYRTON.

(*Continued from page 545.*)

At a very early stage in the experiments I am describing, it was found that altering either the current or the length of the arc caused a change in the shapes of the carbons and visible arc, which in some cases was very considerable. Therefore, it was thought advisable to obtain a record of these changes under all circumstances, and diagrams of the carbons and arc were taken, when the potential difference had acquired its steady value, for all the currents and lengths of arc observed in the experiments from which the curves in Figs. 4, 5, and 6 (pp. 336 and 337, *The Electrician*, January 18th) were taken.

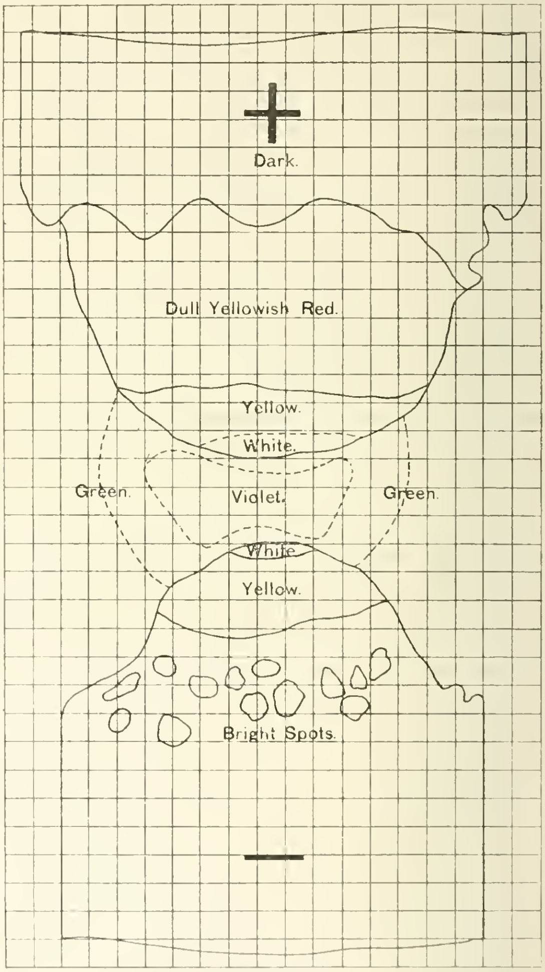


FIG. 26.—Image of Carbons and Arc 5 times full size. Current, 10 amperes. Length of Arc, 3mm. P.D. steady at 46·5 volts.

The diagrams were obtained by placing a piece of squared paper over the screen on which the enlarged image of the arc was projected, and drawing the complete outlines of the carbons and image. The carbons were always easy enough to draw, for they were very definite; but the exact curve which outlines the purple image of the arc is much more difficult to obtain, because this image melts off very gradually into the surrounding darkness.

While, therefore, the diagrams in Figs. 26 to 32 show very accurately the shapes of the ends of the carbon under the given conditions, the dotted outlines of the arc must be taken to be only approximately correct. They show, for instance, that the diameter of the visible part of the arc is smaller, the smaller the current, with a given length of arc, but not with absolute accuracy exactly how much smaller.

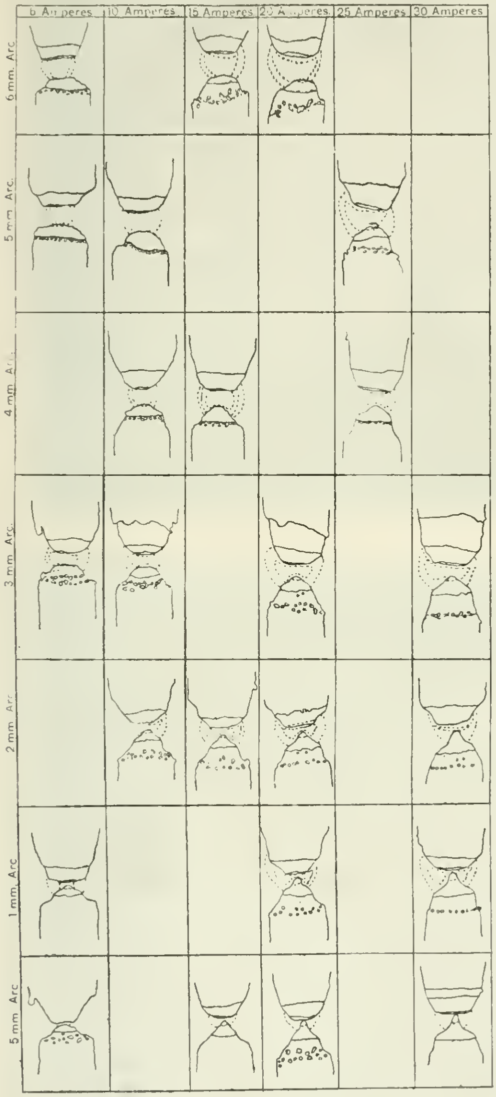


Fig. 27.—Carbons, Positive (upper) 18mm. cored. Negative (lower) 15mm. solid.

Fig. 26 is a reproduction of one of the diagrams half of the original size, and since the original diagram enlarged the carbons *ten* times, this reproduction shows them *five* times full size. It may be observed that while there is a white-hot crater at the end of the positive carbon, there is also a white-hot tip to the negative, but the area of the crater in the positive is, as a rule, much larger than the area of the white-hot tip of the

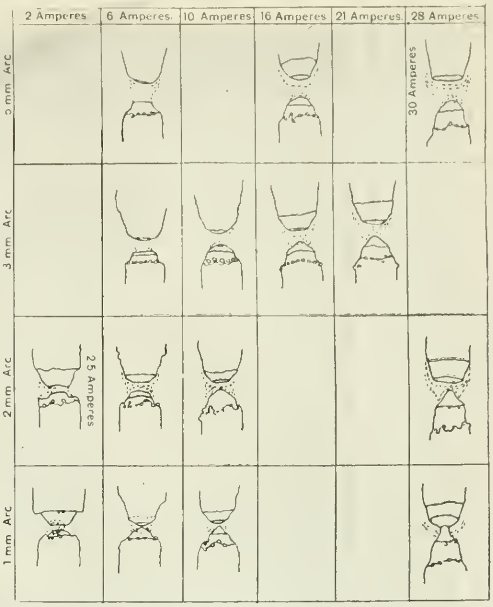


Fig. 28.—Carbons, Positive (upper) 13mm. cored. Negative (lower) 11mm solid.

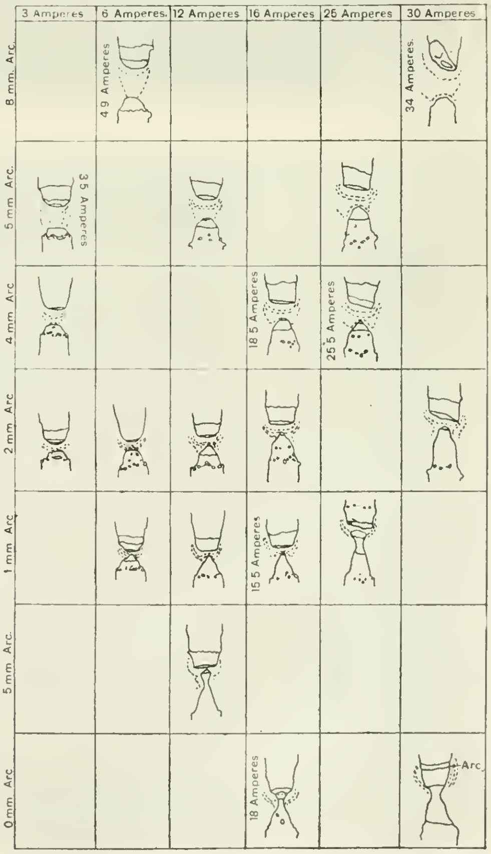


Fig. 29.—Carbons, Positive (upper) 9mm. cored. Negative (lower) 8mm. solid.

negative. It seems possible that this white-hot spot which is always present on the tip of the negative may be as hot as the crater of the positive, for the light it gives out is apparently quite as intense as that given out by the crater, though much less in *quantity*, of course. That this glowing tip of the negative carbon does give out a fair amount of light may be easily seen by observing the light on its way to a screen after reflection at a mirror such as M, in Fig. 2 (p. 336, *The Electrician*, January 18th).

The beam of light divides itself into two distinct parts, separated by a dark space, so that it looks like two beams, one coming from the bright spot on the negative carbon, the other from the crater of the positive. If a piece of paper be placed in the dark space between the two beams it will have a faint violet light on it, but this light is evidently not sufficient to make the dust particles in the air visible. The area of the bright spot on the tip of the negative carbon increases with the current, but at a much slower rate

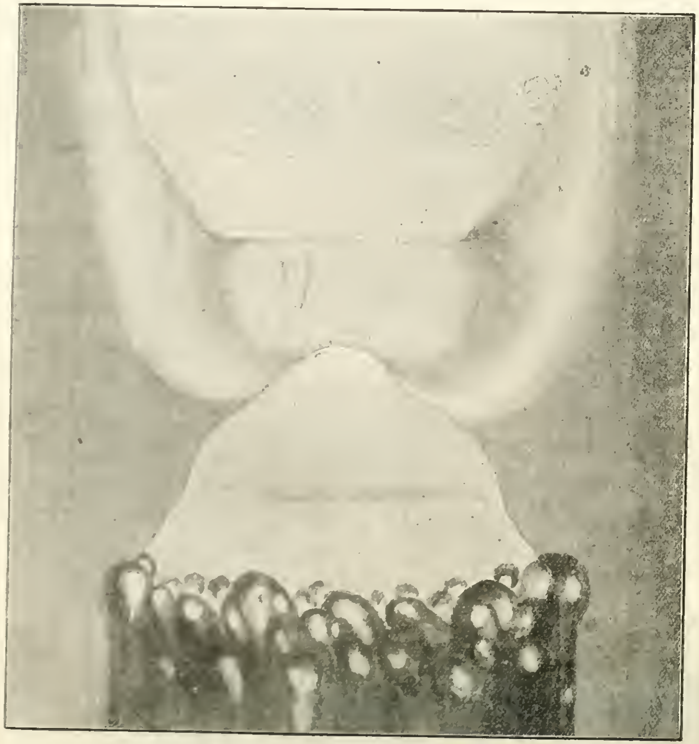


FIG. 23.—Carbons: Positive, 18mm. solid; Negative, 15mm. solid Current, 20 amperes. Length of Arc, 4mm

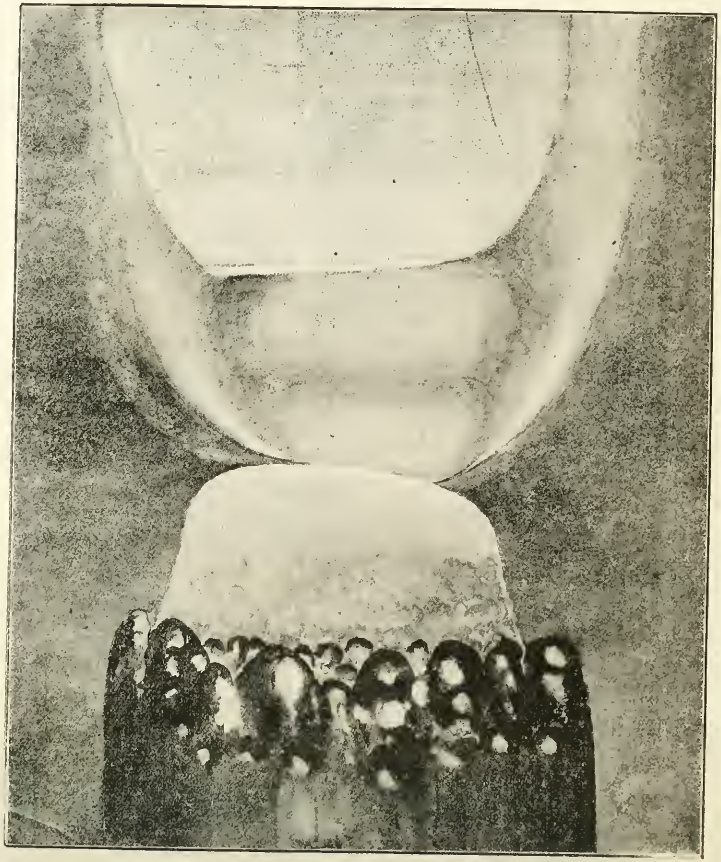


FIG. 35.—Carbons: Positive, 18mm. cored; Negative, 15mm. solid. Current, 20 amperes Length of Arc, 7mm.

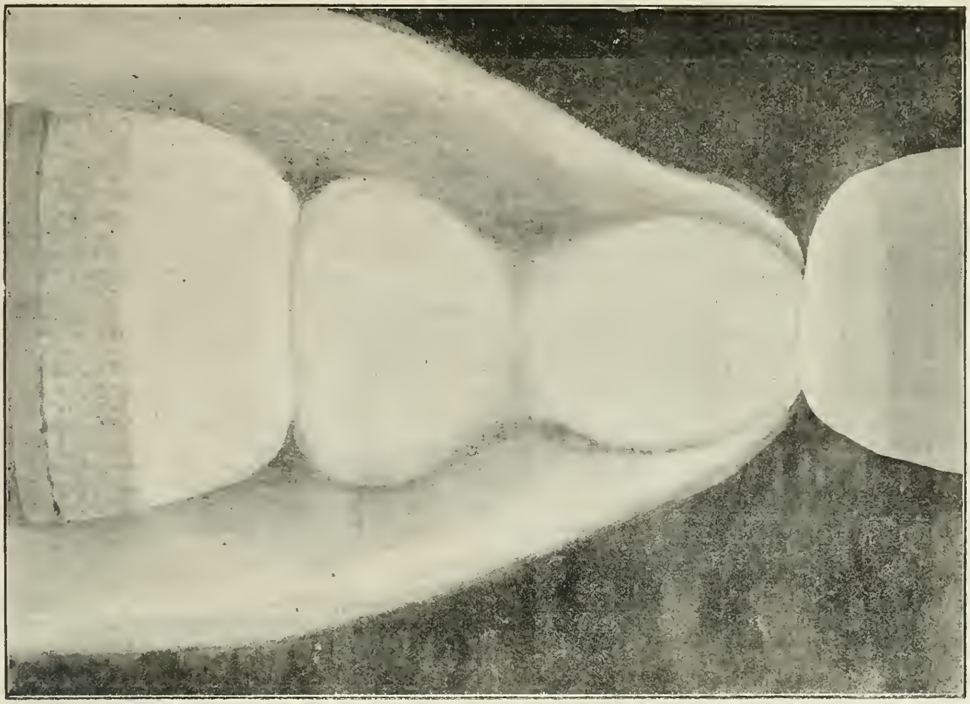


FIG. 36.—Carbons: Positive, 18mm cored; Negative, 15mm. solid. Current 20 amperes. Length of Arc, 18mm.

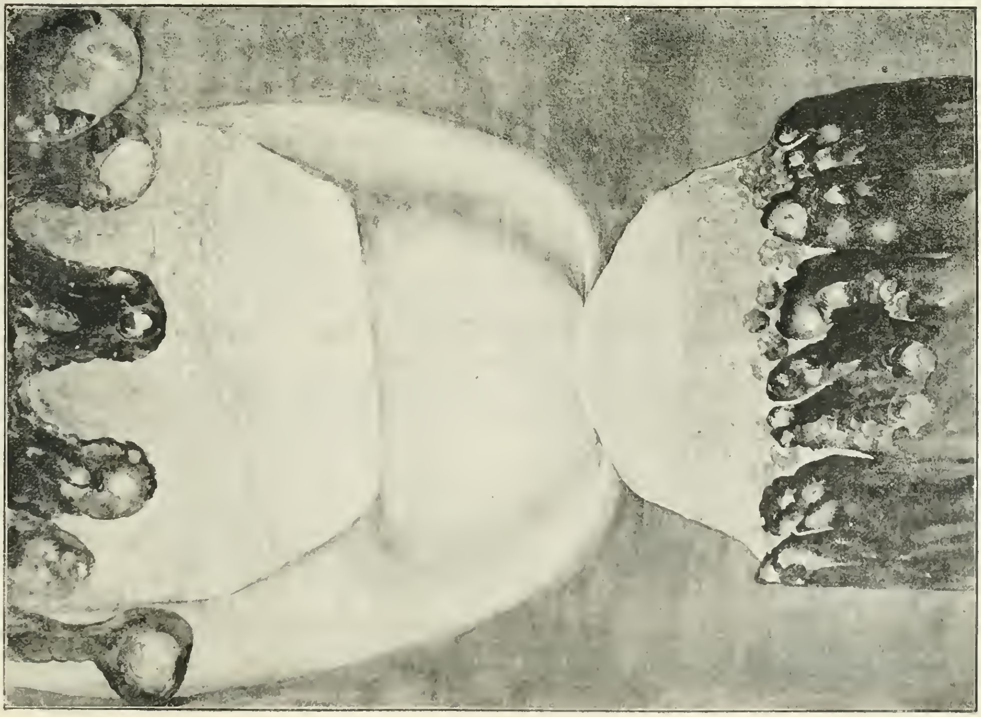


FIG. 34.—Carbons: Positive, 18mm. solid: Negative, 15mm. solid. Current, 20 amperes] Length of Arc, 7mm.

than the area of the crater in the positive, so that the ratio of the area of the crater to the area of the negative bright spot increases rapidly as the current increases, with silent arcs.

The part marked "bright spots" on the negative carbon (Fig. 26) represents a circlet of seething balls, which are either boiling carbon, or the tar or syrup, in which the carbons are soaked in the course of manufacture, in a state of ebullition. Whatever they are, these balls always appear at the junction of the light and dark parts of the negative carbon. Above them, as far as the line which is marked "yellow," the carbon presents a granulated appearance, being covered with very small boiling balls, and the whole being of a reddish yellow colour. Then comes the yellow-hot part, marked "yellow," which is quite smooth, and finally the white-hot tip.

The positive carbon has also its smooth yellow-hot part marked "yellow," and its band of granulated darker yellow part above that, and higher still its circlet of seething balls—larger than those on the negative. The outlines of these balls are indicated (Fig. 26) in the highest wavy line, but they cannot generally be seen very distinctly, because no light is thrown on to them to be reflected back again, as the light from the crater is cast on to the negative carbon. The negative cannot send its light on to the positive circlet, because that light is stopped on its way by the crater; and the light from the crater can naturally not struggle round the corner to get on to the upper part of the positive carbon. Thus, it is only when the current is so large as to flood the whole image with light that the boiling balls on the positive carbon can be seen as well as those on the negative.

Between the part of the arc marked "violet" and that marked "green" there is really a dark space, which is scarcely perceptible with small currents and short arcs, but becomes very wide and well marked with large currents and long arcs. The "green" line shows the extreme edge of the luminous part of the arc, or, at least, of that part which is bright enough to show light on the image.

In Figs. 27 to 32 a large number of the diagrams made have been reduced from ten times full size to two-thirds full size, and arranged in order of the sizes of the carbons, the lengths of the arc, and the currents. Figures in the same horizontal row are for the same length of arc with different currents, and figures in the same vertical column are for the same current with different lengths of arc. It may be noticed in all the figures that with a short arc, say 0·5mm. (Fig. 27), the negative carbon is quite pointed, even with a small current, and that it becomes more and more pointed as the current becomes larger and larger. With a 1mm. arc the negative is less pointed, both with small and large currents, than with a 0·5mm. arc, and as the arc gets longer the negative becomes blunter and blunter, although in every case it is more pointed with a large current than with a small one for the same length of arc. At last, when the arc is 6mm. long, the negative is quite blunt, even when a current of 20 amperes is flowing. Thus, the tip of the negative is more pointed—

(1) The shorter the arc,
(2) The larger the current.

Before explaining the causes of these phenomena, we must examine the shapes of the negative tips a little more closely. Comparing the 6-ampere $\frac{1}{2}$-mm. arc with the 6-ampere 3 mm. arc in Fig. 27, one sees that the former is like the latter, with a sort of extra point added; comparing the 30-ampere arcs for the same two lengths, the same thing is observable. This sort of extra point is, in fact, found on all the negative carbons when the arc is short, whatever the current, and it is not found on any when the arc is long. This point must, therefore, depend upon the carbons being near together, and is caused, I think, solely by carbon deposited on the negative tip from the crater of the positive. As the arc is lengthened, less and less of the carbon shot out by the positive reaches the tip of the negative, and this little extra tip becomes smaller and smaller, and finally disappears.

When the distance between the carbons is great, the arc often plays about the end of the positive carbon, sometimes seeming to travel round and round it, sometimes remaining stationary in one place for a short time, and then going to another, and so on. But, however the positive end of the arc may move, the negative end generally appears to remain in the same place, so that the negative bright spot remains fixed in position, and when this is so, on extinguishing the arc, it is found that there is a small crater at the end of the negative carbon.

It is possible that this crater would always exist in the negative carbon were it not that when the arc is shorter the crater is constantly filled up by the carbon deposited on it from the positive carbon.

When the arc is very short, and the current large enough to cause hissing, the deposition takes place so rapidly as to cause a "mushroom" to form. Even when the arc is short and silent the deposition is still often rapid enough to cause the negative carbon to grow longer instead of shorter, and this fact alone would seem to prove the point that the extra tip noticed on the negative carbon with short arcs is caused by carbon deposited on it from the crater.

It is true that with large currents the tip of the negative carbon is somewhat pointed even with long arcs, but it seems to be pointed in a different way. The end of the carbon has no little extra tip on it, but becomes more nearly cone shaped, and this sort of pointing is attributable, I think, to quite a different cause—namely, the burning away of the carbon. Most of the heating of the negative carbon takes place from the outside, and is caused partly by radiation from the crater and partly by the volatile carbon giving up its heat to it. When the current is small the heat is comparatively small; therefore only a thin layer and a short length of the negative carbon are made hot enough to burn away, and consequently the point, which is the result of the burning away, is short and blunt.

With large currents, however, the heat, being greater, reaches farther, both through and down the negative carbon, and the resulting tip is longer and more slender. It is more or less conical, because the parts farther away from the positive carbon get less heat, and, therefore, a thinner layer of them is burnt away.

Thus with short arcs there are two distinct causes tending to give the tip of the negative carbon its special shape, whereas with long arcs one of these causes is nearly or quite inoperative, hence the difference of the character of the shapes of the negative carbons in the two cases.

It is much more difficult to see what happens to the positive carbon when the arc is lengthened or the current increased, because that carbon is very rarely luminous over the whole length of its tapering part. As has already been pointed out, the negative carbon is always bathed in the light from the positive, and, therefore, its shape is very easily discernible; but the positive sends all its own light away from it, and can receive little, if any, from the negative. But even so, by comparing the carbons in those cases in which it has been possible to trace the positive carbon to its unburnt part, it may be perceived that it also tapers more with a short arc than with a long one for the same current, and has a longer, but less pointed, tapering part for a large current than a small one.

For instance, take the 6-ampere 0·5mm. arc and the 6-ampere 5mm. arc in Fig. 27, evidently the positive carbon tapers more in the former than in the latter; and in the 5mm. arcs in the same figure the positive carbon has a longer tapering part with 25 amperes than with 5 amperes.

Apparently what happens is this. The positive carbon is consumed in two ways—(1) by volatilisation, (2) by burning in combination with air. It is not probable that volatilisation, which requires an enormous temperature, can take place anywhere except at the surface of the crater, and perhaps at the parts of the tip immediately surrounding that surface; therefore all the shaping of the positive carbon, except the formation of the crater, must depend upon the burning in combination with air. At the extreme tip the burning will take place most rapidly, because, owing the immediate vicinity of the crater, the surface carbon will be hotter there than anywhere else, and the larger the crater the more rapidly the tip will burn away. Thus, instead of becoming more pointed as the current increases, the positive carbon actually becomes less pointed, because the tip burns away so much faster than the sides, The point is longer, however, the larger the current, because the increased amount of volatile carbon extends farther up the sides, and thus burns away a longer portion of the carbon.

When the arc is short, the volatile carbon, not finding room between the tips, spreads out farther, and so also spreads farther along the surfaces of the carbons and causes them to burn away farther along than when the arc is long. In fact, a given amount of volatile carbon must take up a given space with a given pressure all round it. If it can get this space between the carbons, it takes it; if not, it extends itself sideways and longways. Thus the ends of both the carbons have longer points on this account with short arcs than with long ones.

Fig. 30 shows very well the alteration that takes place in the shapes of the carbons when the current is suddenly changed from a higher to a lower and from a lower to a higher value. The left-hand figure shows particularly well the alteration in the negative carbon. In this case, after the carbons had been formed by a current of 30 amperes, it was suddenly changed to one of 4 amperes, and three minutes afterwards the dotted line diagram was taken, showing the negative carbon with a long tapering part. But with the smaller current the volatile carbon did not extend down nearly as far as before; consequently, as the tip of the carbon was gradually burnt away, the tapering of new parts of this negative carbon was not kept up. Hence, in 25 minutes after the current had been reduced from 30 to 4 amperes, the end of the carbon had become blunt, as shown by the continuous line. The small piece at the top of the carbon, which is of much smaller diameter than the remainder, indicates how far down extends the burning action of the amount of volatile carbon given off by the smaller current.

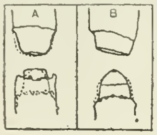


Fig. 30.—Carbons: Positive (upper) 13mm. cored. Negative (lower) 11mm. solid. Length of Arc 4mm. A, Current suddenly changed from 30 amperes to 4 amperes. Dotted lines show the shapes of the Carbons 3 minutes after the change. Continuous lines show their shapes 25 minutes after. B, Current suddenly changed from 10 amperes to 30 amperes.

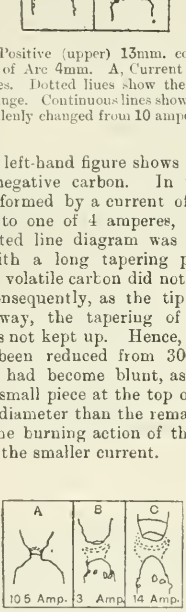


Fig. 31.—A, Carbons: Positive (upper) 13mm. solid. Negative (lower) 11mm. solid. Length of Arc. 0mm. B and C, Carbons: Positive (upper) 9mm. solid. Negative (lower) 8mm. solid. Length of Arc, 4mm.

Fig. 31 shows the arc with solid carbons. In B (Fig. 31) a current of 3 amperes is flowing through an arc of 4mm. Comparing this with the arc of the same length, and with the same current in Fig. 29, in which the carbons are of the same edge, the only thing to notice is that the visible arc, as shown by the dotted lines, is larger with a solid than with a cored positive carbon. Experience has shown that this is quite correct. In every case in which I have been able to compare the size of the arcs obtained with solid and cored positive carbons under similar conditions, I have found the area of the visible part to be larger when the carbons were both solid.

In Fig. 32, the positive carbons are solid, and the negatives cored, with the result that the latter are burnt away farther down than they would have been if the cases had been reversed.

Wishing to obtain drawings, which I could compare with one another, of the arc under different conditions, I have, within the last week, drawn the originals of Figs. 33 to 36.

These figures were obtained by tracing the enlarged outlines of the carbons and arc in the way already described; but very special attention was given to the outlines of the purple part of the arc, the shadow, and the green outside part.

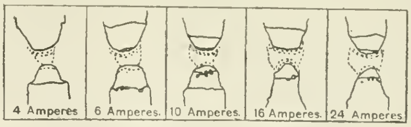


Fig. 32.—Carbons: Positive (upper) 13mm. solid. Negative (lower) 11mm. cored. Length of Arc, 4mm.

In Fig. 34, I was fortunate enough to obtain the outlines of the balls of boiling carbon on the positive as well as on the negative carbon. In Figs. 33 and 35 they could only be seen on the negative carbon, and in Fig. 36 the arc was so long that the screen was not large enough to show the boiling balls on either of the carbons.

Having obtained all the outlines as correctly as possible, I shaded them with sepia, so as to give as nearly as possible the *values* of the light given out by each part. Thus the most light was given out by the crater of the positive carbon, and by the tip of the negative carbon; therefore these are left white. The shadow between the purple and green parts of the arc are somewhat more abrupt than they really were, but their *shapes* are, I believe, correct.

Unless the axes of the two carbons are absolutely in line, the arc is always a little to one side or the other, and that is the reason that the arc in all these four figures is slightly out of the centre; it is almost impossible to get it perfectly central.

The current used for the whole four figures was 20 amperes, the carbons were 18mm. positive and 15mm. negative.

In Fig. 33 the length of arc was 4mm., and the carbons used were both solid. The central purple part of the arc is of the form of an oblate spheroid broken in upon by the tips of the carbons. Another diagram I made of an arc of the same length and with the same current, but with the positive carbon cored, shows a central part of much the same shape, but of smaller area, smaller, in fact, not only in width, but in length, because although the distance between the tip of the negative and the plane through the edge of the crater was in each case 4mm., the central part with the solid positive carbon surrounded a much greater length of the point of the negative than with the cored positive. The green part of the arc also started much higher up the negative with the cored than with the solid positive carbon, and ended touching the positive carbon 4mm. from its tip, whereas the green part with the solid positive (Fig. 33) could still be seen at a distance of 14·5mm. up the positive carbon. Thus, the whole visible part of the arc is much larger with a solid positive carbon than with a cored for an arc of 4mm. and a current of 20 amperes, but the general *form* of the arc is very much the same.

In Figs. 34 and 35 the two arcs are of the same length, 7mm., the current 20 amperes; but in Fig. 34 the positive carbon is solid, and in Fig. 35 it is cored. Here, again, both the central purple part and the green portion surround the negative carbon to a greater distance with the solid positive than with the cored; again, also, both the central portion and the whole visible arc are larger with the solid positive than with the cored. But in these two figures the *form* of the central part is also different. With the cored carbon it is gourd shaped, with the solid, pear shaped. The tip of the positive is more, and the tip of the negative less, pointed with the cored than with the solid carbon, which may be due to a lower temperature of the crater in the cored carbon, for it has been shown above that greater heat meant a more pointed negative carbon and a less pointed positive.

The balls on the positive carbon in Fig. 34 were not really luminous the whole time I was observing the arc for that figure, but every now and then there was a little hiss caused by some imperfection in the carbon, which lighted them up, and during one of those periods I drew them.

In Fig. 36 the positive carbon was cored, and the arc was 18mm. in length, the current still 20 amperes. In this arc the gourd shape is much accentuated—the central part looks almost like two air balls, the one next the positive carbon placed horizontally, the other placed vertically below it, and touching the negative carbon. The vertical ball has inside it a small ball touching the negative, and all three balls were of different shades of purple. The small one was palest, the large one near the negative darker, and the one near the positive was of a still darker shade.

The shade of purple, with solid and cored positive carbons, is quite different, being much redder with the solid than with the cored positive.

I tried to obtain an arc of 18mm. with both carbons solid, in order to compare the two diagrams, but found it impossible to maintain an arc of more than 14mm. with two—18mm. and 15mm.—solid carbons. Every time the length of the arc was increased beyond this the arc went out.

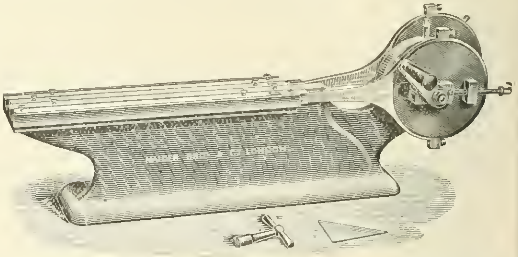
The shape of the 14mm. arc, however, showed no tendency towards the double ball form observable with the cored carbon; it retained the pear shape noticed in Fig. 34.

Thus it is clear that the use of a cored positive carbon, instead of a solid, changes the *size*, the *colour*, and, in long arcs, the *form* of the visible part of the arc.

(To be continued.)

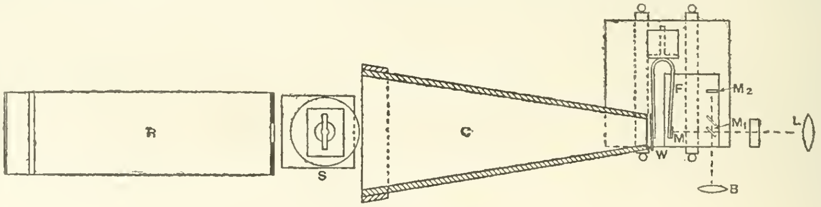
WILKINSON'S VALVOMETER.

Messrs. Nalder Bros. and Co. are making an instrument, designed by Mr. H. D. Wilkinson, for facilitating the design and setting of slide valves. It consists of two sliding bars, on which the ports may be set out, and two eccentrics, which can be independently adjusted for throw and angle of advance. The handle shows the position of the crank. The adjustments and means of reading the angles and throws are more complete than is usual in such instruments.



THE PHYSICAL WORK OF HERMANN VON HELMHOLTZ *

The career of von Helmholtz was, the lecturer said, a career of singular distinction. In days when the range of natural knowledge was so vast that most workers were compelled to be content if they could add something to one or two of the sub-divisions of one of the main branches of science, Helmholtz showed that it was not impossible to be at once a great mathematician, a great experimental physicist, and, in the widest sense of the term, a great biologist. Making all allowance for the spell of his name, the lecturer felt sure that he was only expressing the views of all those who knew Helmholtz's work best, when he said that the present generation placed him, and he believed the future would confirm the verdict, in the front rank of those who had led the great scientific movement of the present time. His life was a calm one; he passed from success to success till he was recognised by all as the Admirable Crichton of modern science: the most widely cultivated of all students, the first scientific man in Germany, and one of the first scientific men in the world. Helmholtz's third contribution to science was the famous essay on "The Conservation of Force." The lecturer said he had told elsewhere (*Fortnightly Review*, November, 1894) the dramatic circumstances under which this essay was given to the world, and the interest it excited amongst the members of the Physical Society of Berlin; of the refusal of the editor of Poggendorf's *Annalen* to publish it, and the final triumph of the author's views. Helmholtz was not, and did not claim to be, the original author of the doctrine of the conservation of energy: but two young men—Sir William Thomson in England and Helmholtz in Germany—independently, and within a month of each other, were the first persons who compelled the scientific world to regard it seriously. The most characteristic work of Helmholtz was that in which his knowledge of physics and his knowledge of anatomy were both directed to a common end. The two works in which Helmholtz's solutions of physiological problems were treated were his "Physiological Optics" and his "Sensations of Sound." With a view of giving the audience some idea of the intricate problems with which Helmholtz dealt, and the pitfalls amongst which he walked so warily, the lecturer said that he had chosen one single branch of Helmholtz's work to discourse upon that evening, viz., his work on "Sound."



General Plan of Apparatus.

Among the chief achievements of Helmholtz was his explanation of the physical difference between pairs of notes, which we recognise as concords and discords respectively. After having elucidated Helmholtz's theory, the lecturer went on to say that when two notes were sounded simultaneously, a third tone was often perceived, the frequency of which was equal to the difference of the frequencies. There had been considerable controversy as to whether the beats, when they became rapid, could produce a note, and if so, whether this note was or was not the same thing as the difference tone it was necessary to distinguish between the two. Helmholtz also drew attention to the fact that, together with this difference tone, there was also produced a note, the frequency of which was equal to the sum of the frequencies of the two primaries, and these he called the first summation tone. Together with these, he believed that there existed summation and difference tones of higher orders, the whole series being included in the single name of combination tones. The sense of dissonance between pure notes was explained as dependent on the beats produced by the combination tones. Up to the time of Helmholtz, it was generally believed that these tones were produced in the ear itself, and had no objective existence in the external air. Helmholtz admitted that these tones in most cases were "ear-made," but he also asserted that they were sometimes objective. This statement had, however, been denied with singular unanimity. The lecturer then stated that he hoped to show that evening that difference tones were capable of exciting a resonator.

The essential part of the apparatus was the tuning fork F, to one prong of which was attached a mirror, M, and to the other a square of thin wood, W. The frequency of the fork was 64 ∼; the mirror M_1 was silvered so finely that half the light which fell upon it was reflected, and half transmitted. The ray proceeding from the lantern L was divided at M_1 into two rays, which followed respectively the paths L M_1 M_2 M_1 B and L M_1 M M_1 B. Interference bands were thus produced, which could be projected on a screen so as to render them visible to a large audience. If the prongs of the tuning fork moved through the eighty-thousandth of an inch, that was through a distance equal to a half wave-length of light, the path of the ray which fell upon it was shortened by a whole wave-length, and the position of each band was shifted to that previously held by its neighbour. If the fork vibrated with amplitude of this almost infinitesimal amount, the bands would disappear or would alternately appear and disappear according to circumstances. The fork might thus be used to detect by resonance the presence of vibrations, the frequency of which was 64 ∿. Every precaution had been taken to prevent the fork being affected by extraneous tremors. To supplement the sensitiveness of the tuning fork, there was placed in front of the siren S a hollow wooden pyramid, C, the narrow end of which was near to and was of the same area as the wooden plate attached to the tuning fork. This served to collect the sound waves, and concentrate them on the fork. Behind the siren was a large resonator R, by König, tuned to respond to 64 ∿.

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* Abstract of a discourse delivered at the Royal Institution by Prof. A. W. Rucker, F.R.S., Friday, March 8th.

As an illustration of the sensitiveness of the apparatus to vibrations of 64 ∿, and its obtuseness to other sounds, the lecturer stated that provided the current of air did not travel directly down the cone, organ pipes might be blown just outside it without effect. If, however, the exciting forks were tuned to 64 ∿, and if they were struck as lightly as possible with the handle of a small gimlet used as a small hammer, the handle having been previously covered with rubber, the bands immediately vanished. The siren was arranged to give simultaneously 256 ∿ and 320 ∿, the interval being 64 ∿. When the standard fork of 320 ∿, and the upper note of the siren were judged to be in exact accord, the 256 note was then produced and the bands immediately disappeared. It was therefore evident, the lecturer said, that Helmholtz was right when he asserted that the difference tone given by the siren existed outside the car. The lecturer then turned to summation tones, and described a device successfully used to detect their objective existence. He was content, he said, if he had convinced the audience, as he had convinced himself, that Helmholtz was correct in saying that the siren produced objective tones whose frequencies were equal to the sum and difference of their primaries.

After a brief allusion to Helmholtz's optical, electromagnetic and general physical work, the lecturer said that, Helmholtz being an universal genius, his opinions on side issues were of more than ordinary importance; his *obiter dicta* were worth attention. For this reason Helmholtz's popular lectures acquired a special interest; and the lecturer concluded by quoting largely from Helmholtz's lecture on educational problems, the keynote of which was freedom.

A METHOD FOR OBTAINING ALTERNATING CURRENT CURVES.*

BY LOUIS DUNCAN.

In some cases a telephone method for obtaining the curves of alternating currents and electromotive forces is very convenient.

The method ordinarily employed for obtaining current curves is to shunt from a non-inductive resistance in the circuit, and include in the shunt circuit a contact-making arrangement on the dynamo shaft, a telephone, and an electromotive force, due to a constant current. This constant current is adjusted until there is silence in the telephone. When this occurs, the fall of potential due to the alternating current is equal to the fall of potential due to the continuous current, and knowing the latter, we get the value of the alternating current at the instant the contact on the shaft is made. Electromotive forces may be obtained in the same way by balancing a continuous electromotive force against the instantaneous value of the alternating electromotive force when the contact on the shaft is made.

There are several difficulties in this arrangement. Any small thermal electromotive force at the contact makes it difficult to get even an approximate balance, while only one curve may be obtained from a single contact-making arrangement on the shaft. I have employed with some success a method in which some of these difficulties are eliminated. To a telephone diaphragm, made preferably of mica, I attach a small coil of fine wire. Beneath the diaphragm are two coils wound together, and so placed that the diaphragm coil is in a magnetic field due to currents flowing in them. Through the diaphragm coil I send instantaneous currents obtained from a contact-making device on the shaft, there being a battery in circuit with the coil and the contact-maker. Through one of the stationary coils I send a current proportional to the electromotive force to be measured, or a current obtained from a shunt on a non-inductive resistance in the dynamo circuit. The other coil has a continuous current flowing through it, which latter is measured. I now adjust the continuous current until the sound in the telephone is zero. If the coils are equal, this will mean that the continuous current is equal to the instantaneous value of the alternating current when the intermittent current is made. The method is independent of any small electromotive forces due to the contact, and any number of curves may be obtained from the same contact-making device. This method, though fairly sensitive, has the difficulty that unless the contact only lasts for an infinitely short time, there will always be a sound in the telephone. By making a sharp contact, and after some practice the results are good.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March 1, 1895*

Cost of Power at Niagara.—At a recent meeting between municipal authorities of Buffalo and an official of the Niagara Power Company, the latter made several alternative propositions as to the terms under which the Niagara Company would supply 10,000 H.P. to the municipality of Buffalo. For the use of the water power, Buffalo to furnish both turbines and generators, the price named was $8 per annual horse-power; for the power at the head of the turbine shaft, $13 per annual horse-power, and for the power at the generator terminals, $18 per annual horse-power. The terms of the contract between the Niagara Company and the Pittsburg Reduction Company, whose works are but a short distance from the power house, were disclosed, showing that the latter is paying $20 per annual horse-power. At the same time the representative of the Niagara Company furnished figures showing the cost of developing steam power as determined by the results of investigations of steam plants, some of which were recently made by competent engineers or accountants, who were given access to the necessary books in the plants examined. It was found that the lowest cost was $32.70c. a-year, while in the public station of the Buffalo Waterworks it attained $65, and the testimony of President Huntley, of the Buffalo lighting companies, was offered to show that the development of steam power for electrical purposes in even large quantities ranged from $35 to $50. The Niagara Company refused to name a maximum selling price for power as a condition for receiving the grant of a franchise to enter Buffalo, or to accept any conditions as to the time in which they would guarantee to supply any definite amount of power. It would accept a franchise only on terms that would permit it to deal without restrictions in disposing of power in Buffalo.

The Monocyclic System.—Dr. Louis Bell, in his Paper read before the National Electric Light Convention at Cleveland, introduced the monocyclic system to the electric lighting interests, its full details being explained there for the first time. The diagrams showed the monocyclic system to be in principle a simple alternator, having a supplementary winding connected to the middle point of the main winding, and so placed on the armature in relation to the latter as to have an E.M.F. displaced 90deg. in phase from the main E.M.F. The length of the supplementary winding is so adjusted, that when its E.M.F. is compounded with the E.M.F. of either half of the main winding, a difference of phase of 60deg. will be produced between the supplementary line wire and the two main-line wires. The wire leading from the supplementary coil is of less cross-section than either of the main wires, it being stated that it would never need to be larger than one-half the cross-section of either of these. The motors used on the line are either monocyclic motors similar in design to the generator, or ordinary three-phased motors. In the latter case, phase transformers are used in order to produce a difference of phase of 120deg. between the E.M.F.'s. In the discussion, Mr. John F. Kelly said that the monocyclic system was a step backward, and should have come before the multiphase system. He stated there were no practical difficulties in balancing a two-phased system, as asserted by Dr. Bell, in which he was supported by the manager of a station employing the two-phased system, who had experienced no difficulty even with a difference of 30 per cent. in load between the two sides of the circuit. Mr. C. F. Scott considered that the monocyclic system, operating with three-phased motors, has really the principles of the three-phased system somewhat distorted, while the monocyclic motor he designated as a "decrepit two-phased motor." Mr. C. P. Steinmetz insisted that the monocyclic system is entirely single-phase, since the total flow of energy issuing from the generator passes through zero and is fluctuating, while the flow of energy in multiphase systems is more or less constant. A debatable point brought out by the Paper was in regard to the definition of the multiphase system, Dr. Bell accepting that of Mr. Steinmetz and Messrs. Kelly and Scott repudiating it.

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* From the *Electrical Engineer* of New York.

Acetylene.—A company has been organised under the name of the Electro-Gas Company for the manufacture of calcic carbide. It is understood that they claim that the carbide can be manufactured for $12 per ton—on the basis of electrical energy from water-power at the rate of $5 per annual horse-power.

CORRESPONDENCE.

"LABOUR-SAVING" APPARATUS AS AN INSTRUMENT OF EDUCATION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Although I am taking part somewhat late in the discussion which has been going on in the columns of *The Electrician* in connection with Prof. Ayrton's communication to the Physical Society, I feel I cannot but comply with your kind request and state my opinions, which I believe are in agreement with those of a large number of my French colleagues.

It is curious to note the number of apparently independent questions which have been successively raised during this discussion. Started by an electro-thermic apparatus which rendered several corrections unnecessary, the debate became a controversy on the use of direct-reading instruments in college laboratories. Then it turned on the propriety of requiring students to actually construct their own apparatus and of confining them to the use of such. Finally, the comparative efficacy of laboratory and lecture-room teaching was discoursed about. The arguments put forward on both sides on all these points have been excellent. On either hand the object aimed at is the instruction of students with the minimum expenditure of time and trouble. The aims, even the very principles, seem the same. How, then, can we account for this sudden and violent explosion of opposition which has been caused by such a simple piece of apparatus? It is because at the bottom there is an irreconcilable difference of opinion between the two parties—a difference of opinion which may, I think, be made plain if we analyse the following question, thrown out in the course of the controversy to embarrass an opponent, and which appears to me to sum up the points at issue :—

"The supporters of old methods," say the technical men, "wish their students to make their own galvanometers, with which to measure electric currents. Why not have them make their own seconds-watches, with which to measure time?"

The discussion relates apparently to the selection and method of using instruments intended to instruct students. As a matter of fact, it hides a fundamental disagreement. It is, in truth, a battle between the scientific and the utilitarian spirit, between exhaustive and abbreviated instruction, between methodical treatises and pocket-books. Now, my own personal experience has taught me that there can be no such thing as abbreviated instruction; it must either be complete or it is not instruction at all. Science is not a collection of independent facts, which may at will be isolated the one from the other; it is a body of laws by which facts are bound together and welded into one solid whole. To suppress the links of the chain is to destroy science, and to dry up the spirit of research and of practical applications.

The skill of the professor, it is true, plays an important part in matters of instruction. He may simplify complicated proofs, discard superfluous considerations, make use of luminous comparisons; in fact, he may reduce to a minimum the number of fundamental difficulties. But has he the power of rendering simple that which is essentially complex and difficult? Certainly not; there is a limit to simplification and abbreviation, beyond which, especially with beginners, one cannot go. Let me take an instance from the present discussion.

Let us suppose that a professor has to teach his pupils how the difference of potential existing between any two points in an electrical network is measured in *volts*; he will finally come to the description of the voltmeter. Can one greatly curtail the explanation of the principles on which this instrument is based? I think not. The voltmeter represents in a concrete form the combination, the superposition of a considerable number of ideas absolutely new to the beginner. In fact, there is connected to, and linked with it, the following serried array of ideas:—

First of all, all the notions of electrostatics which have led up to the definition of, and to the properties of, electrostatic potential, and to its relation with the work done by electric forces. Secondly, all the notions relative to the laws of current, including the definition of and the measurement of current, electromotive force, resistances, &c. Thirdly, all the notions relating to the definition of, and the measurement of, magnetic fields, electromagnetic forces, and, in the case of voltmeters based on Joule's law, all the notions connected with the laws. Fourthly, all the mechanical notions which have been used as a basis for the C.G.S. system of units, and for the practical units the volt, ampere and ohm. However skilful the professor, it would be impossible for him, unless at the risk of being obscure or inaccurate, to appreciably diminish the number of the fundamental ideas which I have just enumerated. He must, therefore, first of all explain them in the lecture room, and then illustrate them by practical examples in the laboratory. Now, among the correct ways of familiarising the student with this long series of factors—to him quite new—current, resistance, electromotive force, magnetic field, absolute units, &c., I agree with the learned director of the Electrotechnical Institute of Liège, that one of the simplest is to set the student to make and calibrate his own galvanometer. The time and trouble devoted to this task are far from being lost, since the student will have taken the always difficult step from the abstract to the concrete; he will have joined together in succession those, to him so complex and so novel notions, which are summed up in the one word voltmeter, and this altogether apart from the acquisition of a certain degree of manual skill, which is in itself so useful.

Are we to ask him to also make a watch? Certainly not! because the idea of *time* which the watch measures is not to the student an unknown and complex idea, as is the case with a difference of potential; it is a simple, primordial notion, to which he has long been accustomed. The construction of a watch would add nothing to his fundamental knowledge. That is why the professors, who wish to preserve the old but good methods of instruction, think it advisable to set their students to make galvanometers and suitable shunts without asking them to make either watches, weights, or divided rules. The technical professor, on the contrary, who is, let us assume, a clever engineer, though far removed by his ordinary labours from scientific meditations, will have a tendency to set to work in quite another manner when he comes to explaining what a voltmeter is. From his point of view, the voltmeter measures a *pressure*. This very clear idea is enough for him, since he daily observes on his distribution networks the *flow* measured by the ammeter, proportional to the *pressure* measured in volts. What is a volt? He has no need to trouble his head about that, since the idea of measuring the electric pressure in *volts* is as familiar to him as is the measurement of the length of his cables in *feet* or *metres*. Moreover, he has long ago lost sight of all the scaffolding upon which rests the measurement of a potential in C.G.S. units; he does not, therefore, dwell long on the preliminary notions, but puts as soon as possible a direct-reading voltmeter, "a good commercial instrument," in the hands of his students, and these will end by persuading themselves that the volt is an irreducible unit of electric pressure in the same way as the pound or the kilogramme is an irreducible unit of force, and the foot or the metre of length. In the same way as the volt becomes an irreducible unit so does the ampere, namely, that of electric flow. Then we have the typical compressed system of instruction; proofs are replaced by the manipulation of, and familiarity with, apparatus. Now for the consequences.

In hydraulics it is taught that the product of a flow into a height of fall represents *work;* technical students experience no difficulty in granting—I do not say in understanding—that the product of a certain number of amperes into a certain number of volts also represents work done, namely, the equivalent of that of the motor which generates the current. It seems simplicity itself. Similarly, the apparatus devised by Prof. Ayrton will in very truth be "A Student's Apparatus for Determining the Mechanical Equivalent of Heat;" it will respond to his frame of mind. The students will see on one hand that which they have been accustomed to call electric work; on the other, they will find heat produced, and they will not have any hesitation in seeing in the experiment a veritable determination of the mechanical equivalent of heat.

But if a more cautious student reflects a little, he will feel that the experiment is not so simple as it appears to be. Words are offered him in the place of things. He will certainly see in the quantity of heat produced the verification of Joule's law, but mechanical work—the product of a force into a length—why is it to be regarded as equal to the product of a difference of potential into a current? This has never been explained to him. In fact, the student, whose mind brings everything into relation with his primitive ideas, requires, in order to thoroughly recognise the idea of work, in itself quite complex enough, to separately see *force* in the shape of a weight, and *displacement* in the shape of a path along a divided rule. These things he sees clearly in Joule's celebrated experiment, but he refuses to see them in Prof. Ayrton's electro-thermic apparatus. In order that he may be able to grasp the idea, the student must study once more, one by one, the notions of electrostatics, electro-magnetism, and mechanics, which the so called abbreviated instruction has passed over in silence.

I have designedly exaggerated the scientific deficiencies of the technical professor's course of instruction to bring out clearly what it is that separates the two tendencies. But there must be no misunderstanding. The character of technical instruction, although the course of instruction may be founded by eminent men of science, is condemned, by the cast of mind of the men to whom it will ultimately be confided, to drift further and further away from its point of origin, and to abandon, as useless for practical purposes, the scientific bases which are the true foundation of practical applications. It is this tendency which was felt instinctively by certain members of the Physical Society; it was this tendency which awakened their susceptibilities and provoked their sharp opposition. As physicists, they feel that there will be a cleavage between the course of instruction of the *savant* and of the engineer. The technical professor, instead of taking as his basis our knowledge of the laws of physics and mechanics, will lay down as primordial definitions the indications of commercial instruments. The danger is a grave one. The movement has already begun, and it is favoured by the creation and diffusion of official standards. The electrical units, for instance, will soon no longer represent the result of the combination of harmonious laws, an exhaustive knowledge of which comprises the whole science; they will be independent standards, bought of a certain maker, and bearing the official mark. From the point of view of uniformity of standards and the facilitating of commercial transactions, this will prove a grand piece of progress. But I have my doubts whether the spirit of discovery and practical applications will be a gainer to the same degree.

To resume. The error to be combated was indicated by the cries of alarm heard at the Physical Society. It consists in thinking that there at two sorts of instruction—one scientific, the other technical; one complicated, the other abbreviated; one addressing itself to the intelligence, the other founded on blind practice. There is only one method of instruction: that in which the student passes by imperceptible steps from the known to the unknown, from the simple to the complex, and which consists, above all, in building up a new notion on an idea already familiar. This is at once the method for instruction in research work and for practical purposes. That which distinguishes technical instruction from scientific instruction is the nature of the arguments employed, and the style of the proofs made use of. The science professor is not afraid to employ in succession delicate ideas, abstract reasoning, mathematical calculations, or to bring forward discoveries in their historic order. The technical professor, in a hurry to reach a practical goal, will get to work preferably with elementary experiments carried out with commercial apparatus; in other words, he will materialise abstract ideas. But both instructors are bound to make plain the complete chain of ideas on which are based the final results. That is a principle from which no deviation can be allowed. If, under the pretext of being practical, simplification is sought at the expense of the fundamental notions, the economy of time and trouble effected in this way will only be apparent; indeed, it will be dangerous, since it will have the effect of filling the students' minds with words void of meaning when one should fill them with precise and coherent ideas.

I do not know if I have faithfully represented the secret thoughts of the eminent physicists on whose side I have just ranged myself, but in any case I have to thank the Physical Society for having afforded me an opportunity of defending a principle which is assailed not only in England, but in all countries where technical instruction tends to develop.—

Yours, &c., A. CORNU.

SODIUM AND EXPLOSIONS IN CONDUITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: This "sodium" discovery is very interesting. The writer took the trouble, for his own edification, to inspect the scene of a recent explosion, and the following were among his observations:—

1. A gas pipe was laid alongside the conduit and the manhole.

2. The interior of the brick conduit most certainly was not dry, but generally damp, and in some places actually wet; the concrete caps, or cover, did not make a water-tight joint, and were generally bad; the outside soil was damp; on one side the surface ground drained towards the conduits.

3. The conductors were more discoloured (with copper carbonate or chloride by appearance) in some places than others; the normal colour of the conductor was cuprous oxide.

4. The insulators carried a condensed film of moisture.

5. The gradient, or fall, of the conduit towards the chamber or well was not sharp enough, and it was irregular; in places water could collect; the material of the conduit was too porous; water and water vapour could enter easily.

6. The copper strips were tightened in the slots of the insulators with pieces of *wood*, which most emphatically were not dry, but in some places saturated with moisture. Now "sodium" (or potassium?) may come from several sources: (1) From the insulators (in the present case they showed no sign of being attacked, the glaze was bright and smooth; but vitreous substances are good water condensers); (2) from alkali salts entering the conduits by infiltration from without, or from the cement, if mixed with common salt, as it sometimes is with advantage for some purposes and at some seasons, or from other material of the conduit, as soda or potash in coal-tar products; or (3) it may come from the salts contained in the pieces of wood employed as wedges, as previously mentioned. Most certainly the conditions appeared good enough for an electrolytic circuit: the pieces of wood would act like little reservoirs for the electrolyte, and the film of moisture on the insulators a good enough conductor for an appreciable current to pass. These wooden wedges appeared to be a contrivance for tightening the strips to prevent lateral sagging, but being of irregular shape and composition, were not originally thought necessary. Most certainly they are undesirable. What was seen appeared to be made up of broken pieces of plaster lath.

We must not forget that soda salts are always present in the atmosphere, and carried down by moisture, whether frozen out or otherwise; and, further, a spark may just as easily pass from terminals of an electrolyte as from a metallic conductor, with the well-known results in the presence of lighting and certain other mixed gases; and light explodes certain mixtures.—Yours, &c., J. C. R.

London, March 10, 1895.

STONEWARE INSULATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In passing along the Euston-road this morning, I noticed men at work brushing out the trench in which the St. Pancras electric mains were laid. The bare conductors were passed through an earthenware block, which appeared to me to have the ordinary salt glaze generally used upon a great deal of pottery ware. With the condensed moisture on these blocks, which must always be present in such trenches, and the bare copper strips conveying current resting upon the glaze, we have the conditions of electrolysis; and I believe the current is a direct one. If my assumption is correct, this explains where the salt comes from which yields the sodium discovered by Major Cardew; and in that case it may be found safe to use such glazed earthenware blocks with an alternating current, although highly dangerous with direct currents.—Yours, &c.,

March 8, 1895. J. SINCLAIR FAIRFAX.

"KATION"—A PROTEST.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If Dr. Waddell had kept his considering cap on for a short time longer he would, doubtless, have refrained from casting any doubt on the classical culture of his scientific brethren. It is perfectly true that "ka*t*ion" would be derived from *κάτειμι* — to flow down; but it is also just as true that "ka*th*ion" may be derived from *καθίημι*—to send down (passive), to be carried down, *e.g.*, *καθεῖτο τὰ τείχη*—the walls were carried down to the sea, for we surely consider the kathion in the light of a carrier of ions to the kathode, an idea which *κάθιημι* expresses, rather than the idea of the liquid itself flowing (*κάτειμι*). The former is therefore fully, if not more scientifically, accurate.

So that Dr. Waddell may rest assured that we can stick to "good old kathion" without fearing a false analogy with kathode, or besmirching the fair name of "electro-classics."—Yours, &c., ROLAND S. PORTHEIM.

10, Compayne-gardens, S. Hampstead, March 5, 1895.

LEGAL INTELLIGENCE.

Attorney General v. St. James and Pall Mall Electric Lighting Company (Limited).

The case of the Attorney General *v.* the St. James and Pall Mall Electric Lighting Company came before Mr. Justice Kekewich in the Chancery Division on Tuesday last.

Mr. Warmington, Q.C., and Mr. Macmorren appeared as counsel for the plaintiff; and Sir R. Webster, Q.C., M.P., Mr. Fletcher Moulton, Q.C., M.P., and Lord Robert Cecil for the defendants.

Mr. WARMINGTON, in opening the plaintiff's case, said that the action was brought by the Attorney-General at the relation of the Vestry of the parish of St. James', Westminster, for an injunction to restrain an alleged public nuisance, such nuisance arising out of smell, smoke, vibration, emission of gas, steam, and hot water, caused by the defendants' works at their central station in Mason's-yard and Duke-street, Piccadilly. Mason's-yard, prior to the erection of the defendants' works, was used as a mews, the stables being in the centre, and there being a roadway round. When that was purchased by the Company, the whole of the mews was converted into the station, and they also put some of their works underneath the roadway to a great depth. A great many of the witnesses that he should call resided in Duke-street. Complaints began at the latter end of 1890, and continued up to the present time. At the end of 1893 the defendants started to erect another station in Carnaby-street, which, no doubt, relieved the work which was formerly done at the station in Mason's-yard, and vibration was not then so serious as it once was, but unfortunately with regard to smoke, smell, and more particularly to dust and ashes, it was still very serious. The defendants' case was that there was no nuisance at all; that if there was a nuisance it had been remedied, and that they were a public body acting under a Provisional Order, and had only done what they had a right to do. He thought that it would be conceded that the plea of justification could not avail having regard to the decision of that Court in the case of Shelfer v. The City of London Electric Lighting Company, such decision being affirmed by the Court of Appeal, and which it was believed would be the subject of consideration by the House of Lords. The proceedings on the part of the Vestry were instituted under the provisions and powers of sections 13 and 21 of the Public Health (London) Act, 1891. There had been active correspondence between the Vestry and the defendants between November, 1891, and May, 1894. Inhabitants of the district had written to the Vestry complaining of the nuisance caused by the defendants' works, and copies of those letters were sent by the Vestry Clerk to the defendants. The defendants from time to time made excuses, but as a rule they said that they would try, by new works, by improvements and amendments, to abate the nuisance. The only reason he emphasised that was because it had been said in the defence that the plaintiffs had been guilty of delay.

Sir R. WEBSTER said that before witnesses were called, as he wanted to save time if possible, he ought to mention to his Lordship that proceedings were taken by the Windham Club at the corner of St. James's-square. That case came before Mr. Justice North, and Sir Horace Davy appeared for the present defendants. He was quite willing to give his learned friend the same order as was given in that case.

After Mr. Warmington had consulted his clients and Sir R. Webster, his LORDSHIP by consent made an order, that if in the opinion of an engineer to be appointed by the Board of Trade, or by agreement between the parties, the works of the defendants in Mason's-yard now caused, or should hereafter cause, any nuisance by vibration or noise, or by permitting to escape from the chimney shaft of the works black smoke, soot, ashes, or dust, or effluvia offensive and injurious to health, or by discharging into the sewers of the Vestry of hot water or steam, the defendants would forthwith, at their own expense, make and execute all such works necessary for remedying the nuisance as the engineer should direct. The defendants to pay the costs of the action and the expenses of the engineer, the costs of the inquiry before the engineer to be at his discretion.

Incandescent Electric Lamp Company (Limited) v. Brush Electrical Engineering Company (Limited).

This was an action, heard before Mr. Justice Wright, in the High Court of Justice, last week, for damages for breach of a covenant for quiet enjoyment.

The plaintiffs are underlessees of certain premises at Brook-green, Hammersmith, under a lease of September 20, 1893, from the defendants, containing the covenant for quiet enjoyment now sued upon, and the legal point involved in the action was the provision of a separate entrance to an adjoining property, held partly under the same lease.

Mr. Justice WRIGHT regretted he need not call on counsel for the defendants. Judgment would be for the defendants with costs. This would not hinder the plaintiffs in any action they might bring for rescission of the contract, if they entered into the lease under the impression that the right of way was merely temporary; and stay of execution, pending appeal, would be granted on the usual undertaking.

South v. Hawes and Son.

Last week, in the Westminster County Court, before Judge Lumley Smith, a claim for £3. 10s. for three incandescent lamps at £1. 3s. 4d. each was made by Mr. H. South.—Plaintiff's case was that defendants had had thirty lights put in for £35. They then had an additional four, for which they paid *pro rata*, £1. 3s. 4d. each. Three further lights were ordered, and defendant only wanted to pay 5s. each for them, and had paid 15s. into court.—A member of the defendant firm said the £35 included installation, fittings, and everything.—A witness, called for the defence, said the extra lights were not really lights. They were simply tappings.—His Honour very properly held that they were lights, and found for the plaintiff with costs

Two-Phase Transmission in Switzerland.—The Electricitätswerke am der Sihl, of Wadensweil, a company which has been formed to supply the villages on the left shore of Zurich Lake with electrical energy for lighting and power purposes, has given the contract for the electrical machinery to Messrs. Brown, Boveri and Co., of Baden, and for the turbines to Messrs. Escher, Wyss and Co., of Zurich. The plant to be at first put down will comprise three turbines, which, with an average fall of 213ft. and about 350 revolutions per minute, will give 450 H.P. The alternating machines will be directly connected to the turbine, the exciters being belt-driven. The two-phase four-wire system has been decided upon, with a primary voltage of 5,000, the plant to be capable of taking 7,000 volts. The central station will be situated at the Waldhalde, near Schönenberg, and from thence six distributing mains will spread out radially, some extending as far as 20 kilometres. Four of the mains will serve for power purposes and two for the lighting. The two-phase generators will be so designed that they may be used as single phase machines.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NOW READY.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Although about 100 pages are added to the book, no addition is made to the price, which is 7s. 6d., post free 8s. 3d., abroad 9s.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices :—*

THE LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, presented with our issue of January 4th, can be obtained mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s. each post free. The Map showing positions of Supply Stations is mounted on the back of the Table. The Coloured Map issued with the Jan. 18th number and the Electricity Supply Statistics issued with the Feb. 1st number are also mounted on some copies, and the price of these, complete, post free, is 5s.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

LABORATORY NOTES AND FORMS.—With the above title, we are publishing a set of Elementary (ready) and Advanced Exercises (portion now ready, remainder end of March) for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"ELECTRO-CHEMISTRY."—This useful work, by Dr. G. Gore, is still on sale, the price being 2s., post free.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. net., is now ready.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d (abroad 8s.). Prospectus on application.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and Wilkinson, price 6s. 6d., post free.

TENDERS INVITED.—At or before 12 o'clock noon of Monday, the 25th inst., the Llanelly Borough District Council will receive plans, designs, specifications, and estimates of cost of providing and fixing electrical plant and machinery, including street lamps and laying down mains for lighting certain portions of the town. Plans and all further particulars may be obtained on application to Mr. G. Watkeys, C.E., Borough Surveyor, Llanelly, and tenders have to be sent in on the day above mentioned to Mr. John Jennings, Clerk to the Llanelly Borough District Council, Town Hall, Llanelly. Some further particulars are given in our advertisement columns.

——— The Bradford Corporation invite tenders for the construction and delivery of two steam dynamos for use at their electricity works, Bolton-road, Bradford. Specifications may be obtained of Mr. Baynes, electricity department, Town Hall, Bradford, and tenders must be sent in to the Town Clerk, Mr. W. T. McGowen, not later than Thursday, the 28th inst.

——— The Corporation of Derby invite tenders for the construction of three mild steel Lancashire boilers, and the necessary accessories, for use at their electric lighting station. Tenders have to be in by twelve o'clock on Monday, March 18th.

——— The Corporation of Norwich require tenders for fittings for an installation of the electric light at the new baths and wash-houses, also for two Galloway boilers, &c. Tenders have to be in by 3 p.m. on the 2nd prox.

TENDERS INVITED.—La Société Lyonnaise des Forces Morrices du Rhône of Lyons, in connection with the central station it is establishing, invites tenders for the electrical plant. These have to be in by April 1st.

——— Tenders are invited by the Corporation of Worcester for the wiring of the Victoria Institute, Worcester, for the electric light. Tenders have to be sent in to the architects, Messrs. Simpson and Milner-Allen, 10, New Inn, Strand, London, W.C., by April 6th.

TENDERS ACCEPTED.—The Blackpool Town Council have accepted the tender of Messrs. R. E. Crompton and Co. for two dynamos and one spare armature for the tramway department for the sum of about £600.

——— The Gas Committee of the Dundee Town Council have recommended the acceptance of the offer of Messrs. Whyte and Cooper for the work in connection with the substitution of brass tubes for the iron tubes at present in use at the electric lighting station, at a cost of £40. 10s.

——— The tender of Messrs. Strange and Sons has been accepted by the Tunbridge Wells Town Council for constructing three underground transformer stations in connection with their electric lighting scheme.

TENDERS RECEIVED.—At a special meeting of the Moss Side School Board, the tenders recently sent in for the electric lighting of the Princes-road School were considered. Mr. W. E. Rowcliffe, the Clerk to the Board, announced that in all 27 tenders had been sent in, ranging from £760 to £1,500. After carefully considering the financial position of the Board, especially with regard to the loan obtained for this school, it was resolved by the Board that none of the tenders should be accepted.

PLANT FOR SALE.—The St. James' and Pall Mall Electric Light Company, Limited, owing to extension of supply from their supply stations, necessitating the use of larger units of plant, have for disposal by private tender a quantity of machinery guaranteed to be in full running order. Some particulars are given in our advertisement columns, and further information may be obtained of the general manager and secretary, at the Company's offices, Carnaby-street, Golden-square, London, W.

PERSONAL.—Mr. T. Smith, late secretary of the General Electric Power and Traction Company (Limited), notifies that he has assumed and adopted the name of Featherstone in addition to that of Smith, and that hereafter he is to be known by the name of Thomas Featherstone Smith.

——— Mr. Frank B. Lea has been appointed by the owners of the Rouen Tramway System as their resident engineer in the conversion of the line from horse to electric traction. Mr. Lea's address for some time forward will be 2, Rue de la Republique, Rouen.

BANKRUPTCIES.—In the matter of Browning and Gardner, electricians, of 122, George-street, Edinburgh, the following list of chief creditors is issued (sequestration) :—

Edison and Swan United Electric Light Company ...	£67	0	0
Crypto Works Company	28	17	1
Crompton and Co.	138	0	0
Evered and Co.	101	17	9
Banks and Co.	22	5	9
Siemens Brothers and Co.	40	5	5
Ericsson Bell Telephone Company	22	11	3
India Rubber Company	21	16	6
W. T. Glover and Co.	44	13	3
W. Patterson	9	5	9
Laurence Scott and Co.	10	13	3
Bailey Brothers	6	6	0
Easton, Anderson and Goolden	6	13	9
Rootbaan and Allewijnse	65	0	0
Arthur S. Black	40	0	0
Preferential claims	124	0	0
Liabilities	931	4	9
Assets	364	0	0

——— In the failure of Chalmers, Paterson and Co., electrical engineers, of 152, West Regent-street, Glasgow, the list of chief creditors contains the following :—

Edison and Swan United Electric Light Company ...	£29	13	9
Krupka and Jacoby	15	3	6
G. Braulik	11	13	7
Ericsson Bell Telephone Company	38	0	10
Wilson and McLellan	28	16	7
General Electric Company	47	15	5
W. McGeoch and Co.	18	3	9
Brown and Co.	29	14	1
Korting and Mathieson	138	17	0
W. T. Glover and Co.	11	10	6
Telegraph Manufacturing Company	64	3	6
Liabilities	828	18	8
Net Assets	719	13	8

——— G. F. Rogers, trading at 5, Great Winchester-street, London, E.C., as an electrical engineer, has presented his petition in bankruptcy, and, upon the application of Messrs. Phelps, Sidgwick and Biddle, the usual receiving order has been made. The assets are stated to consist chiefly of household and office furniture to the value of £350. Amount of the liabilities not given.

Liquidations.—All persons having claims against the Planet Electrical Engineering Company (Limited), are requested to send in forthwith particulars of the same to Mr. R. W. Caldwell Moore, 142-143, Palmerston-buildings, London, E.C., the liquidator in the voluntary winding up.

———— A motion has been agreed to this week for the appointment of a Debenture Holders' Receiver in the winding-up of the Ford-Lloyd Electrical Manufacturing Company. The Official Receiver is already in possession under the order granted by the Court last week. By the present order Mr. Jeffries has been appointed, with the sanction of the Official Receiver, in order to arrange for the sale of the plant. Mr. Grove, the petitioner, holds a First Mortgage Debenture for £1,000.

Medical Electrical Institute (Limited).—A petition for the winding-up of this Company was presented at the High Court of Justice on March 6th by James Willing, jun., and is directed to be heard on the 20th inst. Any creditor or contributary of the Company desirous of supporting or opposing the making of a winding-up order must send in particulars at once to Mr. W. V. Bradley, 27, Chancery-lane, London, W.C.

Re J. and W. Weems.—The trustee in this matter, Mr. John Gourlay, C.A., has called a meeting of creditors to be held at 24, George-square, Glasgow, on Friday, April 5th, at 11 o'clock, for the purpose of considering an application to be made by him to obtain discharge from his trust. Particulars of the funds of the estate, made up to February 28th last, have been presented and examined by the Commissioners.

Agence Dalziel, Limited.—The High Court of Justice has appointed a Committee of Inspection to act with the Official Receiver and Liquidator in the winding-up of the above Company.

Dissolution of Partnership.—The partnership trading under the style of Messrs. F. W. Ball and Co., electrical engineers, of Unity-street, Bristol, has been dissolved. Debts will be paid by Mr. F. W. Ball.

Appointment.—The Corporation of Eccles have appointed Mr. S. V. Clirehugh consulting engineer for carrying out the Corporation's electric lighting scheme, upon which an estimated expenditure of £20,000 is contemplated.

Removal Notices.—The registered address of the Electric Construction Company (Limited) is now Dashwood House, 9, New Broad-street, London, E.C.

———— Owing to extension of business, Messrs. Fuller and Co. find it necessary to acquire more commodious premises. After the 24th inst. the firm's address will be 28, Bush-lane, Cannon-street, E.C., in place of Mansion House-chambers, Bucklersbury, E.C.

Mr. G. Straus.—We are requested to mention that the fact of Mr. G. Straus having given up one of his agencies for incandescent lamps does not in any way interfere with his regular business in that department, and that he has decided to keep a large and assorted stock for immediate delivery.

Contract for Pipes.—Messrs. Edward Le Bas and Co. have secured the contract for the whole of the lap-welded wrought-iron pipes required by the City of London Electric Lighting Company for their cable conduits.

E.P.S. Cells.—The Electrical Power Storage Company (Limited), of 4, Great Winchester-street, E.C., have received a flattering testimonial from Messrs. Edwin Andrén and Co., of Gothenberg, Sweden, of which the following is a translation:—"The accumulator locomotive which Messrs. Edwin Andrén and Co., in January, 1892, supplied to the Skutskär Sawmills, has, since that time, had her accumulators charged 631 times, in all about 2,000 hours, and up to the present not a single one of the accumulator plates has been destroyed or been required to be replaced, all plates continuing to be in full working order."

Non-Slipping Stair Treads.—The Safety Tread Syndicate (Limited), of 15, Barbican, E.C., send us their latest list of unwearable non-slipping stair treads, which have now come into very general use. In addition to the work for which these treads were originally designed, the Company supply manhole covers specially designed for roadways and for heavy traffic, hydrant covers, electric light box covers, &c. A very large number of these covers have been put down by the Company, and the number of testimonials accompanying the list is a satisfactory proof of their durability. The Company are contractors to the War Office, and have supplied the whole of the steps for the new Tower Bridge.

Electrical Testing Instruments.—We have received another letter from Mr. Paul on the alleged catalogue copying, but the dispute, which is of no public interest, cannot be continued in these columns.

Catalogue.—Messrs. Johnson and Phillips have sent us a copy of their latest catalogue and price list of pure and vulcanised india-rubber-covered cables and wires. The information is well arranged, and, being mostly in tabular form, is very convenient for quick reference. We note with gratification the increase in information which this and similar catalogues afford in their most recent editions.

The New Telegraph Code Vocabulary.—An interesting article appears in the *Monthly Record* of the Manchester Chamber of Commerce for February, signed "Beta," which subjects the new Berne Official Vocabulary to severe criticism. That this criticism is just there can be no question. The new vocabulary is open to quite a number of objections, some of which are of a most serious nature. "Beta" points out that the code is supposed to have been compiled by experts of the International Bureau at Berne, and he urges that the compilers have lamentably failed in their task. It was fully expected, when the preparation of the code was resolved upon by the last Telegraph Conference, that a minimum of 400,000 words would be reached; whereas the new code consists of less than 257,000 words, an altogether insufficient quantity. The limitation of lawful words in the eight accepted languages is also pointed out by "Beta" as a gross interference with public right. In addition the compilation is technically very defective, and "Beta" points out a number of words practically identical in sound, and, further, as the vocabularly contains a large number of words which are similar in telegraphic signs, the failure of the bureau to satisfy code users is transparent. One most serious point, however, "Beta" does not refer to, and that is the fact that the vocabulary contains an altogether undue proportion of German and Dutch words, which are composed of letters which it is most difficult to write, and which must result in a vast number of inaccuracies, giving serious annoyance to those using the vocabulary, and entailing immense labour, in the form of repetitions, upon the cable companies' and affiliated systems. Mr. William Douglas, who is well known in connection with telegraph codes, has written to the Chairman of the Glasgow Chamber of Commerce complaining of the restricted and incomplete character of the Berne production. It is suggested that, as between the United Kingdom and its colonies and dependencies, the eight authorised languages should continue to be employed as at present, and that the code compilers in this country should have the same liberty given them as the Berne compiler of using proper names and names of existing places; also that all properly-compiled vocabularies published for telegraph ciphers should be recognised as standard dictionaries on the compilers (?) being satisfied of their general correctness philologically. The Glasgow Chamber has decided to support a movement to this effect.

Acton (Middlesex).—In regard to the offer of Messrs. New and Mayne to take over the Acton District Council's Electric Lighting Order, the firm have agreed to substitute 16-c.p. for 10-c.p. incandescents for the general street lighting, and to put in arc lamps in the main roads, similar to those in use in the adjoining district of Ealing. Messrs. New and Mayne's latest proposal is now being discussed by the Council in committee.

Belfast and Ligoniel Tramway Company.—At a meeting of the shareholders of this Company, held at the offices, May-street, Belfast, a deputation was received who presented a memorial calling the attention of the Directors of the Company to the need for an improved service to the district of Ligoniel. Owing to the steep gradients, it frequently happens that the tramcars are brought to a stop at a considerable distance from Ligoniel, and the object of the deputation was to impress upon the Directors the necessity for a different system of traction, preferably electric. The Chairman, in reply to the memorial, said that it was perfectly obvious that their service needed improvement, but the question of the system of traction to be adopted was a matter for serious consideration. There had been much disappointment felt not only by the memorialists but by shareholders that their cars were not able to run the whole length of their line; but the Belfast Street Tramway Company, with whom they were in working agreement, were at present seriously considering the question of applying mechanical locomotion to their entire system. If they were able to carry this into effect their difficulties would doubtless be overcome. The number of passengers carried during the past year on their section of tramway was 131,760, with a mileage of 57,720, and the receipts had been 7½d. per mile run, which he, the Chairman, understood would pay a profit with either a cable or overhead electric system, although it would scarcely pay the cost as worked at present, four horses being required for every car.

Birmingham.—It is gratifying to learn that, after further consideration, the complaints as to the contract for the electric lighting plant at the Technical School not having been given to a Birmingham house have died down. It would be a huge joke for Birmingham, of all towns, to complain of such a decision on the part of the local authorities, seeing that the district supplies manufactured goods for almost every electric lighting installation in the country.

Blackpool.—The Blackpool Tower Company have decided to instal a large battery of accumulators, and we are informed that the work has been entrusted to Messrs. B. Verity and Sons at an estimated cost of £1,500. Messrs. Verity inform us that Chloride accumulators are to be supplied.

Bradford.—At the County Council meeting on Tuesday, Mr. Dixon presented the gas and electricity accounts for the year ended December last. The net profit had been £1,179. 10s. in 1893, against £1,449. 18s. 6d. They had now commenced to form a depreciation fund, and had this year taken off £1,062. 16s. 3d., which left a net profit of £387. 2s. 3d. The current consumed in the December half-year of 1892 was 224,232; 1893, 272,874; and 1894, 307,977. The cost per unit per ton of coal had been, in 1892, 0·454; 1893, 0·743; 1894, 0·541. The average cost per ton of coal and coke used had been, in 1892, 7s. 10¼d.; 1893, 13s. 1d.; and 1894, 8s. 1¼d.

Brechin.—The representatives of the Scottish House-to-House Company have received a notification from the Board of Trade that, before the Provisional Order now being applied for for lighting the Brechin district by electricity is granted, clear proof of the ability of the Company to carry out the Order will be required, and also insisting upon the deletion of the clause entitling the local authority to a share of the profits in the undertaking. The letter points out that in the opinion of the Board of Trade the scheme to supply electric light at 25 per cent. below the present price of Brechin gas is remarkable, and, unless the objectionable clauses referred to were withdrawn, the Order would not be granted. At a meeting of the Police Commission, where the letter was discussed, it was decided to adjourn the consideration to a special meeting to be called.

Brighton.—The Corporation discussed at its meeting last week the report of the Electric Lighting Committee, dealing with a reduction in the charges for electric current, &c., which has previously been referred to in these columns. The report also included the recommendation of the Committee that the salary of Mr. Arthur Wright, the Corporation's electrical engineer, should be increased from £400 to £600 per annum, and that of Mr. R. C. Quinn, outside superintendent, from £3. 10s. to £4. per week. Mr. Councillor Stafford, in proposing the confirmation of the report, said he was pleased that the forecast made by the Committee some time ago had been amply justified by events. The Committee's total expenditure for the year was £11,505. In income they had received for current for private purposes, £13,913; for street lighting, £1,358; and for meter rents, £1,076. The actual net profit for the year was £4,870. This would enable them them to hand over to the ratepayers of Brighton £1,121 in favour of the rates, and to place £3,000 to a reserve fund. Those who had studied Mr. Wright's exhaustive report would agree, he felt sure, to the reduction in the charges which were suggested therein, the reductions benefiting no less than 87 per cent. of their customers. He was pleased to be able to announce that, on a full consideration of the proposals made in Mr. Wright's report, the local authorities of Reading, Cheltenham, Preston, Bournemouth, and Stafford had decided upon adopting the Brighton scale, and using the same meters as at Brighton, while twelve other towns have the matter under consideration. The committee had absolute confidence in the integrity and conscientiousness of their able electrical engineer, and they therefore unanimously approved of the suggestion to increase his salary from £400 to £600 per annum. After a brief discussion of a more than usually business-like character the recommendations of the committee were unanimously agreed to.

Bristol.—The *Times and Mirror* opportunely points out, with regard to the steps now being taken by the Electrical Committee of the Corporation to canvass certain districts of the town for support in its efforts to extend the electric lighting mains to districts outside the present area, that, if intending consumers were assured that the Coporation would itself put in the fittings and charge a fair percentage on the cost, a very satisfactory response would be the result. This is considered to be the only step necessary to ensure the almost general adoption of the electric light in Bristol. It has come to be generally known that the electric light is nothing like so expensive as it was at first believed to be, while the many advantages it possesses over other methods of illumination are, in Bristol at any rate, fully appreciated.

Cardiff.—Mr. W. H. Massey has written a letter to the *Western Mail* deprecating the attempts made by the local journals to unduly exaggerate the slight mishaps to the Corporation's electric light machinery. Mr. Massey states that since the middle of November, when the private lighting was first started in the town, there had been but two slight failures from preventible causes, and that with regard to the street lighting, although there had been small failures, these have caused the public little or no inconvenienc. The course adopted by the local Press in condemning the light has had a tendency to frighten probable customers, and Mr. Massey asks for the assistance of the public journals to enable the Corporation to obtain additional consumers. Some day, perhaps, an explanation will be forthcoming of the cause of this more than usually venomous opposition to the electric light on the part of local journals. Thirty-eight applications for the post of engineer-in-charge of the electric light station have been received by the Town Council, and this number was, at the last meeting, reduced to four:—Mr. W. M. Huskisson, of London, Mr. N. Applebee, of London; Mr. C. W. Sully, of Burnham, Somerset; and Mr. J. Backtick, of Chelmsford. The final selection is to be made on Tuesday next. At the same meeting of the Council a lengthy discussion arose on the electric lighting question. Mr. Riches said he thought serious steps should be taken to deal with the matter. They had valuable machines rendered inoperative owing to the engines attached to them being inefficient, and they were spending £200 a year on the rectifier which might easily be saved. The Mayor asked Mr. Riches whether he was satisfied that the manufacturers of the machinery (Messrs. Siemens Brothers and Co.) were amongst the best firms in the world for this class of work, and Mr. Riches said that there was no doubt whatever that no better electrical manufacturing firm existed than Messrs. Siemens, but they must not forget that their engineer's specification stipulated for a certain engine, and this, he considered was the cause of their trouble. The Mayor said that rectifiers were only put in when certain difficulties were experienced, and in the case of Cardiff the rectifier was adopted in order to save about £2,000 in laying extra cables. Mr. Riches was of opinion that if the Council spent a further £3,000 they would save the £200 a-year now being spent in wages for the men who look after the rectifier. The Borough Engineer pointed out that there had been a great deal of fuss in the papers about the electric light, but he himself was very sanguine that everything would come all right. They already had 4,000 lamps wired. When they had selected a competent man to give his whole attention to the matter, things would settle down, and their electric lighting undertaking would be as successful as they all hoped it would be.

Cheltenham.—Mr. Alderman Norman, in presenting the report of the Electric Lighting Committee to the last meeting of the Corporation, stated that he had no doubt the electric lighting undertaking would be completed during the present month, although current would not be switched on on the responsibility of the Corporation. The contractors would take all responsibility for the first four weeks. The Committee were very pleased with the disposition of the plant at the station, and a very little time would now elapse before the work in connection with the last of the engines and alternators would be completed. The Committee have agreed to light the public library for the sum of £40 per annum—although this may lead to a slight loss—on the condition that the work is carried out under the supervision of the borough electrician.

Chester.—At the monthly meeting of the Town Council, held on Wednesday, a recommendation from the Electric Lighting Committee "That the Committee be authorised to accept the tenders which will be submitted for engines, boilers, and dynamos, amounting to £8,518." Mr. Deely, chairman of the Committee, brought the recommendation forward, but explained that he did not agree with it. He disapproved of the idea of accepting tenders from different people, and considered they should go to some well-known firm and place the entire installation in their hands. He complained that Dr. J. Hopkinson had disregarded the Committee's instructions in not asking for tenders on the Oxford system. The deputy-chairman of the Committee, although formally seconding the recommendation, complained that the action of the Committee was inconsistent and their scheme incomplete. He did not think that Dr. Hopkinson could supply the city with electric current under his system for a smaller sum than £50,000. Alderman L. Gilbert then proposed as an amendment that the matter should be referred back to the Committee, with instructions to treat with a firm or firms for the lighting of the city, and, failing satisfactory terms being agreed upon, to bring before the Council plans, specifications, and tenders for a complete scheme on the basis of the successful firm or firms agreeing to run the installation for a given period to the satisfaction of the Council. The Mayor (Mr. W. H. Churton) defended Dr. Hopkinson from the criticisms of the members, and pointed out that under his scheme it was possible to supply the light to the whole of the city. He asked them to trust the skilled engineer they had called in, and to leave to him the responsibility of carrying out the scheme. After some discussion, the amendment was carried by 21 votes to nine, and it was resolved to apply to the Local Government Board for sanction to borrow £25,000 in connection with the electric lighting. Mr. Alderman R. Gilbert was added to the Electric Lighting Committee.

Church Lighting.—Owing to the frost, it was for a time found impossible to connect up the church of St. Thomas, Nottingham. The work has now been done, and service was conducted by the electric light for the first time on Sunday last. Ninety-five lights are installed.

County Council Elections.—Amongst the unsuccessful candidates for County Council honours is Mr. J. G. Lorrain, chartered patent agent, who was defeated in the Old Chiswick Ward of the Middlesex County Council by Mr. W. J. Adamson, builder.

Darlington.—Alderman Sedgwick, at the last meeting of the Town Council, asked whether any requisition had been made for electric lighting, to which Alderman Barron replied that there had been communications concerning the matter from six persons who had been informed that "electric light would be provided when there was a sufficient number of applications for it." This answer scarcely satisfied Alderman Sedgwick, and Councillor Marshall thought the time had arrived when a circular inviting expressions of opinion on the subject should be issued.

Derby.—On the proposal of the Electric Lighting Committee of the Town Council that a sum of £5,000 be granted for alterations of the premises adjoining the electric lighting station for distributing and connecting mains and additional boilers, a heated discussion arose at the last meeting, during which Mr. Alderman Marsden said the boilers were required immediately, as they were risking a stoppage in consequence of running every pound of steam at their command. He complained of the manner in which the committee were treated by the Council, from whom they got no encouragement in their arduous work. It had been proposed by one speaker that the services of Messrs. Bramwell and Harris should now be dispensed with, but Mr. Marsden pointed out that there was a contract between the Council and their engineers which it was essential should be adhered to. There was, however, a proposal before the committee to alter the terms of their arrangement with Messrs. Bramwell and Harris, and it was the wish of the committee to bring the agreement to an end as soon as possible. The proposal of the committee was ultimately adopted.

Ealing.—The report of the Electric Light Committee was presented at last week's meeting of the District Council. The consulting engineers, Messrs. Bramwell and Harris, have recommended considerable extensions of the electric lighting scheme, including the addition of two engines and dynamos. In the course of the next two or three years it is estimated that the additional plant and mains necessary will cost about £16,000, which the consulting engineers consider will be money well expended. As to the staff at the electricity station, the surveyor reported that it would be necessary to appoint an electrician in charge at £200 per annum, increasing £25 to £300, a first assistant engineer at £2. 5s. per week, increasing to £2. 10s ; a second assistant engineer at £1. 10s., increasing to £2, engine drivers, stokers, &c. On the question of the appointment of the electrician in charge at the works, it was decided to offer the post to Mr. A. P. Foord-Moore (who had been in charge for Messrs. Bramwell and Harris) at a six months' engagement, the surveyor to arrange for the other employés. The Council will take over the entire charge of the works from Saturday, March 30th. There are now 3,375 8 c.p. incandescents in use, and the whole of the arc lamps in the main roads would be finished immediately.

Edinburgh.—The Electric Lighting Committee of the Town Council have provisionally fixed Wednesday, April 10th, for turning on the electric light in the city.

Electric Organ.—The Hope-Jones Electric Organ Company (Limited) are furnishing a new organ on their electric system for St. George's Church, Hanover-square, London, W. The console is fitted with the Company's patent stop keys and double-touch, and with a new type of device for controlling stops and couplers from the keyboards.

Electro-Harmonic Society.—A smoking concert is to be held at the St. James's Hall Restaurant, Regent-street, London, W., on Friday next, the 29th inst., at 8 o'clock. An excellent programme is provided, under the able musical direction of Mr. T. E. Gatehouse and Mr. Alfred E. Izard.

Exhibition.—The Electric Lighting Committee of the Oldham Corporation has established a fittings show room, which is now open at Rhodes Bank, where a large quantity of electrical apparatus and fittings is on show. A number of manufacturers have taken advantage of the opportunity to display their goods.

Fareham.—With regard to the friction between the newly-elected District Council and the local Electric Lighting Company as to the purchase of the latter's undertaking, it is pointed out that the late Local Board, in approving the purchase, undertook to use "their best endeavours to obtain from the Local Government Board their approval of the transfer, and their sanction to the borrowing by the Local Board of the amount to be paid to the Company, in pursuance of the agreement then entered into." Under these circumstances, it is considered by many that the local Company have a strong case against the recent action of the new Council.

Fermoy.—The Town Commissioners have received an offer from "a large firm of electricians" to erect the necessary plant to light Fermoy by electricity, on condition that a guarantee is given that ultimately 2,000 lights will be taken. Mr. T. Coughlan, the chairman, said he considered that if such a scheme would pay a private firm it should also pay the Commissioners, and he was in favour of keeping the lighting in their own hands. It was pointed out that if schemes which the Commissioners have at present in hand were proceeded with their borrowing powers for the purposes of electric lighting would be very small.

Hammersmith (London, W.).—The Electric Lighting Committee's recommendation, that the Vestry forthwith carry into effect the provisions of their Electric Lighting Provisional Order, and that for this purpose it be referred back to the Committee for consideration as to the proper course to be adopted, was, with the modification "that the work be carried out by contract or otherwise," approved at the last meeting of the Vestry. It was stated that the scheme would probably cost about £50,000.

Hampstead.—The Lighting Committee will recommend at the next meeting of the Vestry: "That the Vestry do employ their own engineer to superintend the carrying out of all future work in connection with the electric lighting in this parish."

Hoole.—The Chester United Gas Company is an undertaking with a share capital of about £120,000, and the statement of accounts for the past year shows a profit of about £10,000. This very satisfactory showing does not quite approve itself to the members of the Hoole District Council, and Mr. Duck thinks that it is time the question of the electric light for Hoole and district should be referred to the Works Committee, with a recommendation that the Council should themselves provide the electric lighting for the district. The chairman of the Council considers that the Gas Company have a monstrous monopoly, and that the low-tension system of electric lighting could be introduced into the district for about £3,500. The idea finds favour in all directions.

Lambeth (London, S.E.).—At a recent meeting of the Vestry, it was practically decided to shelve the question of electric lighting. The Vestry have, however, now received a letter from Mr. Sydney Morse, on behalf of the County of London Company, asking the Vestry to appoint a committee to receive a proposal from the Company in relation to the transfer of their electric lighting order. This the Vestry have decided to do in order that further information may be obtained on the subject generally.

Lectures.—Mr. Hope-Jones delivered a lecture at Birkenhead on Wednesday last week on "The Laws of Sound as Exemplified by the Phonograph, the Telephone, and the Megaphone." Much interest was taken in the megaphone, an instrument for magnifying sound, invented by the lecturer.

Leeds.—The Corporation Tramways Bill before Parliament, against which petitions have been deposited by the Lancashire and Yorkshire and Midland Railway Companies, and the Yorkshire House-to-House Electricity Company, came before the House of Commons' Committee on Standing Orders on Tuesday, and compliance with standing orders is to be excused on the condition that the powers relating to the construction of generating stations should be struck out of the Bill.

Leicester.—On Tuesday Mr. Alderman Lennard moved the adoption of the report of the electric lighting department. This is the first balance-sheet presented by the Electric Lighting Committee to the Council, and Alderman Lennard pointed to the fact that he was taken to task on the initiation of the scheme for his sanguine views as to the possibility of the scheme being carried through without a call upon the rates. There was, however, no longer any necessity to prophesy; they has passed through the early stages, and their balance-sheet showed, after placing £130 to the reserve fund (which was practically profit), that only the small loss of about £191 had been made up to Christmas last. This small sum they proposed to carry over to the next account. They had raised the full amount of capital authorised, viz., £42,748, but up to the present had only spent £18,882. The gross profit on the revenue account was £264. Their fuel account had been extremely low, as they had been using what was practically refuse, only a degree better than the absolute refuse which they used as fuel in the chemical department of the gasworks. The price charged per unit for electric current was at present 6d., but the Committee hoped before the end of the present year they would be able to ask permission to reduce the charge to 5d. Tradespeople were realising the splendid advertisement which the electric light afforded, and when, as they hoped, the supply of current was sufficient to enable them to supply the light at 4d. per unit, Alderman Lennard had no doubt whatever that a profitable and satisfactory addition would have been made to the Corporation's departments. On April 25th he, as Chairman of the Electric Lighting Committee, hoped to invite the Council and the leading townspeople to the formal opening of the electric light department. Complaint was made by a member of the Council that profit was being earned from the fittings department, both for gas and electric light. He said that this seriously affected many of the smaller tradesmen of the town, and he hoped that the fittings department would be abolished altogether. Alderman Lennard, in reply to the discussion which followed, stated that, with regard to electricity meters, the Committee were only charging the interest on the sum actually expended, and he felt sure the small charge would not prevent anyone taking the current. The present was hardly the time to go into the question of abolishing the fittings department, and he did not think private traders had any grievance in this respect.

Liverpool.—It is stated that the negotiations for the purchase of the Electric Supply Company's undertaking are still pending, as no purchase price has yet been decided upon.

Lowestoft.—The report has been presented by Mr. T. W. Baker on the subject of the utilisation of town refuse and electric lighting. Mr. Baker takes the initial cost of a joint scheme at £10,000, which the Corporation can borrow at 3½ per cent., and from the employment of which sum he estimates a profit on the fourth year's working. The result of the adoption of the scheme would be that the refuse disposal section of the scheme would be costless after a short period, and that a much better system of street lighting would result. The report is to be considered at a future meeting of the Town Council.

Metric Weights and Measures.—Before the Select Committee of the House of Commons, presided over by Sir H. E. Roscoe, Mr. Dowson, C.E., Chairman of the New Decimal Association, pointed out the advantages of the metric system of weights and measures, compared with those at present taught. He said that the decimal system was adopted by 245,000,000 people, and no country which had once adopted the metric system had ever given it up. He had estimated that the teaching of this system would save at least a year in the life of children.

Newport.—In reply to a question as to when the electric light supply would be ready, Mr. Alderman Moses, at the last meeting of the Town Council, said they anticipated that the works would completed in about a month or six weeks, and that the day plant, providing for about 900 lights, would be ready in a few days for those who were immediately in want of the light, and for lighting the Town Hall.

Obituary.—Mr. Crosby Lockwood, senior member of the firm of Messrs. Crosby Lockwood and Son, died at his residence at Highbury, London, N., on the 4th inst., in his 68th year. Mr. Lockwood was a member of the Court of the Stationers' Company, and was for many years associated with the publication of works dealing with engineering, metallurgy, mining, and other branches of applied science.

Perth.—An action has been raised in the Sheriff's Court by W. A. Bryson, electrical engineer, of Glasgow, against the Magistrates and Commissioners of Crieff, and Provost Adie, as an individual, for £26. 5s., being fee and expenses for providing a report upon the Falls of Barvick water supply for the purposes of the electric lighting of Crieff.

Piecework in the Electrical Department of the Post Office.—A resolution has been presented to the Postmaster-General which was passed at a recent delegate meeting of the London Trades' Council on the subject of overtime in the electric lighting department at Mount Pleasant, London. The resolution calls upon the Postmaster-General—

> "To observe the same conditions and customs in the Electric Lighting Department at Mount Pleasant as are observed in the various shops in the London district; and abolish the present system of piecework in existence at the Instrument Factory at Holloway, where it is possible for a recognised skilled mechanic to earn the sums of 7s., 9s., and 11s. for three consecutive weeks' work."

The following is an extract from the Postmaster-General's reply:

> "As regards that part of the resolution which recommends the abolition of piecework, since the date on which the resolution was carried the men employed at piecework rates at the Instrument Factory have unanimously adopted a memorial asking that no change may be made in this respect."

Press Telegrams.—At the annual meeting of the Association of Chambers of Commerce, held in London on Wednesday, the Postmaster-General stated that press messages were despatched at a loss of £500,000 sterling. The arrangement by which this heavy loss was incurred was contained in a concession granted at the time the telegraphs were taken over by the State. With regard to placing telegraph and telephone wires underground, he pointed out that the latter system was much more expensive than the former, and that wires laid underground were not more than half as durable as those placed overhead.

Queenstown.—It has been decided by the Town's Commissioners to defer the consideration of the subject of the cost of the public lighting of the town until the report of Mr. R Hammond, to whom the subject has been referred, shall be before them. The matter is to be further discussed at a special meeting of the Commissioners. An endeavour is to be made to utilise for power purposes the machinery erected at the pumping station.

Rhondda Valley.—Mr. Sydney F. Walker, having disposed of the lighting of Cardiff, is now turning his attention to the supply of electric current to the Rhondda Valley. In a lengthy letter to the *South Wales Daily News* Mr. Walker gives his views on the subject.

Rothesay.—The subscribers to the telephone in this district are anxious to have trunk line communication with Glasgow, but the National Company have intimated that their arrangements with the Government prevent their establishing such trunk communication, and recommend the subscribers to approach the Postmaster-General on the subject.

Safety Candle Fittings.—In reference to a note which appeared in our last issue (page 588) on Safety Candle Fittings, Messrs. Laing, Wharton and Down write:—"82a, New Bond-street, London, W., March 14th—In your issue of Friday last we notice you describe some electric candle fixings which are apparently new to you. We should like to take this opportunity of correcting that assumption, and of informing you that we have now for several years manufactured candles, which have not only all the advantages pointed out in the candle you describe, but one additional advantage. Our candles have rubber swelling bases, so that they may fit sockets with considerably different diameters. They also have a means of holding the candle tube perfectly secure, and beyond this can be drawn into two pieces quickly, so that fittings may be dismantled with practically no expense when they have to be packed for shipment or consignment in the country, or else when it is required to pack them up owing to the family being out of town. We should be glad if you would kindly make a note of this fact."

Shoreditch (London, E.).—The Vestry have adopted the report of the Electric Lighting Committee, which has been for some time under discussion, and now propose that a firm of consulting engineers be employed to carry out the electric lighting and dust destructor scheme, plans and specifications for which are to be prepared by the contractors, the consulting engineers being paid a commission of 3 per cent. on the amount of the tender accepted, as an inclusive remuneration for all work in connection with the scheme, for the effective and successful execution of which the said consulting engineers are to be responsible.

Southport.—Acting on the advice of Prof. A. B. W. Kennedy, the Electricity Committee of the Corporation recommend the addition of 40 arc lamps for the lighting of Lord-street and the Promenade and some of the adjacent thoroughfares not now lighted electrically. After considering Prof. Kennedy's report, a sub-committee of the Council visited Portsmouth to inspect the street lighting there, and were of opinion that this was perfectly satisfactory. The recommendations of the Committee have been approved by the Council. A question arose as to the action of the Electricity Committee in splitting up certain tenders after they had been referred back. It was agreed that the practice was justifiable.

St. Luke's (London).—The County of London Company have notified the Vestry of their intention to at once commence the supply of electric current in certain thoroughfares within the Vestry's district.

Sunderland.—In formally inaugurating the town's electric lighting scheme, last week, the Mayor pointed out that 71 years had elapsed since gas was first used for lighting purposes in the town. The function passed off most successfully. In giving a brief history of the scheme, Councillor Bruce said the matter first came up for discussion in 1883, when the first private company to supply the light was formed. Another was promoted in 1890, but the Corporation were able to get the Orders obtained by both companies revoked. In 1893 the Corporation obtained their Order, and the work had proceeded quietly since that time. Prof. A. B. W. Kennedy was called in, and estimated the total cost at £22,000, and ultimately tenders were accepted for the sum of £19,358, which represented a considerable saving on the estimate. The total cost of the scheme up to the present, including everything, had been £21,256. Mr. C. S. V. Brown, the Corporation's engineer, had superintended the whole of the work to the great satisfaction of the Council. Current equivalent to 2,350 8-c.p. lamps were connected, and orders were in hand for a large additional number, so that their total present capacity of 6,000 8-c.p. lights was already quite half bespoke.

Telegraph Wire and Apparatus Export Trade.—February has proved to be one of the quietest months experienced for some time in the export trade of this country in telegraph wire and apparatus connected therewith, the exports having only amounted to £9,411, as compared with £133,118 in 1894. For the first two months of the year the exports are already £107,252 behind those of 1894—£44,604 against £151,856.

Thefts.—Horace Radford, an electrician in the employ of Mr. Hughes, of Hatton Garden, London, E.C., was last week sentenced to six weeks, with hard labour, for robbing his employer. The magistrate described the prisoner as a skilled workman in receipt of adequate remuneration and the case as a very bad one.

——— An electrician named Otter was sent to gaol for three months by the magistrate at Clerkenwell last week for stealing 56lb. of brass rod, a number of batteries, and other articles, the property of the Ford-Lloyd Manufacturing Company, in whose employ the prisoner was.

Tilbury.—The Parish Council for this district have appointed a committee to consider the question of lighting the parish by gas or electricity.

Trans-African Telegraphs.—The section of telegraph line from Buluwayo to Charter, a distance of 212 miles, is now complete.

Walsall.—The local authorities of this town have received a letter from the Walsall and District Trades' Council strongly condemning their action in giving a contract to Mr. Gough, of Wolverhampton, for the erection of the electricity station, "his tender being only £22 less than the tender of a Walsall builder." The recommendations of the General Purposes Committee for the appointment of a resident electrical engineer at a salary of £150 per annum, the acquisition of three transformer stations, and the making of certain contracts, so that the Corporation may be in a position to supply electric current during the coming autumn, were agreed to.

Warsaw, Poland.—The electric lighting question is at present engaging the attention of the municipal authorities of this city.

Wells.—The Town Council have decided to grant a concession for the electric lighting of the town to Mr. A. D. D. Brown. Terms have been arranged under which the Corporation can, if they think proper, purchase the undertaking at a later period.

Weston-super-Mare.—At the monthly meeting of the Urban District Council on Wednesday, a long discussion took place upon the recommendation of the Lighting Committee in favour of the introduction of the electric light into the town. The Chairman of the Committee, Councillor Deverell, in moving the adoption of the report, reviewed the action they had already taken in the matter, and pointed out the benefits which would accrue to the district from the introduction of the light. Mr. Medhurst (the consulting engineer to the Council) attended, and gave particulars of his scheme, which includes the erection of a refuse destructor. Mr. Medhurst offers to take all the risks of loss during the first five years' working, and as a guarantee offers to deposit £500, on the understanding, of course, that any profits arising from the scheme should go to him. Councillor Dublin moved that the question of introducing the electric light be deferred for the present, and on a division this was carried by ten votes to five.

Workshops Lighting.—Messrs. Ernest Scott and Mountain, Limited, have completed a considerable installation at the new joiners' shops recently built by Messrs. J. T. Thompson and Sons, at North Sands, Sunderland. The arc lamps used in the work are of Scott and Mountain's improved type, fitted with light flashed opal globes with solid bottoms, so that it is impossible for sparks or pieces of carbon to fall through. This is a most important matter in joiners' shops, where shavings are abundant. 18 arc lamps are used on the ground floor of the buildings, and between 40 and 50 incandescents for the varnishing and adjacent shops.

Works Lighting.—The extensive Villiers Tin-plate Works at Briton Ferry are now lighted by electricity. The Electric Construction Company's machine is used, the fittings being supplied by the Edison-Swan Company.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

February 11, 1895.

2,999. The Cowper-Coles Galvanising Syndicate (Limited) and S. O. Cowper-Coles. London. Improvements in and means to be employed for the obtainment of zinc from its ores, and the electro-deposition of zinc upon iron or other metals or alloys.

3,000. C. A. Faure. London. Improvements in secondary batteries.

3,002. G. Devey. London. Improvements in electric arc lamps for photographic purposes.

3,003. W. P. Thompson. London. Improvements relating to the regulation of electric motors. (E. Lanhoffer, A. Burghardt, and J. Burghardt, Germany.)

3,006. W. E. Burnand. London. Improvements in electric arc lamps.

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3,055. F. King. London. Improvements in or connected with electric steering apparatus.

3,062. E. M. Boynton. London. Improvements in electric locomotives.*

3,066. E. Henriquez. London. Improvements in means for preventing the liquid of primary and secondary batteries being spilt, and for rendering it motionless, more especially during transport.

3,076. H. H. Lake. London. Improved combined telephone and telegraph systems. (C. A. Shea and F. F. Raymond, United States.)

3,081. A. Essinger and W. Parrott. London. An improved ventilating box cover for electric lighting culverts or ways, sewers, cellars, or other places needing ventilation.

3,085. J. Jahnsson. London. Improvements in and relating to electric. gas lighting devices.*

3,086. H. H. Lake. London. Improvements in automatic telegraph machines. (World Flash Company, United States.)*

3,087. H. H. Lake. London. An improved telephone system. (C. A Shea and F. F. Raymond, United States.)

3,095. G. W. Hey and A. E. Parsons. London. Improvements in and relating to electrical exchange systems.*

February 13, 1895.

3,125. C. Meason and T. Ford. Birmingham. Improvements in brackets for gas, oil, or electric light.

3,134. F. W. H. Hempel and A. Maerker. Glasgow. Improvements in apparatus for indicating or recording telephonic connections.*

3,172. A. Coke. London. A method of ventilating the pipes, manholes, chambers, &c., containing the wires conveying electricity through streets and public ways.

3,178. W. Macpherson. London. Improvements in and connected with testing and junction boxes, manholes, and culverts for electric light mains and other purposes and in the covers therefor.

3,179. J. Monteith. London. Improvements relating to electric light fittings.

3,183. L. Wacker. London. Process for the production of concentrated sulphuric acid by means of electrolysis.

February 14, 1895.

3,226. F. E. Adams. Bolton. An apparatus for steering steamships and other vessels automatically by the aid of electricity and the mariners' compass.

3,228. J. Frick. London. Improvements in the ventilation and combined electrical and chemical purification of the atmosphere in open and closed spaces.

3,233. T. E. Walter. London. A combination electric lamp and battery.

3,250. V. de Spruner-Mertz and J. Koch. London. Improvements in globes for electric glow lamps.

February 15, 1895.

3,331. F. W. Dickinson. London. Improvements in or relating to electric arc lamps.

3,336. W. Acroyd, W. Best, and J. Peel. London. Improvements in or connected with apparatus for electrically lighting miners' safety lamps.

3,358. M. Wheless. London. Improvements in electric railway systems. (Date applied for under Patents, &c., Act, 1883, Sec. 103, December 3, 1894, being date of application in United States.)*

February 16, 1895.

— E. Grahame. London. Improvements in electrical indicators applicable for various purposes.

February 20, 1895.

22,965a. W. P. Thompson. Liverpool. Improvements in the method of and apparatus for electrically heating metal or other conducting bodies. (C. L. Coffin, United States) [Date claimed under Patents Rule 19, November 27, 1894.]*

February 18, 1895.

3,458. J. B. Barton. London. Improvements in and connected with arc lamps. (W. Jandus, United States.)

3,511. J. W. Courtis, F. P. Sibley, and C. Dallimore. London. An improved method of electrically signalling upon railways.

3,512. J. W. Courtis, F. P. Sibley, and C. Dallimore. London. An apparatus for electrically communicating from a fire engine to a fireman in charge of hose on building.

February 19, 1895.

3,531. L. Kamm. London. Improved telegraphic type writer.

3,548. W. Edge. London. Improved electric switch.

3,573. N. L. Burchell. London. Improvements in telephonic apparatus.*

3,582. H. Reason. Brighton. Improvements in casings for electricity conductors.

3,593. W. B. Shaw. London. Improved wire draw vice and key, particularly intended for use in telegraph and telephone wire line work.

3,605. O. Stuart and T. H. Ashcroft. Liverpool. Improvements in or relating to devices applicable for electrically lighting pipes, cigars, cigarettes, or the like.

3,622. W. E. Wheeler. London. Improvements in electric dental engines.

3,625. C. Offermann and E. Bailey. London. An improved process for coating or plating metals with aluminium or aluminium alloys by electricity.

February 20, 1895.

3,632. A. E. Cook. Birmingham. Improvements in appliances for polishing and finishing after electro-plating.

3,633. T. Parker, J. H. Woodward, and E. S. G. Rees. Wolverhampton. Improvements in or connected with the distribution of electricity

3,662. J. R. Scott. Newcastle-on-Tyne. Improvements in electrical contacts for torpedoes.

3,679. T. S. Foster. London. Improvements in the construction of electric arc lamps.

3,685. W. S. Boult and C. R. Boult. London. Improvements in or relating to electric traction.

3,693. J. F. W. Morris and G. Mumford. London. New and improved electric lock and system of electric locking for the purpose of securing additional safety in railway signalling.

3,701. W. C. Bersey. London. Improvements in the electrical driving-gear for vehicles.

February 21, 1895.

3,770. J. Graham and H. Chapman. London. Improvements in or connected with the filaments of incandescent electric lamps.

3,779. A. Albrecht. London. Improvements in economising apparatus for the carbons of electric lamps.*

3,788. B. Lebrun. London. Improvements in electric locomotives chiefly designed for use in mines.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

207. De Ferranti. Electrical transformers.

1,903. Wuillot. Secondary battery electrodes.

2,437. Cardoso e Bastos. Electric time, alarm, and synchronising apparatus.

2,493. Randell. Electric lamp holders.

2,730. Grant. Protector for electric cables.

6,888. Imray. (Société Anonyme pour la Transmission de la Force par l'Electricité.) Telegraphic and telephonic apparatus.

7,054. Clubbe and Southey. Electrically propelled vehicles.

7,853. Thoms and Burgum. Electro-deposition of metals.

8,011. Jehl and Von Hardtmuth. Arc lamps.

18,480. Jaskey and Else. Electrical gas lighters.

20,330. Vago. Electromagnetic motor.

24,564. Heys (Heilmann). Electro-locomotives.

24,583. Whittingham. Electric car heaters.

25,076. Boult (Spiro). Telegraphic transmitters.

1895.

56. Siemens Bros. and Co., Limited (Siemens and Halske). Electrical cut-out.

157. Jensen (Jacobsen). Telephone call stations.

348. Close. Electric current rectifiers.

462. Levy. Photographic diaphragms.

497. Love. Electric railways.

COMPANIES' MEETINGS AND REPORTS.

Hove Electric Lighting Company (Limited).

The third annual general meeting of the members of this Company was held at the City Terminus Hotel, Cannon-street, on Tuesday, under the presidency of Colonel H. Wood, C.B.

The SECRETARY (Mr. Francis R. Reeves) having read the notice calling the meeting,

The CHAIRMAN proposed the adoption of the report and accounts for the year ended December 31, 1894. He said : Before formally asking you to pass this resolution, I will just make a few remarks about the state of the Company. In the first place we may all congratulate ourselves on the satisfactory progress it has made during the past year. The fact that the number of lamps connected with the Company's system has increased during the year by nearly 10,000, is a very satisfactory evidence of the appreciation by the residents of Hove of the work carried out by the Company. Another matter for congratulation is the fact that the machinery, the accumulators, and the mains, supplied by Messrs. Crompton and Co. under their contract, have proved so very good that the work of supplying electricity at Hove has been carried out during the year without the slightest difficulty or hitch ; and the Directors congratulate themselves upon having had such a reliable firm of contractors to carry out their work. The lighting station is now almost complete, with the exception of some minor details, and already the Directors have had to exceed the original contract by more than £7,000 for mains alone to meet the demands of intending consumers. Beyond this, additional machinery has had to be placed in the Company's station for the purpose of generating the electricity, and these additions will, no doubt, have to be further supplemented by other machinery during the current year. The sale of current to the consumers has increased during the past year from £1,265 in 1893 to £3,508, and as the major portion of the lights now connected with the system were only coupled up late in the year, the receipts for the present year will doubtless be again considerably increased As an evidence of this fact, it may be mentioned that the Directors. keep a careful record of the operations of the Company week by week, and make an estimate of the weekly profits as closely as it is possible to do, and already during the current year there is an increase of £654 over the profit earned in the corresponding period of 1894, the net profit to date amounting to £763. Consequently it is evident that the revenue for the present year bids fair to be in every way even more satisfactory than the last. The profits for last year would, no doubt, have been even larger than they are had it not been for the fact that the Company was not able to press forward the completion of the permanent station as rapidly as they desired owing to want of funds, and in consequence, until the present moment, the Company had had to meet the pressure of the lighting during the past winter by working what are practically two stations—namely, part of the machinery in the permanent station and part in the temporary station — the effect of which is considerably to increase the cost of production, and, therefore, to reduce the profits. This state of things, however, will now cease. The temporary station will be dismantled, and the surplus machinery sold in reduction of capital expenditure, and the work of the staff engaged in the production of electricity will be more economically carried out in one building. This alone will represent a substantial saving. There is another matter of economy which the Directors have deciding upon effecting, and that is doing away with the local office, which was opened at 79, Western-road during the erection of the permanent station, and dispensing with the services of the separate local secretary. It has been decided by the Directors to appoint Mr. Smith, the gentleman who has had charge of the station from the commencement, the Company's resident engineer, and under him an efficient staff of clerical and other assistants through whom the local work of the Company will be carried on. The saving in rent and salaries by this change is expected to be not less than £150 per annum. The Directors have thought it would be a matter of interest to the shareholders to see in the revenue account the corresponding figures for the previous year, in order that they may compare them for themselves and judge of the steady progress of the Company. In dealing with the net profit available for division, £680, it will be observed that the Directors propose to write off £75 from the suspense account. At first sight it may be considered that this is rather a small amount to write off a total preliminary expenses suspense account of £1,456, but the Directors have it in contemplation to write this amount off more quickly in the future if the results of the working continue satisfactory, as they have no doubt they will. Even, however, if the rate of writing off in the past year be maintained, the Directors will succeed in wiping out this amount entirely by the time the local authority at Hove will be in a position to purchase the undertaking. It will be remembered that the terms on which the Commissioners—or, rather, the District Council of Hove, as they are now called—can purchase the Company's business are that they can obtain the property and undertaking of the Company by repaying to the Company the actual capital expenditure, plus a cumulative dividend at the rate of 7 per cent. per annum, after deducting any amount paid to the shareholders by way of dividend. Thus, if the Directors, in the 20 years, by writing off 5 per cent. per annum from the suspense account, have wiped out the whole account, the balance remaining on capital account will be the sum payable to the Company, should the Local Authority elect to purchase, and the Directors feel that the course they are adopting in this respect will meet with the approval of the shareholders. With reference to the dividend, if the business of the Company was of a doubtful and changing character, the Directors would have had some hesitation in recommending the payment of a dividend so early in the Company's existence ; but, seeing that the business of the Company consists in the supply of a commodity which has now become almost a necessity of everyday existence, and that, consequently, the growth of the revenue is practically assured in the future, they have no hesitation in recommending the proposed dividend. It will be observed in the statement of accounts that the Directors have borrowed £10,000 temporarily from the Company's bankers, an amount which they now desire to pay off. It is with this object they have offered the members the opportunity of subscribing for the remaining shares of the Company, and any balance will probably be offered to the public at a premium, which the Directors think they are justified in asking, looking at the established and sure position which the Company has attained. The Directors prefer to raise the money by the issue of shares, as they are desirous of seeing the share account closed, and reserving for a future issue, if necessary, the remaining debentures to meet the expenditure on extension works. There is one matter as to which the Directors feel bound to express their disappointment. They had hoped long before this that the Commissioners of Hove would have decided to go in for a large amount of public lighting ; but although they have put four lamps in Western-road and Church-road, they have not yet decided what they will do with regard to a general adoption of electric lighting for the public streets. The matter is under consideration by a Committee, and the Board hope, when next they have the pleasure of meeting the shareholders, that they may be able to announce that a contract for a large number of public lights has been made. It will be readily understood that, as the demand for current increases, the cost to the Company decreases, because there is little or no alteration in the fixed charges of the Company, the only additions being the cost of fuel, &c. There is one matter about which the shareholders may expect something to be said, and that is with reference to the accidents which have been reported in the public press as having occurred in the mains of other companies in London and elsewhere by explosions in consequence of accumulations of gas in the mains. This matter has given the Directors some anxiety, as in consequence of the recent severe weather, several of the pipes of the Brighton and Hove Gas Company have proved defective, and in some cases very large quantities of gas have found their way into the culverts of this Company. It will be easily understood that the frost has not only, by disturbing the roads, broken some of the gas company's mains, but has also disturbed the cover stones of the culverts, and allowed a space for the gas to enter. The Directors have pleasure in assuring the shareholders that they have reason to believe there is no danger of an explosion occurring in this Company's culverts, first, by reason of the fact that the box covers are lifted and careful examination made for any traces of gas, and further, that as the gas cannot be ignited without a spark, the possibility of a spark occurring in the Company's mains is an extremely remote one, inasmuch as the system adopted by the Company enables the mains and insulators to be carefully examined and the latter cleaned from time to time to prevent any formation of salts on their surface, thus rendering it practically an impossibility for a short circuit to occur. It is also a fact that up to the present time no such accident has occurred in any mains laid on Messrs. Crompton and Co.'s system of bare copper in culverts. This is surely a reassuring fact for the shareholders.

Mr. CARLETON F. TUFNELL seconded the motion.

A brief discussion followed, and in answer to Mr. Cooper and Mr. Price,

The CHAIRMAN stated that 258 of the remaining shares of the Company had so far been applied for. Some complaints had been made as to the cost of the current; but the people of Hove were economic in its use, and the cost had not come out very high compared with other places.

The SECRETARY: Excepting Brighton.

The CHAIRMAN, continuing, remarked that the larger the demand for electricity in Hove the cheaper it would become, and they were at present at a disadvantage in this respect compared with some other places.

The resolution was then unanimously carried.

On the motion of the CHAIRMAN, seconded by Mr. HAROLD A. HOARE, a dividend at the rate of 3 per cent. per annum was declared for the year ended December 31st last.

The retiring Director, Mr. Hoare, was re-appointed, and Mr. Robert Payne, F.C.A., was elected auditor for the ensuing year.

A vote of thanks to the Chairman was then passed, and, in reply,

The CHAIRMAN expressed his acknowledgments to the Secretary for giving him such information as had made him *au fait* in the Company's affairs, and had enabled him to make the clear statement which he had presented to the meeting regarding the position they were in.

Birmingham Electric Supply Company (Limited).

The annual meeting of the shareholders of this Company was held on Thursday at the offices of the Company, Dale-end, Birmingham, Mr. Henry Buckley presiding.

The CHAIRMAN, in moving the adoption of the report (an abstract of which appears below), said he was confident it would meet with the general approval of the shareholders. During the last year there had been an increase of about 20 per cent. in the output of current, but, what was still better, there had been an increase in the number of consumers of about 28 per cent. It was true their average price per unit was not so large as in the previous year, but that was partly due to the fact that motors were now beginning to be used. The Directors hoped that each year would see a considerable increase in the number of motors; indeed, he was satisfied it would be so, especially when they were able to supply the jewellers' quarter, for where only ¼H.P. or ½H.P. was needed it was impossible to get anything more convenient or economical than electric motors. It would be seen from the accounts that the Company had amply earned, and more than earned, the dividend recommended in the report. As to their proposal to carry forward £1,001. 11s. 9d. to next year's account, the Directors felt that such a course would add materially to the stability of the Company. They would, moreover, be undertaking a considerable capital expenditure in the ensuing year, which in a great measure would not be earning anything. The did not want to pay a decreased dividend next year, and he was satisfied that under the arrangement proposed they would be able to maintain the same dividend, or possibly to declare an increased one. The Directors had made up their minds to reduce the price to consumers almost immediately from 8d. and 6d. to 7d. and 5d. per unit, being of opinion that the increased demand which would result would more than make good the diminution of profit per unit. Since the last annual meeting they had obtained from Parliament powers to enter the jewellers' quarter, and an area at Edgbaston. They had acquired the sites necessary for laying down distributing centres in Newhall-street and near the Ivy Bush, Edgbaston, but they would have sufficient room at the existing generating works to supply the demand during the next three or four years. It was the intention of the Directors to shortly call up the unpaid capital (£2) on the 10,000 shares, in order to deal with the extension of business when the necessity arose. The Directors recommended that the capital of the Company be increased from £100,000 to £200,000. The concern was never in a sounder or more promising condition than at present.

The report having been adopted,

The CHAIRMAN, in proposing

"That the capital of the Company be increased by £100,000, divided into 20,000 shares of £5 each (making the total nominal capital £200,000),"

promised that, before issuing any of the new capital, a meeting of the shareholders should be called.

The resolution was then agreed to, and Mr. G. S. Albright and Mr. G. H. Johnstone, the retiring Directors, and Messrs. Sharp, Parsons and Co., the auditors, were re-elected, and the meeting terminated.

The annual report showed that the amount of net profit, including a balance of £409. 12s. brought forward from last year, was £5,609. 5s. 6d. The Directors recommended the payment of a dividend of 4 per cent., absorbing £2,754. 18s. 6d., placing £1,602. 15s. 3d. to the credit of the depreciation reserve fund, a further sum of £250 to the general reserve fund, and carrying forward the balance of £1,001. 11s. 9d. to next year's account. On making that appropriation the total of depreciation, general reserve, and undivided profits amounted to £6,864. 0s. 8d.

W. T. Henley's Telegraph Works Company (Limited).

The following report of the Directors of this Company is issued, and will be presented to the shareholders at the ordinary general meeting, to be held at the Company's offices, Martin's-lane, Cannon-street, London, E.C., on Friday next, the 22nd inst., at 12:30 o'clock:—

The accounts show a net profit of £16,455. 13s. 11d., and, after payment of interest and income-tax, making allowance for depreciation of plant, and the expenses of issuing the Four and a-Half per Cent. Mortgage Debenture Stock, there remains £11,819. 8s. 3d., added to £5,187. 14s. 2d. brought forward from last year. Deducting £1,050, the half-year's dividend on Preference shares paid in October last, there remains a balance of £15,957. 2s. 5d. £2,180. 9s. 2d. has been added to the reserve fund, and the Directors propose the payment of a further half-year's dividend on the Preference shares at the rate of 7 per cent. per annum, and a dividend for the year at the rate of 6 per cent., free of income-tax, on the Ordinary shares, these payments together absorbing £5,152. 4s.; £8,624. 9s. 3d. is thus carried forward. In the month of August last, an issue was made of £50,000 Four and a-Half per Cent. Mortgage Debenture Stock. The whole amount has been issued, and the proceeds applied to paying off all existing mortgages and debentures, and to providing additional buildings, plant and working capital. All expenses in connection with the issue of this new stock have been charged against the revenue of the year. The Company has not had during the year a single large contract for submarine cables, but the large increase in its general business has enabled a dividend to be paid of 6 per cent., instead of 5 per cent. as heretofore. The Directors heartily congratulate the shareholders on this result, and on the general satisfactory position of the Company.

The retiring Directors are Mr. R. J. Jenkins, C.E., and the Hon. Randolph Stewart, who seek re-election, as do the auditors, Messrs. Ball, Baker, Deed, Cornish and Co.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1895, pages *304-332, &c. &c.*]

BENTLEY AND JACKSON (LIMITED).—This Company was registered on March 1st with a capital of £40,000 divided into 900 Preference, 450 Ordinary-Preference, and 2,650 Ordinary shares, of £10 each, to acquire the business of Bentley and Jackson at the Lodge Bank Works, Lord-street, Bury, Lancs., and to carry on the business of founders, engineers, metal workers tool makers, &c.

SIR JAMES FARMER AND SONS (LIMITED).—This Company was registered on March 1st with a capital of £15,000, in £50 shares, to acquire the whole or part of the undertaking of Sir James Farmer and Sons (Limited), engineers, of Salford, and to carry on the business of mechanical engineers, tool makers, boiler makers, brassfounders, &c.

INCANDESCER (LIMITED).—This Company has been registered with a capital of £4,000, in £1 shares, to enter into agreements with Messrs. Francis H. Medhurst and D. C. Defries, and to carry on the business of manufacturers of and dealers in the "patent incandescer," &c.

IRWELL RUBBER COMPANY (LIMITED).—This Company was registered on March 2nd with a capital of £30,000, in £10 shares, to acquire and carry on the business of india-rubber goods manufacturer carried on by Isidor Frankenburg at the Irwell Rubber Works, Mill-street, Salford, Manchester.

MAY'S METALS SEPARATING SYNDICATE (LIMITED).—This Company was registered on March 2nd, with a capital of £20,000, in £100 shares, to enter into an agreement with J. A. May for the acquisition of certain patents relating to the separation and refining of metals, and to carry on the business of mechanical engineers, machinery, and tool makers, metal workers, boiler makers, machinists, &c.

NISBET AND CO. (LIMITED).—This Company has been registered with a capital of £1,000, in 600 Preference and 400 Ordinary shares, of £1 each, to carry on the business of designing, building, selling, repairing, housing, letting out on hire, and selling on commission, as agents, boats, yachts, launches, &c., and all appliances connected therewith, and of manufacturing and fitting up machinery to produce motive power of any kind for any form of launch or yacht, electric or otherwise, and of producing, storing, and supplying such motive power.

ARC ACCUMULATOR COMPANY (LIMITED).—The annual return of this undertaking, made up to December 7th, has been filed. The nominal capital of £1,000, in £1 shares, has been taken up, and 993 have been issued as fully paid. Nothing has been paid on the remaining seven shares.

ASSOCIATION FOR THE PROTECTION (?) OF TELEPHONE SUBSCRIBERS (LIMITED).—A letter has been received by the Registrar of Joint-Stock Companies to the effect that this Association never had directors or managers, and is practically wound up. The Association was registered with a great flourish of trumpets on March 25, 1892, as a company limited by guarantee, having a membership of twenty, each of whom were liable for £1 in the event of winding-up. Its objects were "to assist and protect telephone subscribers in the United Kingdom, and in particular those of London and its neighbourhood, and to consider all questions connected with telephonic communication." As was generally anticipated, the Association was never taken seriously, either by telephone subscribers or the public, and was laughed out of existence by the National Company.

CAPSULE BATTERY COMPANY (LIMITED).—The statutory return of this Company, made up to February 6th, has just been filed; 3,157 shares have been taken up out of a nominal capital of £30,000 in £1 shares, and the full amount per share has been called.

CARBON SYNDICATE (LIMITED).—The statutory return of this Company, made up to February 2nd, and just filed, shows that 2,064 shares have been subscribed for and allotted, out of a capital of £100,000, divided into 25,000 Preference and 75,000 Ordinary shares of £1 each, resulting from a call of 10s. on each share.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LIMITED).—The annual return of this Company, made up to March 7th and just filed, shows that out of a nominal capital of £250,000, in £5 shares, 30,000 shares have been taken up. Several important changes in the holdings have taken place during the year, and Messrs. A. and S. Gatti, who last year held 9,284 shares, are now credited with 18,817.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The annual return of this Company, made up to February 7th, was filed on March 7th. The whole capital of £220,000, in £10 shares, has been taken up, and paid in full.

EASTERN TELEGRAPH COMPANY (LIMITED).—The annual return of this Company, made up to February 7th, has been filed. The capital is £4,700,000, divided into 400,000 Ordinary and 70,000 Preference shares, each of £10. 469,938 of these have been subscribed for and allotted, and the whole amount called and paid.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL COMPANY (LIMITED).—The annual return of this Company, made up to January 2nd, has been filed. The nominal capital is £250,000, divided into 75,000 Ordinary and 50,000 Preference shares of £2 each. 74,218 of the former and 13,580 of the latter have been taken up, and the full amount called. £146,086 has been paid with respect of the Ordinary shares, leaving £1,350 unpaid, while £25,105. 1s. has been paid on the Preference. £612. 10s. has been paid on 782 forfeited Ordinary shares.

IRISH HOUSE-TO-HOUSE ELECTRICITY COMPANY (LIMITED).—This Company has held no meetings during the years 1892, 1893, and 1894, and no business has been transacted, but as it is desired that the name should be kept on the register, returns for those years were filed on January 7th, when 100 Founders' and 527 Ordinary shares out of a capital of £100,000, in £5 shares (of which 100 are Founders'), were taken up. The latter have been issued as fully paid, and the Ordinary have had 10s. per share called.

LEEDS AND LONDON ELECTRICAL ENGINEERING COMPANY (LIMITED).—The annual returns for 1894 (made up to December 31st and 1895 (made up to January 28th last) have just been filed. The nominal capital amounts to £100,000, divided into 250 Founders', 9,750 Preference, and 10,000 Ordinary shares of £5 each. In each return all the Founders', 734 Preference, and 5 Ordinary have been taken up, and the full amount has been called on the Founders', 634 Preference, and the Ordinary shares, while a call of £1 per share has been made on the remaining 100 shares. The full amount of £4,545 has been paid.

"LIGHTNING" (LIMITED).—The annual return of this Company, made up to January 14th, has been filed. The whole nominal capital of £3,000, divided into 2,400 Ordinary and 600 Founders' shares of £1 each, has been taken up, and 300 of the latter class have been issued as fully paid.

LINEFF ELECTRIC TRACTION AND LIGHTING COMPANY (LIMITED).—The annual return of this Company, made up to January 3rd, has been filed. 11,431 shares have been taken up out of a capital of £15,000, in £1 shares, and 8,003 of these have been issued as fully paid. The full amount has been called and paid on the remaining 3,428 shares.

LONDON ELECTRIC WIRE COMPANY (LIMITED).—The annual return of this Company, made up to February 5th, has been filed. The nominal capital is £60,000, in 5,000 Ordinary and a like number of Preference shares, of £5 each, and 4,188 Preference and 4,597 Ordinary shares have been taken up. 3,860 of each class have been issued as fully paid, and the full amount has been called on the remaining 328 Preference and 737 Ordinary shares.

MEDICAL ELECTRICAL INSTITUTE (LIMITED).—The statutory return of this Company, made up to February 28th, has been filed. The capital is stated to be £75,000, divided into 25,000 £7 per cent. Preference shares of £1 each, and 20,000 Ordinary shares of £2. 10s. each, and seven of the latter have been taken up, but no calls have as yet been made. A winding-up order has just been made, and the landlord, Mr. C. B. Harness, has distrained!

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING COMPANY (LIMITED). The annual return of this Company, made up to February 25th, has been filed. The whole nominal capital of £50,000, in £10 shares, has been taken up, and £8 per share has been called.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY (LIMITED). The annual return of this Company, made up to February 26th, has just been filed. The nominal capital is £200,000, divided into 20,000 Preference shares of £5 each, 19,980 Ordinary shares of £5 each, and 100 Founders' shares of £1 each. All these have been taken up, and each share has had the full amount called and paid.

WEYBRIDGE ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to December 31st, has been filed. The share capital is £15,000 in £5 shares, and 1,487 shares have been taken up, of which all but seven have been issued as fully-paid to the Laing, Wharton and Down Construction Syndicate (Limited), now the British Thomson-Houston (Limited). The full amount of £5 per share has been called and paid on the remainder.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY (LIMITED).—The annual return of this Company, made up to February 19th, has been filed. Out of a nominal capital of £100,000, divided into 19,990 Ordinary and 100 Founders' shares of £5 each, 10,000 of the former and all the latter have been taken up, and the Founders' shares have been issued as fully paid to the parent Company. The full amount has been called on the Ordinary shares.

CITY NOTES.

BORDEAUX TRAMWAYS AND OMNIBUS COMPANY (LIMITED).—A meeting of the shareholders of this Company was held at Winchester House, E.C., on Wednesday, under the presidency of Lord Richard H. Browne, who, in presenting the report and statement of accounts for the past year, said: "The Directors considered the time was fast approaching when the shareholders must deal with the subject of the adoption of electricity for their tramways, and he hoped to bring the matter forward at the next meeting and move a resolution."

CHELSEA ELECTRICITY SUPPLY COMPANY (LIMITED).—During the week the Directors of this Company have invited applications for £60,000 Four and a-Half per Cent. Debenture stock, at the price of £103, payable £10 on application, £23 on allotment (including premium), £30 on April 17th next, and £40 on June 28th. The Debentures are redeemable after December 31st, 1910, at £110. The Debentures are secured by specific mortgage of freeholds and leaseholds, and by a floating charge on the whole of the undertaking and property of the Company, exclusive of uncalled capital for the time being in respect of any shares hereafter created or issued. The present issue is intended to be used in the redemption of £36,900 Six per Cent. Debentures, and to provide capital for further development of the Company's business. The list opened on Tuesday last and closed on Wednesday.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended March 10th were £971, as against £930 in the corresponding week of 1894, being an increase of £41. The total receipts for the half-year amount to £9,911, as against £9,474 for the corresponding period of 1894, an increase of £437.

HOBART ELECTRIC TRAMWAYS COMPANY.—A private meeting of this Company was held at the offices, College Hill-chambers, London, E.C., on Wednesday.

IMPERIAL TRAMWAYS COMPANY (LIMITED).—In the half-yearly report of this Company to December 31st last, reference is made to the introduction of electric traction to the Company's Dublin Southern District Tramways. The Directors have, as the result of negotiations, concluded a definite contract with the British Thomson-Houston (Limited). The works under the contract will include the reconstruction of nearly the whole length of tramways as double lines, in lieu of the existing single lines with passing places, and the complete electrical equipment, including building alterations, generating and distributing plant, and motor cars. The contract has been extended to include the section from Kingstown to Dalkey (about two miles), which is to be relaid as double lines, and equipped for electrical working uniformly as part of the through line from Dublin to Blackrock and Kingstown. The contract price is £109,200, which is to be met by a payment of £10,000 in cash and the issue of £30,000 in Five per Cent. Debenture and £69,200 in Five per Cent. Preference shares in the Dublin Southern Company. It is anticipated that the work will be completed in about four months.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 10th inst. amounted to £937. The amount for the corresponding week of last year was £687.

MARTINY (LIMITED).—A petition for winding up this Company has been restored to the list, and on the application of counsel on behalf of the Directors, Mr. Justice Vaughan Williams has agreed to adjourn the matter for a week in order that longer notice may be given to the Directors, the Company's works being in France.

SHEFFIELD GAS COMPANY.—Sir F. T. Mappin, M.P., presiding at a meeting of the shareholders of this Company on Monday last, said the result of the past half-year's working had been a very satisfactory one. The sale of gas had increased by 24,000,000 cubic feet, and although they had not yet equalled the consumption in the corresponding half of 1894, this was no doubt due to the bright weather of the latter part of the half-year and the competition of the electric light. A shareholder asked if there was any probability of the price of gas in Sheffield being reduced, as such a thing he thought would be appreciated by the public, and would prevent them "running after the electric light." The chairman replied that it had been with a great deal of hesitation that the Directors had raised the price of gas, and when an opportune time came it would be reduced. The usual 10 per cent. dividend was declared.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended March 8th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,639.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Divi-dend.	Name.	Previous Week's Price, Mar. 6.	Price Wednesday, Mar. 13.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Mar. 13.	
			TELEGRAPHS.			£ s. d.		Highest	Lowest
£1,012,880	Stock	14 0	Anglo-American	40 41	41 42	4 15 3	Jan., Apr , July, Oct	0½	..
£2,993,500	Stock	28 0	Do. Preferred	75½ 76½	78 79	5 1 3	" "	77¾	76½
£2,993,560	Stock	5/0	Do. Deferred	6 6½	6 6¼	..	..	6¾	6
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101 104	101 104	3 17 6	January and July	101⅝	..
130,000	£10	3/0	Brazilian Submarine	11¾ 12¼	12¼ 12¾	5 2 0	Mar., June, Oct., Dec.	12⅜	11⅞
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	109 113	109 113	4 9 3	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	148 152	148 152	4 12 1	Jan., Apr.,July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13 14	13 14	5 14 4	February and August	11	..
6,000	10	10%	Do. Preference 10 per Cent.	20 21	20 21	3 16 2	" "	..	..
12,931	5	1/8	Direct Spanish (fully paid)	4 4½	4 4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9½ 10	9½ 10	5 0 0	" "	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103% 106%	103% 106%	4 4 11	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8½ 9	8½ 9	5 0 0	Jan., Apr., July, Oct.	..	..
400,000	10	2/6	Eastern	16¼ 16½	16¼ 16½	3 18 9	" "	16½	16¼
70,000	10	6%	Do. 6 per Cent. Preference	17½ 18	17½ 18	3 6 8	" "	17¾	17½
£1,297,837	Sto k	4%	Do. 4 per Cent. Mort. Debenture Stock	124 127	124 127	3 3 0	May and November	124½	124
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105 108	105 108	4 13 0	February & August	..	..
250,000	10	2/6	Eastern Extension	17⅛ 17⅜	17⅛ 17⅜	4 0 8	Jan., Apr., July, Oct.	17⅜	17
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	123 126	123 126	3 3 6	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	104 107	103 107	4 14 1	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	104 107	103 107	4 14 1	" "	105½	104½
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106 109	106 109	3 13 9	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112% 115%	112% 115%	3 10 4	May and November	..	..
180,227	10	1/6	Globe Telegraph and Trust	9½ 10	9½ 10	4 10 0	Jan., Apr., July, Oct.	10	9¾
180,042	10	6%	Do. 6 per Cent. Preference	16⅝ 16⅞	16⅝ 16⅞	3 11 3	" "	16⅞	16 11/16
150,000	10	5 0	Great Northern	21¾ 22¼	21¾ 22¼	3 16 7	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104 107	104 107	4 13 6	March & September	105½	
17,000	25	12 6	Indo-European	53 55	52 54	4 12 7	May and November	52¾	52
37,548	10	5/0	London Platino-Brazilian	5 7	5 7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	105 109	105 109	5 10 1	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105 108	105 108	3 14 9	.	..	—
11,839	8	4/0	Reuter's	4 5	4 5	..	April and October	4½	..
3,381	£100 Cert	25/0	*Submarine Cables Trust 6 per Cent.	119 121	119 124	4 16 9	" "	123	122½
15,609	10	5/0	West African Telegraph	4 5	4 5	..	January and July	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	101 104	101 104	4 16 2	March & September	101¾	..
30,000	10	2/0	West Coast of America	1½ 2½	1½ 2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98 103	98 103	7 15 4	June and December	..	..
88,321	10	6d.	West India and Panama	⅞ 1⅛	⅞ 1⅛	..	..	1	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾ 11¼	10¾ 11¼	5 6 8	May and November	11 1/16	10¾
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9 10	9 10	6 0 0	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108 111	108 111	4 10 8	June and December	..	..
64,242	15	3/0	Western and Brazilian	10½ 11¼	10 10½	5 4 6	May and November	10 3/16	10
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼ 6¾	6¼ 6¾	..	..	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	4¼ 4¾	4 4½	..	..	4¼	—
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101 105	101 105	5 14 10	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101 105	101 105	5 14 10	" "	..	—
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115 120	115 120	5 18 11	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	101 103	101 103	5 16 6	March & September	..	—
			TELEPHONES.						
44,000	5	10/0	Chili Telephone (fully paid)	3 4	3 4	—	..	3½	..
224,850	10/0	2⅝d.	Consolidated Telephone Const. & Maintenance	1/16 3/16	1/16 3/16	..	May and November	..	—
171,504	£1	..	Oriental Telephone and Electric (fully paid)	3/16 11/16	3/16 11/16	..	Yearly	—	..
484,597	5	2/6	National	5¼ 5½	5¼ 5½	4 10 11	June and December	5 7/16	5¼
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15 16	15 16	3 15 0	" "	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½ 15½	14½ 15½	3 17 5	" "	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¾ 6	5¾ 5⅞	4 5 1	..	5 13/16	5¾
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104 106	104 106	3 6 0	January and July	105¼	104½
58,000	5	1/0	United River Plate	1 2	1 2	..	" "	..	—
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	85 90	85 90	5 9 11	" "	..	—
			ELECTRICITY SUPPLY COMPANIES.						
40,000	£10	5/0	City of London Electric Lighting (fully paid)	13 14	13 14	1 15 8	—	13¾	13 3/16
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15 15½	15 15½	3 17 5	..	15 5/16	15
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133 136	133 136	3 13 6	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..	..	..	—	..	..
£30,000	£5	2 6	Charing Cross and Strand Electricity Supply Corp.	5 5½	5 5½	3 17 9	—	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..	..	..	—	..	..
8,322	£5	..	House-to-House Electric	..	..	—	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..	..	—	—	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..	..	—	January and July	—	—
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7 7/16 7 11/16	7½ 7⅝	—	—	..	—
111,000	5	..	London Electric Supply	¼ ¾	..	..	..	..	..
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	10¾ 11¼	10½ 11	2 5 5	..	11 3/16	10¾
£150,000	Stock	4½%	* Do. 4½% Debs.	118 120	118 120	3 15 6	June and December	118½	..
6,452	£10	2,0	Notting Hill Electric	7¼ 7¾	7¼ 7¾	..	..	..	..
19,980	£5	4 6	St. James and Pall Mall	7½ 8	7½ 8	..	..	7⅝	..
20,000	£5	7%	Do. 7 per Cent. Preference	8½ 9	8½ 9	3 17 9	..	..	..
59,900	5	5½	Westminster Electric Supply (fully paid)	..	7⅝ 7⅞	3 3 6	..	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	3	1/6	Brush Electrical Engineering	2½ 2¾	2⅜ 2⅝	5 11 3	—	2 11/16	..
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅜ 2⅝	2⅜ 2⅝	4 11 5	..	2½	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	113 116	113 116	3 17 7	March & September	114¼	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	3 3½	3 3½	—	January and July	..	..
12,139	5	..	Edison and Swan United	—	—	—	—	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—	—	—	—	—	..
120,000	2	..	Electric Construction	¼ ½	¼ ½	..	—	..	..
12,845	2	2 9¾	Do. 7 per Cent. Cumulative Pref.	1½ 1¾	1½ 1¾	—	—	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1⅜ 1⅝	1½ 1¾	..	—	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½ 1½	½ 1½	—	—	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	23 24	22½ 23½	4 5 1	February & August	23½	22¾
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102 104	103 105	4 7 7	March & September	..	—
15,995	£10	..	International Okonite Ordinary	..	..	—	—	..	—
16,000	£10	..	Do. 8 per Cent. Preference	—	—	—	December and June	..	—
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	— ⅛	— ⅛	..	..	..	..
37,370	12	36/0	Telegraph Construction and Maintenance	39 41	39 41	8 15 7	March and July ..	40½	39½
£150,000	100	5%	Do. 5 per Cent. Bonds	104 107	104 107	4 14 1	January and July	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	—	—	..	—	..	..
41,098	£5	..	Do. Preference (fully paid)	—	—	..	—	..	..
£63,570	10	10/0	W. T. Henley's Telegraph Works Ordinary	10 11	10 11	4 10 11	..	10¾	..
£30,000	10	..	Do. Preference	..	..	..	..	..	..
			RAILWAYS AND TRAMWAYS.						
£630,000	Stock	1½%	City and South London Railway	45 47	45 47	2 13 2	May and November	46	..
7,000	10	5%	Do. 5% Perpetual Preference	14 15	14 15	3 6 8	..	—	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	130 133	130 133	3 0 2	May and November	.	..
87,500	£10	2%	Liverpool Overhead Railway	8½ 8⅝	8½ 8⅝	2 6 4	..	—	—
0,295	10	5%	Do. 5% Preference	13 13½	13½ 14	3 11 5	..	—	—
125,000	Stock	4%	Do. 4% Debenture	112 114	112 114	3 10 2	January and July ..	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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NOTES.

We are glad to learn by special cablegram that the somewhat sensational Reuter's despatch, which came to hand last week, announcing not only the burning out of Mr. Nikola Tesla's laboratory, but his mental collapse, was inaccurate in several respects. A fire began, it seems, early on Wednesday morning, the 13th inst., in the office of a steam-fitting concern situated on the ground-floor of the building in which Mr. Tesla carries on his work. The watchman reports that the mischief was started by a gas flame. Mr. Tesla's laboratory, on the fourth floor, was almost entirely destroyed. The contents included the whole of his polyphase models, most of his papers, the records of his experiments, the apparatus exhibited at Chicago, his original and latest form of oscillator, and all the apparatus with which he performed so many striking experiments when in London. None of the property was insured. Mr. Tesla, instead of being in a state of collapse as alleged, actively recommenced, on the very day of the fire, the building of a new oscillator. It is unnecessary to add that great sympathy has been expressed for this enthusiastic experimenter in the land of his adoption; an expression of feeling which we feel sure will find an echo in this country where he has made so many friends.

◆

The Postmaster-General's recent declaration as to the loss sustained by the Telegraph Department on account of Press telegrams is being hotly challenged by representatives of Press and Newspaper Associations, but in a somewhat eccentric manner. While affecting to treat the allegation as an empty lamentation, without any covert intention at the back of it, they contest the figures as if they conveyed a serious threat, and demand an investigation. It is almost too much to expect that Mr. Arnold Morley will humour them; but if he were to do so, the public generally would be made aware of some startling facts which the champions of the Press might perhaps prefer should remain undisclosed. One writer, Mr. Whorlow, the Secretary of the Newspaper Society, affects to believe he has disproved the alleged loss by demonstrating that there has not been always a loss on the Telegraph revenue. How this circumstance affects the question whether Press telegrams have been always carried at a loss Mr. Whorlow does not explain. The Postmaster-General's estimate would be just as true, if true at all, whether the annual balance-sheet showed a deficit or a surplus. The gravity of the loss is, of course, enhanced by there being a serious deficit; but that is a different matter. If the telegraph revenue had been flourishing, Mr. Morley would probably have said nothing about the loss on Press telegrams.

◆

A different line is taken by the Chairman of the Press Association, who contends that it is unfair to debit the Press with the same charges for maintenance during the night as during the day, and that as a large proportion—he does not say what proportion—of Press telegrams are sent in the night-time, they merely occupy wires that otherwise would be empty. Pushed to its logical conclusion, this argument would prove that Press telegrams ought to, or might, be sent for nothing. And when the actual tariff is considered, one is inclined to think that this logical climax has been almost reached. The charge for a Press telegram is one shilling; but observe, for this initial charge 75 words may be sent in the daytime, when the wires are most crowded, and 100 words at night—that is to say, after 6 p.m. and before 9 a.m. This, however, falls very far short of representing the extent of the privilege. The addresses go free, and for an additional charge of 2d. the same message may be signalled to any other town; and under this charmingly liberal arrangement further copies of the original telegram are sown broadcast over the whole country at the same small charge of 2d. per copy. A simple sum in arithmetic will show that a distributive message, which would cost any private individual more than twenty shillings is benevolently signalled for twenty pence if the sender is a pressman. We have only to ponder over these figures for a moment, and remember the number and extent of Press telegrams which appear in our town and country newspapers, to see how very simply the Postmaster-General's estimate may have been arrived at. A loss of £300,000 per annum represents an enormous amount of Press work, no doubt; but Mr. Morley, if correctly informed on this point, is entitled to say that the revenue suffers to that extent, and to attribute it to exceptional privileges conceded to the Press.

◆

One other argument must be noticed because of the grotesque confirmation it affords of what we have so often urged when explaining the growing deficit on the Telegraph service. In proof that the low Press rates ought to be cheerfully borne, Mr. Jeans, of the Press Association, points to the income derived by the Post Office from the millions of letters passing through the post in answer to advertisements which have appeared in the newspapers. A sound enough argument, perhaps, if the Post Office and the Telegraphs were treated as one service; but utterly irrelevant as long as they are kept with distinctly separate accounts. As matters stand, if that contention is good for anything, the Telegraph Department is entitled to claim, as a set-off against loss on Press telegrams, the postage of all correspondence relating to advertisements.

◆

The use of printed slips of paper in an illumination photometer is at least forty years old. Mr. Sugg used a portable instrument for street work so long ago as that. He did not attempt to use the minimum illumination at which the print was legible as a measure of the illumination, but used two slips and a lamp. Messrs. Houston and Kennelly have recently described an illumination photometer based simply upon acuteness of vision, and it is not surprising that the mean error of a single observation with it is as great as 10 per cent. Printed slips or black and white patterns were employed originally by Celsius, and afterwards by Sir W. Herschel, not for photometry, but for measuring visual acuteness under illuminations of different intensity and colour. Such measurements are of scientific, and chiefly of physiological interest. If the mean error of one set of observations with this new "illuminometer," as the inventors call it, is as great as 10 per cent., what must it be on different days and with different observers, and what weight can its readings carry in practical and commercial measurements?

◆

Not content with the invention of this instrument, Messrs. Houston and Kennelly go on to suggest a unit of illumination, and of course a name for it. A lux, they say, approximately equals the illumination produced by a standard British candle at the distance of a metre. What it really does equal we are not told; but the selection of the British candle is so flattering that we will not press the point. But why call it a lux, when Mr. Preece, at the Paris Congress of 1889, proposed this name for a carcel-metre—a unit 9·5 times that of Messrs. Houston and Kennelly? We learn further that the inventors strongly advised the adoption of this unit by the National Electric Light Convention at Cleveland. What effect such an adoption would have upon the scientific and engineering world it is difficult to say.

◆

The heliostat and siderostat exhibited by Dr. G. J. Stoney, and the harmonic analyser shown and described by Mr. G. U. Yule, at the last meeting of the Physical Society, were of great interest to those who have a taste for mechanism. The last only has any connection with electrical science, and we have added a sketch to the report of the meeting to enable the action of this very ingenious and simple instrument to be understood. As in the case of the "hatchet" planimeter which we recently described, the very simplicity of construction makes the action of the instrument more obscure. The more simple form of harmonic analyser which gave rise to Mr. Yule's latest instrument is, of the two described by him, the less easy to understand; but both of them are important contributions, not only for practical men who wish to analyse such curves as those which Dr. Fleming has recently published, but for the purpose of teaching what is meant by harmonic analysis.

◆

Ordinary drawing instruments are sometimes called mathematical instruments. There are, however, now many instruments well worthy of the name, and as practical commonsense graphical methods are gradually supplementing the more powerful, but difficult, algebraical methods, though they can never supplant them; so mechanical aids, many of which are but movable diagrams, are being developed. Few engineers have time to keep up the algebra necessary for orthodox harmonic analysis, and the usual way in which students are introduced to it is enough to discourage any but a regular mathematician. Fourier's theorem is enunciated, that is to say, thrown at their heads, and then some unlikely curve, such as a sharp saw tooth, is taken as an example, just to show what a wonderful thing Fourier's theorem is, and the student is at once plunged into expanded series and integral calculus. All this is necessary, no doubt, for a thorough grasp of the theory, but those who have no time for this need not be debarred from the subject. Many of the geometrical properties of a sine curve are apprehended instinctively by any mechanically minded man, and others, such, for example, as the slope of a sine curve, which mathematical teachers generally prefer to call its differential coefficient, can be investigated with a pencil and straight edge in five or ten minutes, with a result as convincing as any that can be afforded by orthodox algebra. The mechanically-minded man can go on to compound a curve or two by addition of ordinates, and is then ready to study what it is that a harmonic analysing instrument does. There are several different kinds which, though they turn out on examination to be inversions of each other, serve as distinctly different examples.

◆

Erratum.—In our description of Cherry's "Forget-Me-Not" Calculator last week, the dimensions were in one place given as 5in. by 5in. instead of 5in. by 2in.

International Telephony.—An agreement has been signed between Holland and Belgium for the establishment of telephonic communication between the two countries. The first line between Brussels and the Hague will be opened on July 1st.

Cable Interruptions:	Date of Interruption.
Latakia—Cyprus	Nov. 27, 1894.
Martinique—Paramaribo	Feb. 21, 1895.
Cadiz—Teneriffe	Feb. 23, 1895
St. Louis—Noronha	Mar. 12, 1895

The Northern Society of Electrical Engineers.—At the last meeting of this Society the following were elected members: Messrs. E. W. Dickinson (Corporation Electricity Works, Bolton), D. C. Jolley (Corporation Electricity Works, Manchester), and W. H. Preece, F.R.S., C.B.

The Institution of Electrical Engineers.—At the meeting of the Institution of Electrical Engineers held on Thursday, March 14th, Messrs. H. P. Bonus, H. E. Keen, J. E. Petavel, R. E. Phillips, M.Inst.C.E.; M. A. Solasker, and W. J. Thomas, were passed into the class of Associates.

Royal Society.—The following were some of the Papers down for reading yesterday:—Lord Kelvin, P.R.S., and Messrs. M. McClean and A. Galt, "The Diselectrification of Air;" Mr. E. C. C. Baly, "A Possible Explanation of the Two-fold Spectra of Oxygen and Nitrogen;" Messrs. A. W. Porter and D. K. Morris, "On the Question of Dielectric Hysteresis."

Accumulator Electric Traction in Germany.—At the annual meeting of the Great Berlin Horse Tramway Company, held a few days ago, the report regarding the working of the tramways by means of accumulators was somewhat gloomy and unfavourable. Only three cars are as yet so operated, and these have to be recharged at the end of every four hours, an operation which is stated to occupy four hours. It was considered that in general the accumulator system was not suited for application in large towns.

Royal Institution.—The following are some of the lectures arranged for after Easter:—Prof. George Forbes, three lectures on "Alternating and Interrupted Electric Currents;" Prof. Dewar, four lectures on "The Liquefaction of Gases." The Friday evening meetings will be resumed on April 26th, when a discourse will be given by Dr. John Hopkinson on "The Effects of Electric Currents in Iron on its Magnetisation." Succeeding discourses will probably be given by Prof. J. Viriamu Jones, M. Cornu, and other gentlemen.

The Telephone Committee.—The Select Committee of the House of Commons appointed to consider the question of the arrangement between the National Telephone Company and the Postmaster-General held its first meeting on Tuesday to appoint the Chairman and to consider the course of future proceedings. Mr. Arnold Morley is appointed Chairman, and the Committee will sit to-day for the reception of evidence. The first witness will be Mr. J. C. Lamb, the head of the Telegraph Department at the Post Office, and afterwards Mr. Provand, M.P., will be examined.

Car Lighting.—In November last the Trustees of the New York and Brooklyn Bridge awarded a contract for lighting the bridge cable cars by electricity. It was decided to use the overhead trolley system for supplying the current. There are 10 16-c.p. lamps in each of the 60 cars operated on the bridge. The rails are used for the return, and are connected by the Vail rail bond. The track is cross-bonded every 500ft. No part of the bridge structure is connected with the return circuit. The trolley wire is 00 hard drawn copper, and lightning arresters, grounded to the bridge structure, are located along the line.

Electric Lighting in Mexico.—Electric lighting in Mexico, says a writer in the *Electrical Engineer* of New York, promises to develop into a great industry. One of its most serious drawbacks is the difficulty of procuring cheap and good fuel. Coal is in many places at an almost prohibitive price. The cheapest kind of Sabinas coal stands, for instance, at Aguas Calientes at $11.66 a ton, and this is of poor quality. The station, therefore falls back on wood for fuel, and brings oak and mesquita from Ronconderomas, about 40 miles away, over the Mexican Central. This wood costs 7½ cents for an aroba, or say, 250lb. The wood yard necessarily entails the maintenance of quite a gang of labourers.

Municipal Electric Lighting at Portsmouth.—The Portsmouth municipal electric lighting station came into operation on June 6, 1894. According to the accounts just published, the total capital expenditure up to December 31st last amounted, in round figures, to £56,000. During the first six months of its existence the station had earned £3,287, and spent £1,773. The amount of the accrued interest and sinking fund assignments, less surplus revenue, now stands at £2,881. The total number of units *generated* is not stated, but the quantity sold to private consumers is given at 82,719, and to the 100 public lamps at 77,501, the steady public lamp load thus amounting to nearly 50 per cent. of the total output.

The Utilisation of Niagara.—In an article in the *Engineer* on this subject, by Mr. E. C. de Segundo, we are told that the after-impressions of a visit to the power house take the following startling shape:—"An earnest reality, an impressive sense of approaching completion distantly analogous to the dying down of the 'singing' of a kettle of water prior to its bursting forth into the activity of steam generation, which cannot fail to convince even the most sceptical that most of the harness is already fitted on to the Niagara river, and that but few and comparatively insignificant a number of straps and buckles require to be adjusted before a portion of the mighty power which for countless ages has run to waste—speaking as a utilitarian—shall be constrained to do work for the good of mankind."

Argon.—The Chemical Society has conferred its Faraday medal upon Lord Rayleigh in recognition of the discovery of argon. Chemists, as *The Times* truly says, have before now made incursions into the domain of physics, as in the cases of Davy and Faraday; but Lord Rayleigh has turned the tables by making a discovery of first-rate importance in what may be regarded as the domain of purely chemical inquiry. His work is the more remarkable because it was carried on upon purely physical lines, and owed its success to the extreme refinement and exactitude with which he repeated the investigations of Regnault on the density of atmospheric gases. It is curious to reflect that nothing but lack of the needful delicacy of admeasurement has delayed for 110 years the discovery upon the threshold of which Cavendish stood in 1785. The previous recipients of the Faraday medal have been Dumas, Canizzaro, Wurtz, Helmholtz, and Mendeleeff. At the last meeting of the Académie des Sciences, M. Berthelot announced that he had succeeded, with the aid of the electric discharge, in making argon enter into combination with certain organic compounds, especially benzine vapour.

The Arlberg Tunnel Telephone Installation.—A special telephone installation was found to be necessary between the Arlberg tunnel and the terminal stations of St. Auton and Langen, in order to communicate with the people at work in the tunnel. The ordinary bell-signal method, used at first, was not a success, and it was decided to use the telephone. To avoid all disturbing elements, a special apparatus was constructed with as little iron as possible, and protected from dust and damp. The speaking apparatus, says the *Zeitschrift für Elektrotechnik*, was arranged in a water-tight cast-iron box, in which the opening of the door effected the necessary connections. The whole was placed in a wooden box. Such an apparatus was erected in each of the nine chambers in the tunnel, and at each end. This installation worked from 1887 to 1893, when disturbances took place. Tests showed a low insulation resistance, due to water condensed in the boxes. The iron box was then done away with, and the apparatus inclosed in a box of larch wood soaked in paraffin, and all the metal parts were coated with paraffin. The telephone and bell wires were also completely separated. The results show that the installation has worked up to the present time perfectly satisfactorily.

Adoption of the Wright Tariff at Bournemouth.—Several important changes in the system of charging for electric supply have recently been made by the Bournemouth and District Electric Supply Company. The sliding scale of discounts allowed under certain conditions upon the gross annual consumption is to be abolished, and the maximum charge lowered from 8d. to 7d. per Board of Trade unit. Recognising, moreover, "that current can be profitably supplied at a lower rate during the hours in which the demand for light is usually small, and with a view to encourage the complete wiring of all premises, and the use of electric light where needed during the daytime, and late at night in bedrooms, &c.," the Company has followed the example set at Brighton, and now finding favour elsewhere, and will base its charges upon the maximum actual demand for current. A maximum demand indicator will be supplied to each customer who desires to avail himself of the new system, and a fixed rental will be charged for this apparatus. The scale of charges is as follows:—For all current used in excess of 300 hours in each half-year of the maximum current demanded, the charge will be 5d. per unit, while up to that point the price charged will be 7d.

Rapid Transit by Trolley.—Under the above heading the *American Machinist* of New York, gives that to the following expression of opinion which is dangerously English in its tone: "The fact that three persons were killed and several more injured by Brooklyn trolley cars in a single day, and that the list of killed by them now numbers upward of a hundred, to say nothing of minor accidents, has aroused the people of that city to an appreciation of the fact (which ought to have been apparent long ago) that the densely populated and crowded streets of a city cannot be turned into railroads to have cars driven through them at speeds sufficiently high to make them serve as a means of getting to and from the suburbs. It is very clear that the ordinary uses of a city street are entirely inconsistent with its use as a rapid transit road-bed, and it is quite apparent that in Brooklyn one or the other of these uses will have to be abandoned. Even if a successful fender is found, we imagine that there may still be very many people who will find it inconvenient and somewhat annoying to be picked up by one of them in rather a promiscuous manner every time they venture to cross a street and be carried a block or two out of their way, while acting as unwilling figure heads, and before the car can be brought to a stop."

Mill Lighting in Bombay.—According to the *Indian Textile Journal* the new Great Eastern Mills at Bombay are about to have their card room lit by electricity, not for the purpose of working at night but to supplement daylight, which at times of cloudy weather, or at morning and evening, is not sufficient for the proper carrying on of the work. There seems, in Bombay at least, to be a field for electric lighting of this kind, which was not contemplated when the system was first introduced. The mills are nearly all storied and built as wide as possible, considering that the daylight has to illuminate them throughout. When extensions are required they are usually made with a view to the utilisation of daylight, and this condition no doubt frequently determines what shall or shall not be done in the way of extension. Electric lighting and good ventilation taken together will now provide facilities for extension in any direction which will be most valuable where land is dear or where the extension is likely to throw existing factory space into the shade, or to rob it of daylight altogether. It has already been noticed that during the rains and in the cold weather the light is so deficient at the beginning and end of the working day as to reduce the value of the work done. The facilities with which electric light may be applied in a mill will doubtless be much better appreciated now than formerly.

The London County Council and the Street Explosions — At the weekly meeting of the London County Council, held on Tuesday at the County Hall, Spring-gardens, Mr. Fletcher, on the reception of the Highways Committee report, asked whether the Highways Committee had had under consideration the alarming explosions which had taken place in the streets in connection with electric lighting, and whether the Chairman could furnish any information to the Council to allay the alarm of the inhabitants of the metropolis. Mr. Edwin Jones (Chairman of the Committee) said the Council opposed the action of the Board of Trade in giving its sanction to the transforming chambers, and the only course now open to them was to apply for an injunction to restrain the Board from carrying them out. They had had five of these explosions during the last three or four months—two of them since the Board of Trade had given its decision in the matter, and he thought responsibility for all further cases which might take place would rest mainly with the Board of Trade. The contents of the present street boxes were only something about 5ft., whereas the proposed transforming chambers were something like 215, and therefore the danger would be very much greater, apart from the inconvenience of placing them where they would interfere with underground work.

A Free Lamp Trade for America.—Our American electrical contemporaries are naturally jubilant over the freeing of the American glow lamp industry in consequence of the decision in the Bate Refrigerator case, announced in our issue of March 8th. The *Electrical Engineer* of New York remarks: "While no judicious observer of the history of incandescent electric lighting will be disposed to minimise the honour due to Mr. Edison for his achievements, we feel well assured that both electrical experts and the general public will approve the final dissolution of the monopoly sought to be founded upon this questionable patent; while they will at the same time be likely to agree, for the most part, that section 4,887 is an absurd provision and that an American inventor who has applied for a domestic patent before he has applied for a foreign patent is merely unfortunate and not derelict if the foreign patent issues first. From the point of view of electrical industry in general, it is gratifying that the manufacture of incandescent lamps will be henceforth free, and that those firms and companies which, relying upon the long delay of the owners of the Edison patent in seeking to enforce their claims, as well as upon their confessed uncertainty as to the life of their patent, have gone into the business in good faith, and have made good lamps, can now expand their work, assure adequate competition, and secure to themselves some reward for their efforts."

Obituary.—Mr. Franklin Leonard Pope contributes an interesting obituary notice of the late Mr. Royal Earl House to the *Electrical Engineer* of New York, from which we take a few extracts. Mr. House died at Bridgeport, Conn., on February 23rd, at the age of 81. Born in the State of Vermont, at Rockingham, he went early in the forties to Buffalo, with the design of studying law, but having gained access to scientific books, he became interested in electrical researches. Returning home, he worked out, without the slightest knowledge of what had been done by others, the scheme of an electric telegraph. From the outset his design was to produce a record in printed Roman characters. He originated and designed the most complicated mechanical structures in all their parts, details, combinations, and dimensions, without embodying them in models, drawings, or other tangible form. In this way he thought out his first printing telegraph, which was adapted to work with two independent circuits, one of which was made to turn a type-wheel step by step, while the other served to give the impression of each successive letter then presented, precisely as is done in many of the more recent "stock-tickers." Having fully completed the design in his mind, House came to New York, and had his machine constructed piecemeal at two or three different shops, afterwards assembling the parts with his own hands. This apparatus was exhibited in successful operation at the fair of the Mechanic's Institute of New York, in the basement of the City Hall, in the autumn of 1844, only a short time after the establishment of Morse's first line between Baltimore and Washington, and long before this had been extended to New York. When perfected, which was not until several years afterwards, the apparatus proved capable, under favourable conditions, of printing messages in plain Roman characters at the rate of more than 50 words per minute. Capitalists ultimately became interested in the scheme, and between 1847 and 1855, an extensive range of telegraph lines was erected, extending from New York along the seaboard to Boston and Washington, and west as far as Cleveland and Cincinnati, on which the House instruments were employed with great commercial success. He designed and constructed the first successful long span river crossing at Fort Lee, in 1849, carrying two piano wires on masts 400ft. above the Hudson river, in a span of over 4,000ft., thus for the first time establishing permanent telegraphic communication between New York and Philadelphia. He designed an insulator having a glass screw-socket to engage with a thread cut upon the top of the pole. When the glass manufacturers insisted that it was impossible to make it, he at once designed a machine for performing the operation. Suits were brought in 1849 by the owners of the Morse inventions against companies using the House machine, but in June, 1850, an injunction was refused. After the general consolidation of telegraphic interests which took place about 1860, the House apparatus gradually went out of use, the simplicity and cheapness of the Morse system, and more especially the vast improvement in the skill, rapidity, and accuracy of the operators, rendering the use of the latter more profitable to the companies. His first patent bore the early number of 1,200. His last was No. 533,600.——The Mr. John W. Willans, whose death was recently announced, was the contractor for the electric railway between Finsbury Park and the City. Mr. Willans was 52 years of age. He was with Messrs. Kitsons, of Leeds, in his younger days, and a few years ago started business on his own account at Manchester. He was contractor for the structure of the Liverpool Overhead Railway.

MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 532.)

Valves, Valve Gears, and Governors.

Balanced Slide Valve.—The longitudinal section of a short-D slide valve, the manufacture of the American Balanced Slide Valve Company, is shown in Fig. 49, and illustrates a very common mode of relieving the pressure between the face and seat of the valve. The downward force on the valve seat is partially or completely, as the case may be, removed by the upward force of the steam on the relief frame against which the upper part of the valve slides.

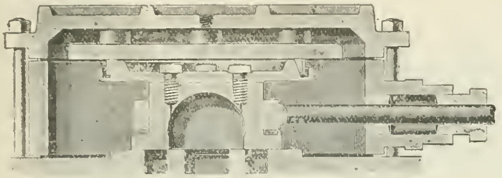

Fig. 49.—Slide Valve with Relief Frame.

Piston Valve.—Another method of relieving the pressure on the valve seat is shown in Fig. 50. This consists in forming the reciprocating valve into a piston, or series of pistons, on the valve rod, the ports consisting of annular openings in the cylindrical barrel in which the pistons reciprocate. In the illustration, which shows a form of piston valve common both in America and in this country, steam is admitted at either end of the chest, and exhaust takes place from the centre; and it will be observed that the exhaust steam passes through the middle of the inner piston, to the right or left, as the case may be. A flat end on each of the two outer pistons prevents the passage of steam from the steam chest directly to the exhaust. It will be seen that in the engine shown in Fig. 50 the valve chest and the cylinder barrel and ends are jacketed. A form of piston valve is used in the Willans engine, and is described in a later article.

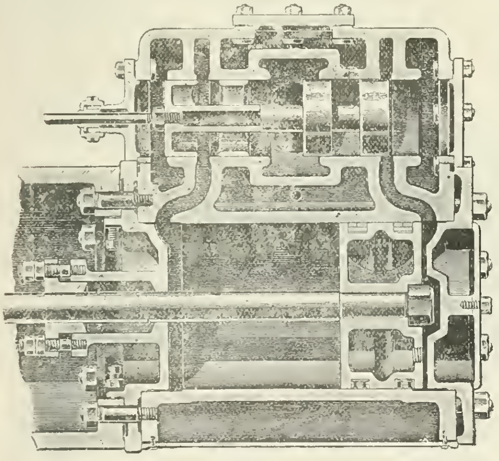

Fig. 50.—Piston Valves.

Oscillating Valve.—A tandem, compound engine of American pattern, made by Messrs. Ball and Wood, is shown in Fig. 51. The steam distribution in this engine is effected by means of an oscillating valve worked by an overhung crank on the main shaft. The rocking valve is in the form of a cylinder, and is ported in such a way as to form, in conjunction with the fixed ports in the seat, a kind of three-way cock. At one extreme position steam passes into one of the ports, and the exhaust through the other; the opposite extreme reverses the distribution. Where a compound distribution is to be effected, more than one simple rocking valve is required, and the two or more are sometimes placed on the same rocking shaft, and actuated from the same eccentric or wrist plate. This form of valve, when actuated by a harmonic motion, and not by trip or trigger action, is not susceptible of causing useful alteration in the distribution of the steam with varying loads; it is, therefore, most commonly met with in engines which are governed by the throttle valve. When used as a trip valve, the oscillating valve is very commonly met with in Corliss engines, but in such examples the steam and exhaust distributions are controlled by separate and separately actuated valves.

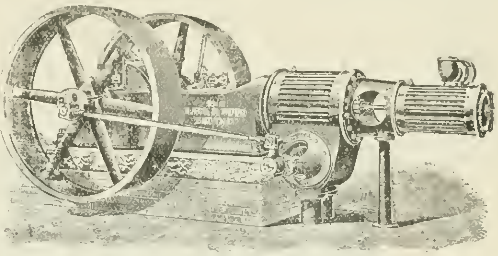

Fig. 51.—Tandem Compound Engine with Oscillating Valves.

Trick Valve.—The oscillating valve of the Ball and Wood engine, in Fig. 51, possesses further interest, inasmuch as it furnishes an example of the Trick valve, a form of valve which is designed to give rapid and wide opening of the ports, with a minimum of travel of the valve. This is accomplished, as shown in Fig. 52, which is a section through the oscillating valves of the engine just named, by contriving a passage for the ingoing steam through the valve itself, as well as through the gap formed between the edge of the valve and the edge of the port. The arrows in the diagram show this, and it will be seen that the full travel of the valve gives a much greater opening to the steam than if there were no such passage through the valve itself. The effect produced is similar to that produced by gridiron or double-ported valves.

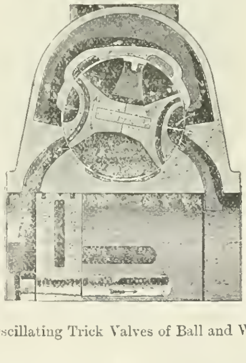

Fig. 52.—Oscillating Trick Valves of Ball and Wood Engine.

Corliss Valves.—The engines in electric traction stations in this country and abroad, and in electric light and general supply stations in America and Europe, are frequently of such a size and are designed to run so slowly that Corliss valves are found to be the most suitable for them. The name

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*From a forthcoming work to be published by *The Electrician* Printing and Publishing Company. All rights are reserved.

“Corliss valves” is applied to a large variety of valves which possess several features in common. These special points of design were first brought together by Mr. G. H. Corliss, of America, in 1849, and comprise the following essentials:—(1) A combination of four valves, two for exhaust and two for the admission of steam—*i.e.*, one of either at each end of the cylinder; (2) quick, snapping opening and closing of these valves, the rapidity of the movements being independent of the period of steam admission; (3) the use of dashpots to check the excessive violence of the movements of the valves and valve gear. Usually all four valves are actuated by means of four rods pinned to a single oscillating disc or wrist plate; but in some cases a system of shifting rods, actuated by main valve rods is employed, as shown in Fig. 53. These rods cause the steam valves to be opened against the resistance of coil springs, and at the proper moment these springs are “fired off” by a liberating gear, and the valves are quickly closed.

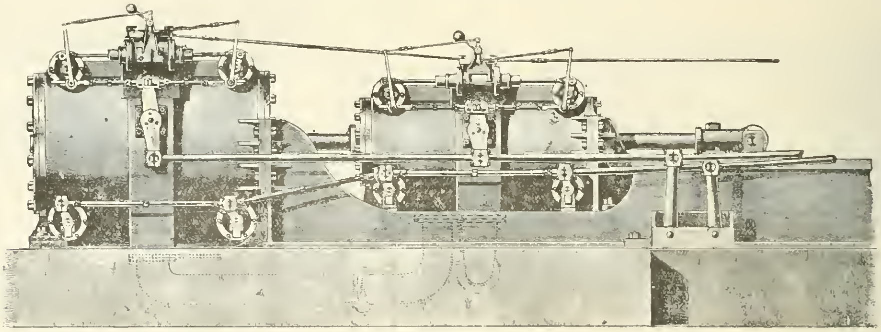

Fig. 53.—Tandem Compound “Corliss” Engine: by Messrs. Musgrave and Company.

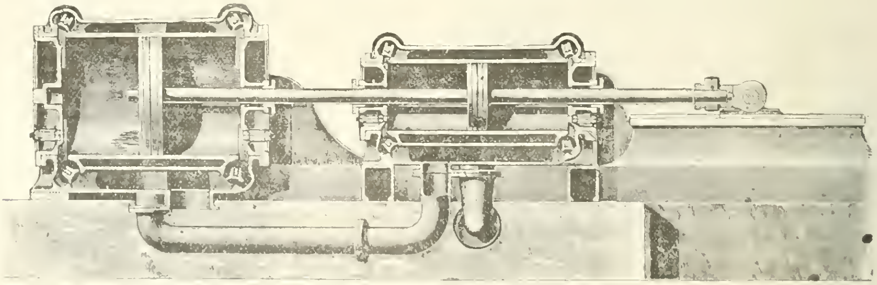

Fig. 54.—Longitudinal section of “Corliss” Engine.

The exhaust ports are usually opened and closed by a reciprocating shifting piece without the intervention of a trip motion. A glance at the indicator diagram of a large Corliss engine is sufficient to reveal the principal merits of this method of steam distribution; namely, the absence of wire-drawing at admission and cut off, and the prompt release and compression. Unfortunately, the mechanical difficulties in adapting this form of valve gear to very rapid cycles stands in the way of its application to small or high speed engines. Fig. 53 shows the exterior and Fig 54 the interior of the Corliss valves and trip gear employed by Messrs. Musgrave and Co. (Limited) in their large horizontal tandem compound engines. The valves of the engine shown are of the rocking or oscillating type; but sometimes in Corliss engines lift valves similar in action to the valves of a modern gas engine are used. Messrs. Musgrave and Co. (Limited) are the makers of the large Corliss engines at the generating station of the Liverpool Overhead Railway.

Automatic Expansion Valves.—Where economy is a vital point, as in engines for the work discussed in this series, it is essential that the variations of the steam distribution at varying loads shall be as little wasteful of steam as possible. To this end it is often necessary to construct the slide valves so that there may be a very wide range in the cut-off without any variation in the points of admission, release and compression. An ordinary slide valve, as pointed out in the previous articles, may be made to give a wide range of cut-off by combining variations in its travel and angle of advance; but where such a valve is designed to work economically with a late cut-off it is impossible to maintain this economy at any very early cut-off. Such a valve may give high economy at full load, but it would be very wasteful at light loads. To meet this difficulty two classes of automatic expansion slide valves have been invented, both classes possessing the common feature that the point of cut-off is controlled by a separate slide valve, called the expansion valve, the other points in the distribution being determined by the main valve, whose behaviour is not subject to variation.

(*To be continued.*)

TELEPHONIC REMINISCENCES.

At the dinner of the National Telephone Company's staff, on Friday last, Prof. Hughes, in replying to the toast of “Our Guests,” indulged in the following interesting historical retrospect:—

> When I look back only some 40 years to the first printed idea in France, and some 30 years to the birth in Germany of the first telephone, and think that it is only 18 years since the idea became really practicable, I am indeed astonished at its widespread success, so that what was a few years since a scientific toy, now has become a necessity of our present age. The earliest record of a perfect theoretical electric telephone was

contained in Du Moncel's "Exposé des Applications" (Paris, 1854), when M. Charles Bourseul, a French telegraphist, conceived a plan of conveying sound and speech by electricity. Suppose he explained "that a man speaks near a movable disc sufficiently flexible to lose none of the vibrations of the voice; that this disc alternately makes and breaks the currents from a battery, you may have at a distance another disc which will simultaneously execute the same vibrations." Unfortunately, M. Boursel did not work out his ideas to a practical end; but in these few words we have the shortest possible explanation of the theory of our present telephones.

It is now exactly 30 years since my first experiments with a working telephone, for in 1865, being at St. Petersburg in order to fulfil my contract with the Russian Government for the establishment of my printing telegraph instrument upon all their important lines, I was invited by his Majesty the Emperor Alexander II. to give a lecture before his Majesty, the Empress, and Court at Czarskoi Zelo, which I did; but as I wished to present to his Majesty, not only my own telegraph instrument, but all the latest novelties, Prof. Philipp Reis, of Friedericksdorf, Frankfort-upon-Main, sent to Russia his new telephone, with which I was enabled to transmit and receive perfectly all musical sounds, and also a few spoken words—though these were rather uncertain, for at moments a word could be clearly heard, and then, from some unexplained cause, no words were possible. This wonderful instrument was based upon the true theory of telephony, and it contained all the necessary organs to make it a practicable success. Its unfortunate inventor died in 1874, almost unknown, poor and neglected; but the German Government have since tried to make reparation by acknowledging his claims as the first inventor, and erecting a monument to his memory in the cemetery at Friedericksdorf.*

The duties connected with my printing telegraph instrument prevented me from continuing my experiments with the telephone of Prof. Reis, but in 1876 we heard in Europe of the invention, by Prof. Alexander Graham Bell, of his wonderful telephone, by means of which the practical transmission and reception of human speech had become an accomplished fact, and early in 1877 the instrument was brought to England. I at once resumed my experiments of 1865 with it, and found that Prof. Bell's telephone, considered as a receiver, was absolute perfection, but that his mode of transmission of magneto-electric currents, generated solely by the movement of an iron diaphragm near its electro-magnet, was defective, as the currents produced were too feeble for any practical use. I then tried to adopt Prof. Reis's system of using a separate battery, brought into play by the movement of a diaphragm.

I will not cite the numerous experiments and difficulties that I met with in this research, but at last I succeeded in finding the effect I wished, by the use of a very slight electric contact of the surface of solid carbon, or any other metals, such as ordinary iron nails. This slight or microphonic contact has the remarkable power of varying the resistance, and, consequently, the force of an electric current, exactly in accordance with the sonorous vibrations of the human voice; and, in fact, the contacts could easily be rendered so sensitive that the instrument became a microphone, rendering audible sounds far too feeble for the human ear. All of these results I gave freely to the public, and brought before the notice of the scientific world in a Paper I read to the Royal Society in May, 1878.

Another discovery which I made in the continuance of my researches, which is now of the highest utility to far-distant telephony, was the use of twisted wires, or wires so arranged upon their insulators that the whole line should gradually revolve on its axis so as to prevent induction from other independent wires. This was given freely to the world in my Paper read before the Society of Telegraph Engineers, March 12, 1879, and fully illustrated by engravings in *Engineering* of the same week. In order to understand this, I will quote a single paragraph from this paper: "If two ordinary aerial lines are thus used, they should have the twist given to these wires by changing their position relatively to other wires from vertical to horizontal at each pole or miles. Thus, if we had two lines, A and B, they should have their four relative positions repeated as often as possible, viz., A B, then $\frac{B}{A}$, then B A, and $\frac{A}{B}$." This is the system employed by the telephone line between London and Paris, and, in fact, upon all successful long-distance telephone lines throughout the world, so I think it is only fair that it should be known that I discovered and published this long before long-distance telephony was ever brought into use.

During the same months of 1877 that I was experimenting with Prof. Bell's telephone, Mr. Edison, in the United States, was also engaged upon a similar research, viz., endeavouring to adopt Prof. Reis's method of transmission by a diaphragm and separate battery, and he succeeded in inventing and patenting his form of transmitter, which he called the Carbon Telephone. This transmitter was brought to England in 1878, and it worked remarkably well, although I felt convinced then, as I am still, that the theory upon which it was supposed to work was wrong. Mr. Edison's views were that its mode of action was based on the varying resistance obtained through a varying pressure of the diaphragm upon an elastic button of carbon. (He believed that the varying resistance of carbon by pressure was an original discovery, but it was well known for many years previous in Europe, through its publication by Du Moncal and its application by Clerac in his carbon resistance tube, whose resistance was varied according to the pressure given to its adjusting screw.)

The error of this theory is shown by the fact that we cannot obtain a difference of resistance through pressure upon any conducting substance of more than a few ohms, say 1 to 10, but with a microphonic joint we can easily obtain the widest range, from almost zero to an infinity of resistance, and this with the smallest possible expenditure of mechanical energy from the diaphragm, or even without a diaphragm. I believed then, as I do still, that its excellent functions were due to a microphonic joint, of which, and of the value of which, Edison was unaware; and I also believe that the often successful transmission of words by Prof. Reis's transmitter was due to an accidental adjustment of his contacts to a true microphonic condition. He was, of course, unaware of the power and importance of microphonic joints, else his telephone would have been a practical success at once. Unfortunately, Mr. Edison and myself had a painful discussion as to priority of invention, in which we have both sustained our individual views up to the present time. Mr. Edison's views have been sustained by all the companies owning his patent; mine have been sustained by nearly the whole scientific world. The companies, however, whose interest it was to sustain and possess for themselves an entire monopoly, have spared neither wealth nor power to obtain this coveted monopoly, and by the means of the ablest legal counsel and expert witnesses, they obtained a legal decision giving them the sole right to the use of a diaphragm pressing upon a variable resistance, notwithstanding that the diaphragm was the discovery of Prof. Reis, and microphonic contacts by myself. This is all now past history, but I am now more than consoled by the fact that at the present time there is not a single transmitter in practical use throughout the world whose function is not based entirely upon its microphonic joints, whether in the firm solid conductors pressing upon each other, or when these contacts are multiplied, as in the form of granules or powder.

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* "Philipp Reis, Inventor of the Telephone; a Biographical Sketch," by Prof. Silvanus P. Thompson, F.R.S., &c., London. (E. and F. N. Spon. 1883.)

THE ELECTROLYSIS OF GOLD.*

BY N. S. KEITH.

Obtaining the contents of gold from auriferous rocks and ores by means of solvents and subsequent precipitation is now attracting much attention, in both scientific and financial circles.

Because in some of the practised plans electricity takes an important part in the operations, I think some electrical information relating to the matter will be acceptable; therefore this Paper.

In fully considering the subject, we would have to enter into the question of the possible formation of native gold in rocks and ores by electro-deposition from the solvent waters of the earth by action of earth currents. But, as my Paper is to deal more with practice than hypothesis, I shall leave that matter to the side, after stating a fact from which various deductions may be drawn. At the Dorn Gold Mine, in South Carolina, U.S.A., the rock formation is talcose slate. The soil is mainly the slate, disintegrated and decomposed. The slate is permeated by quartz veins, of all sizes, carrying gold. The soil is also auriferous. Particles of gold in the soil are all rounded, as if they had been submitted to attrition or solvent action; while those in the rock are crystalline in form, bright, and with sharp, well-defined edges. The gold from both positions is of equal quality, and the soil is of local origin. These facts seem to point to the present decrease of gold from the soil by solution, and increase, by deposition, of the gold in the rock.

Gold exists in natural auriferous materials in its native or metallic state, in irregularly-shaped pieces, from scarcely above the size of an atom to that of, say, a hundredweight. The larger pieces give no special trouble in securing, after they are found, and do not call for consideration in this Paper. The smaller particles—those of which it takes thousands, perhaps, to weigh a milligramme—are the minute things which engage our present attention and the efforts of metallurgists and electro-chemists the world over.

The larger particles of gold are comparatively easily separated by amalgamation from the powdered auriferous rock, owing to their weight causing them to sink into contact with mercury surfaces. But the lighter particles float in the water used, do not come into contact with mercury, and are lost to amalgamation. Many efforts have been made to use electricity in obtaining this finely-divided gold. Most of them have been the dreams of unlearned enthusiasts, or the devices of dishonest men to obtain gold from the pockets of their dupes.

The "Rae process," which has received so much consideration at the hands of "experts" in recent patent litigation involving the "cyanide process" of McArthur-Forrest, was an effort to simultaneously dissolve gold from ores, and deposit it on a cathode by electrolytic action. It failed for at least two reasons—(1) the imperfect knowledge of electro-chemistry of its inventor, and (2) from the impracticability of causing the particles of gold to remain long enough in contact with the anode to be acted on electrolytically. The dynamos used by Rae at the Douglas Mill, in Nevada, about eight years ago, in the effort to gain practical results, were series-wound, and without polarity protectors. Carbon anodes (sometimes, by reversal, the cathodes) were used, suspended in amalgamating pans, in which the pulp was agitated. The sides and bottoms of the iron pans were to be the cathodes. At least half the time they were the anodes. The mercury in the pulp was to combine with the precipitated gold and silver.

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* Paper read before the Institution of Electrical Engineers, March 14th.

By other inventors agitated mercury was made the cathode, and the fine gold was expected to mechanically "follow the current" into the mercury.

Whatever of value the electric current conferred was due to the fact that there was a reduction at the cathode of oxides and salts of metals, thus keeping the mercury with a clean, bright, unoxidised surface, so that it was in a more receptive condition.

The amounts of various metals dissolved or deposited by a coulomb of current have been accurately determined. For example, one coulomb sets free 0·000162 grain of hydrogen. We may express this quantity as one hydrogen-coulomb = 0·000162 grain. From this we gain the following values :—

$$\text{One (dyad) copper-coulomb} = \frac{0{\cdot}000162 \times 63{\cdot}5}{2} = 0{\cdot}0051035 \text{ grain of copper.}$$

$$\text{One (monad) silver-coulomb} = 0{\cdot}000162 \times 108 = 0{\cdot}017343 \text{ grain of silver.}$$

$$\text{One (triad) gold-coulomb} = \frac{0{\cdot}000162 \times 196{\cdot}6}{3} = 0{\cdot}010611 \text{ grain of gold.}$$

$$\text{One (dyad) mercury-coulomb} = \frac{0{\cdot}000162 \times 200}{2} = 0{\cdot}016200 \text{ grain of mercury.}$$

$$\text{One (dyad) iron-coulomb} = \frac{0{\cdot}000162 \times 56}{2} = 0{\cdot}004536 \text{ grain of iron.}$$

$$\text{One (dyad) lead-coulomb} = \frac{0{\cdot}000162 \times 207}{2} = 0{\cdot}016767 \text{ grain of lead.}$$

$$\text{One (dyad) zinc-coulomb} = \frac{0{\cdot}000162 \times 65}{2} = 0{\cdot}005265 \text{ grain of zinc.}$$

For a practical, everyday-work unit, we may multiply each of the above quantities by 3,600sec. in an hour to express the several quantities which an ampere will cause the solution and deposition of each hour. These quantities are as follows :—

Hydrogen	ampere-hour	0·5832	grain.
Copper	,,	18·37	grains.
Silver	,,	72·28	,,
Gold	,,	38·10	,,
Mercury	,,	58·32	,,
Iron	,,	16·30	,,
Lead	,,	60·36	,,
Zinc	,,	18·95	,,

It has been found by experimenters in the line, and it may be accepted as a law, that the various elements bear a relation to each other, which relation we name "electro-positive" or "electro-negative" according to the method of expression. Some call it their "electro-chemical" relation. The electro-positive metals tend to composition with electro-negative elements. Thus, potassium is always electro-positive to the electro-negative oxygen. Elaborate lists of the electro-positive and the electro-negative elements are in the text-books. They have the order of arrangement which puts the most electro-positive first, followed, *seriatim*, by the less electro-positive, till at the lower end the most electro-negative element appears. But one element may be electro-positive to another element in one solution, while in another solution the electro-chemical relation is exactly the reverse. For instance, in dilute sulphuric acid iron is electro-positive to gold ; but in a solution of cyanide of potassium gold is electro-positive to iron. The electro-positive is always more soluble in the solution than is the electro-negative. If the electro-positive and the electro-negative metals be connected, electrically, while in the solution, the solving action of the liquid on the electro-positive metal is much increased somewhat in proportion to the difference in their electro-chemical relation such a combination makes a galvanic battery, more or less approaching perfection. The placing of an extraneous source of electricity in such a circuit may increase the action, or even reverse it, depending on the direction of the electric current. The dynamic value of these actions may always be measured as watts by suitable instruments, such as an ammeter and a voltmeter.

The facts that gold could be dissolved by chlorine, aqua regia, bromine, cyanide of potassium, &c., have been known for many years. These facts have been put extensively into practical use for the obtaining of gold from ores by means of chlorine gas in the Plattner process and its modifications. From the solutions so obtained the gold is deposited by ferrous sulphate ($FeSO_4$). For one reason or another, not necessary to consider here, electrolytic precipitation of the gold from this solution of auric chloride ($AuCl_3$) has not been practised in the art. Electro-gilding, using gold anodes, and various metallic objects as cathodes in an electrolyte consisting of auro-cyanide of potassium (KCyAuCy) in a solution of potassic cyanide (KCy) has been practised for about 50 years. Its details are too well known to need consideration here.

We will consider the subject in its bearing upon the obtaining of gold from auriferous rocks and ores. For this purpose the most important solvent in practical use at present is cyanide of potassium, measured by the production of gold from the mines by its means. It has been stoutly asserted that cyanide of potassium is *not* a solvent of gold, and more surely maintained that it is, by reason of its extensive use for the purpose, spite of the fact that pure solution of potassic cyanide in water will not dissolve gold at a practicable rate, if at all. If, for an experiment, we take a piece of gold leaf and lay it on the surface of a cyanide solution, we will find that it will there be dissolved in a few minutes (the stronger the solution the more rapidly), while a like piece sunk in the solution will be hours in dissolving, the strength of the solution affecting the rate but slightly. It is claimed, and justly too, that the presence of oxygen is necessary for the hastening of the solving action, or, rather, the combination of cyanogen with the gold, so that the resulting auric cyanide be dissolved. This fact was recognised upwards of 50 years ago by Elsner, and the chemical equation was expressed by him thus :

$$4\,Au + 8\,K\,Cy + O_2 + 2\,H_2\,O = 4\,Au\,Cy\,K\,Cy + 4\,K\,O\,H\,;$$

the oxygen in this case furnishing the necessary element to decompose some of the potassic cyanide so as to form the double salt, auric-potassic cyanide and potassic hydrate.

MacLaurin, a New Zealand chemist, has proved with mathematical precision the truth of Elsner's equation. His admirable research was published more than a year ago in the *Journal* of the Chemical Society (London), 1893, p. 724.

Gold leaf of the same thickness and very nearly the same weight was allowed to remain—

——	In stoppered bottle.	In open bottle.	In bottle with O.
	92 hours.	68 hours.	96 hours.
Water	125·0 grm.	125·0 grm.	125·0 grm.
Potassium cyanide	1·0 grm.	1·0 grm.	1·0 grm.
Gold	0·9947 grm.	0·99035 grm.	0·99425 grm.
Loss of gold ...	0·0018 grm. =0·18%	0·09175 grm. =9·1%	0·23995 grm. =24·2%

The minute quantity of gold dissoved in the stoppered bottle is apparently due to a small quantity of oxygen previously absorbed by the cyanide solution from the atmosphere. Just in the same way water, though not a solvent for calcium carbonate, will dissolve the latter to some extent if not previously freed from carbonic acid by boiling.

Recognising the apparent necessity of the presence of oxygen, many experimenters have tried many oxidising substances, besides passing air through the cyanide solution, such as peroxide of manganese ; ferricyanide of potassium ; bleaching powder, or other materials yielding chlorine, bromine, and iodine ; peroxide of sodium. I have tried peroxide of hydrogen with success. All these are more or less effectual in hastening the solvent action ; but, as they have to be added in quantities far in excess of the amount theoretically necessary to effect the reactions, if actually brought into contact with the gold and nothing else, they are wasteful, because they decompose more of the cyanide than is necessary for solvent action. Bromine, chlorine, &c., are simply oxidising agents—secondarily, to be sure, but still decomposers of the cyanide in too great quantities, because they exert their action away from the particles of gold. These oxidising agents have been tersely called "cyanicides." Their actions, direct or otherwise, are practically those of oxygen.

Be that as it may ; in practice the finely divided auriferous rock, or ores, is submitted to the action of successive quantities of aqueous solutions of cyanide of potassium, containing varying quantities of oxygen, or oxygen-producing materials, or analogues, in large vats, as in infiltration and percolation. Each quantity of the solvent is allowed to remain for a greater or less number of hours in, and covering, the ore, and is then drawn therefrom into precipitation vats, where the gold is obtained from the solution by various means, which we will presently consider. Generally, the finely divided auriferous materials are "tailings" from the gold amalgamating mills, which crush and treat with mercury the material for obtaining the contents of gold by amalgamation as far as possible.

These tailings contain extremely fine-divided gold which has resisted amalgamation, and in varying quantities, averaging about five to six pennyweights per ton of tailings. Any economy in the above process, such as hastening the rate of solving the gold ; prevention of decomposition, as far as possible and feasible, of cyanide ; making the gold more easily and cheaply obtainable from the solution, &c., is of vast importance in the metallurgy of gold.

Looking at the matter from the electro-metallurgist's stand point, some time ago I concluded that the action of oxygen was due to its strong electro negative relation to gold in a cyanide solution. Therefore I tried the effects of various materials which are electro-negative to gold in solutions of cyanide of potassium. Carbon in contact with gold in cyanide solutions forms with it a voltaic couple, and the gold is far more rapidly dissolved than when alone. The best practical application of this fact is to finely powder the carbon, and continually agitate it with the auriferous tailings in a cyanide solution. Though the finely powdered carbon causes more speedy action than do a few, or more, large pieces, it is still an operation of chance, because the increased rate of action is dependent upon actual continued contact of gold and carbon until the gold is dissolved. Iron is electro-negative to gold in a cyanide solution. The two form a galvanic or voltaic couple, and the action is the same as in the case of the carbon, only less in speed, because the iron is not so strongly electro-negative as is the carbon. I have discovered that mercury is electro-negative to gold in a solution of cyanide of potassium. I have availed myself of this fact to improve the cyanide solvent, after this manner: I add to the cyanide of potassium solution used for the purpose, in any of its strengths (which latter vary from 0·01 per cent. to 0·5 per cent. of cyanide), a small quantity of potassio-mercuric cyanide ($2\ KCyHgCy_2$), say two ounces, or more, per ton of solution. The action is as follows:—The electro-positive gold decomposes the mercuric cyanide, taking to itself the cyanogen thereof, and receives on its surface the liberated mercury which amalgamates it. Then in the solvent there is the contact of a voltaic couple, under which condition the electro-positive gold is dissolved, and afterwards the extremely attenuated film of mercury again dissolves in the cyanide solution, to react as before. There are no combinations, decompositions, and reactions taking place, except those noted as being caused by the voltaic couple.

There are no oxidations of cyanides to cyanates, which latter are not solvents of gold. The solving action takes place very much speedier, because the electro-negative material is brought into, and retained till dissolved in direct contact with, the electro-positive gold. There is no deleterious material introduced to the solvent, and the mercury acts as an assistant in the subsequent operations of obtaining the gold from the solvent. In the older process, two, three, or more changes of the solvent were made, with intervals between, during which the oxygen of the air was permitted to permeate the mass of tailings, and thus furnish the necessary electro-negative material. By my electrolytic process, the necessary electro-negative material, mercury, is always present; so that the solution may go on uninterruptedly so long as the necessary solvent, cyanide of potassium, is present in contact with the couple. But, in order to ensure this condition, especially with extremely weak solutions of cyanide, the use of which is desirable, the solvent must be kept in motion through the mass, so that the part containing the cyanogen constitutent which should be in contact with the gold may continuously replace the solution which has acquired its *quantum* of gold.

Pursuing the above plan, extremely weak solutions of cyanide of potassium may be used—say 0·01 per centum, or less, by percolating them through the mass of tailings continuously, and simultaneously passing the solvent from the percolator through an electrolytic bath with sufficiently extended electrode surfaces, and enough amperes of current to ensure the electro-deposition of the dissolved gold from the solvent wholly, or in greater part. The solvent can be returned continuously to the tailings to dissolve more gold, if necessary; or, if practically all the gold has been removed, it may be passed to a fresh lot of tailings, to again be passed through the cycle of operations.

The most extensively pursued plan of obtaining the gold from auriferous cyanide solutions is by precipitation by means of zinc. Practice has demonstrated that for effective deposition the zinc must be finely divided, and its surfaces must be bright and metallic, free from oxide or salts. Therefore the "zinc shavings" are always freshly prepared before the time of use.

They are put in boxes having bottoms of iron-wire netting, and these boxes are so placed in the precipitation vat that the solution enters each box of the series through the bottom, up through the mass of zinc shavings, down again, and up through the next box of the series. Having passed through the last box, much of the gold will have been deposited by auto-electrolytic action; and the solution, after being strengthened by the addition of more cyanide, is used to dissolve more gold, as before.

The electro-chemical action is as follows: The electro-positive zinc takes the cyanogen from the relatively electro-negative gold to form zinkic cyanide, which dissolves in the solution, setting free the gold in a finely divided metallic condition. If the action would stop there this process would not be so objectionable. But owing to the voltaic couples formed by the zinc and gold, there is a further decomposition of the solution, with the formation of oxy-cyanate of zinc, zincate of potash, potassic hydrate, &c. Much of the deposited gold, becoming separated from electric contact with zinc, is redissolved by the cyanide, to be again deposited by more zinc. So it is practically impossible to precipitate all the gold by this means.

If the necessary actions could take place in true electro-chemical equivalents, according to our table, 31·5 troy ounces of zinc would only be requisite to deposit 65·55 ounces of gold. Instead of that, the practical amount, owing to the above-described wastes, and others, is about in the proportion of 1,750 troy oz. of zinc to obtain 65·55oz. of gold—over 50 times as much as should be necessary. There is something like a corresponding loss of cyanide of potassium. These wastes I have gathered from the data furnished by Eissler in his Paper on the "Cyanide Process, &c.," read before the Institute of Mining and Metallurgy on November 21, 1894. Free alkali, or an alkaline condition of the cyanide solution, is desirable during the solvent action on the auriferous material; but it is undesirable in the zinc precipitation, on account of its solvent action on the zinc, and its tendency to tarnish the zinc so that the auric cyanide may not readily act on it. On that account the smallest possible amount of alkali is used, when more would be desirable in the solving stage, for decomposingmetallic salts, &c., in tailings.

When the depositing vats are cleaned up the precipitated gold is much mixed with pieces of zinc, insoluble zinc salts, &c. After careful drying, the zinc and gold slimes are treated by oxidising and smelting processes to secure the gold bullion, which is far from fine—say 700 out of a possible 1,000.

With the object of overcoming the enumerated troubles, and other disadvantages, several experimenters have devised—on paper, at least—electrolytic processes for obtaining the gold from cyanide solutions. So far, the most successful one in extensive practice is that known as the "Siemens and Halske process," which is described in a Paper read by Von Gernet before the South African Metallurgical Society some months ago, in the before-mentioned Paper by Eissler, and one by Butters and Smart, hereinafter noted. From these I gather the following facts:—

The cyanide solution is treated in four electrolytic vats, each measuring, approximately, 20 × 4 × 8ft., containing, alternately arranged, anodes and cathodes, which measure each 4 × 8ft., and are placed so that the solution in flowing through the vat moves downward on one side of each electrode and upwards on the other side, or are so arranged that the solution moves upwards by both sides of several electrodes and downwards by a like number, serially, thereafter.

The anodes are plates, or sheets, of iron, enclosed by canvas, and the cathodes are thin sheets of lead, supported in and by wooden frames. The current of electricity is caused by a dynamo taking 5 H.P. mechanically, and yielding 3½ H.P. in electrical energy at 4 volts pressure. (Von Gernet says 4, Butters and Smart say 10, while Eissler says 7.) According to these data, the electric current may be $\frac{746 \times 3\frac{1}{2}}{4} = 652\cdot75$ amperes.

The amount of iron used was 1,080lb. in one month, and the amount of gold deposited in that time was 697oz. 15dwt. 15gr. The resulting products are the above amount of gold, some Prussian blue, ferric oxide, hydrogen, and an amount of impure litharge (PbO) from the cupellation of the lead cathodes; but nothing except the gold is of any economic value, because of the expense of reducing the other products to re-workable conditions.

The facts about this process furnish an excellent text for a detailed consideration of the principles involved in the electro-deposition of gold. To begin at the beginning:—

The Vat, or Depositing Vessel.—It is rightly made large, so that it may contain sufficiently extended surfaces of electrodes. It is made of wood, which sufficiently resists any deteriorating action of the electrolyte used in it. The electrodes are rightly arranged so that as the electrolyte passes through the vat, from end to end, it may come, as far as possible, into actual contact with the surfaces of the electrodes. Whether the surfaces are large enough depends upon the amount of electrolyte which passes throught the vat in any unit of time, and whether, in its motion, it is brought actually, molecule by molecule, into contact with the electrodes. From the statement of the amount of gold—4dwt. 8gr. per ton of solution—remaining in the electrolyte after passing through the depositing box, we may doubt the sufficiency of exposure to contact. The cathode surface is stated by Eissler to be 1,566 sq. ft. But, as it is evident from his other figures that he only took into account one side of the cathodes, the actual surface is 3,132 sq. ft. This is for one of four "precipitation," or depositing vats. So we have 12,528 sq. ft. of lead surfase, upon which were deposited 697oz. of gold in one month. This statement of cathode surface agrees closely with that stated by Von Gernet, and by Butters and Smart in a Paper on the cyanide process, read by the latter two before the Institution of Civil Engineers, February 19, 1895. The iron anode surfaces are 89 × 7 × 3 × 2 × 4 = 14,952 sq. ft., from which we must deduct 7 × 3 × 2 × 4 = 168 sq. ft. of surface of the end plates not presented to an opposite cathode. The anode and cathode surfaces are about 1½in. apart. On the whole, the *mechanical* construction of the vat, and the arrangement of its parts, seem to have been carefully considered, and to only err in the amount of electrode surfaces being too small for the *actual* electrolysis which takes place. The *effective*, or *commercial*, electrolysis is a very much less quantity, as we shall presently see. Von Gernet says that a better effect is produced by doubling the surface of electrodes than by increasing the current tenfold.

The Electrolyte is, of course, the solution of gold in a liquid composed of water, carrying also small percentages of potassic cyanide, potassic hydrate, and various compounds of cyanogen with metallic substances previously existing in the ore which had been treated by the solution, now the electrolyte. By the action of the electric current some ferro-cyanide of potassium is formed in the electrolyte, though much of this is converted into Prussian blue by contact with the oxide of iron formed on the iron anodes. The obvious improvement to be made is avoidance of any iron actions and reactions, because some of them consume electrical energy. The electrolyte is a weak solution at best, and, therefore, specifically, a poor conductor. But, as the quantity is at all times large, the cross section being 6,000 sq. ft., and length between electrodes but 1·5in., the resistance is practically *nil*, and need not be considered. The main consideration, as to resistance to electromotive force, is that offered by the counter electromotive force of polarisation. The oxide of iron formed on the anodes, and in the pores of the bags drawn over them, is, as a matter of resistance pure and simple, of some importance.

The Anode is composed of sheets of iron one-eighth of an inch thick, exposing, in the four vats, 14,784 sq. ft. to electrolytic action. Each of the 356 iron plates is "cased in canvas to retain the small quantity of Prussian blue produced" (Butters and Smart), but also to retain the *large* quantity of ferric oxide produced. Von Gernet and Eissler state that the object of the "canvas is to prevent short-circuits." This last is an obvious precaution and result, owing to the close proximity of anode and cathode. We gather from the Papers cited that an iron anode has been adopted after trying both carbon and zinc. Eissler says: "Carbon could be used as an anode, but it will not withstand the action of the current, and soon crumbles into a fine powder which decomposes cyanide. This finely divided carbon is in suspension, and cannot be removed from the solution by filtration."

Weightman states that he has "been using 'good arc-lamp carbons,' and carbon in other forms, for the last six months, and they are still in excellent condition"

Von Gernet says, in his Paper on the subject read last October before the South African Metallurgical Society, at Johannesburg: "Zinc used as an anode forms a white precipitate of ferro-cyanide of zinc by the reaction of zinc oxide upon ferro-cyanide formed during the leaching. Similarly, iron anodes form Prussian blue by the reaction of oxide of iron and ferro-cyanide."

Let us consider these anodes. Owing to the fact that there must be an analysis (decomposition) of the electrolyte at the anode, electric energy is absorbed, or rendered latent, there; and if the material of the anode does not combine with the anion set free, to form a compound therewith, that energy is lost. Generally, and in this case, oxygen is directly or indirectly the anion, and as it cannot combine with a carbon anode, for instance, it escapes from the anode to the air as gas. The carbon anode is practically *chemically* unacted upon by the oxygen anion, but is *mechanically* disintegrated thereby, and the more rapidly the greater the current, and therefore of the escape of gas. Carbon is objectionable as an anode pure and simple, because of these two properties. But it is further objectionable because the oxygen, reacting on the potassic cyanide, forms potassic cyanate, which is inoperative as a solvent of gold. So, not only is the energy lost, but also the active ingredient of the electrolyte, making it inoperative as a subsequent solvent. Von Gernet's statement as to zinc is not clear. A very little ferro-cyanide should be formed during the leaching process. More likely the "white precipitate" is an insoluble coating of zinc oxy-compounds with cyanogen formed on the zinc anode. This coating offers great resistance to the electromotive force, so that it has to be increased to pass the necessary current; and this in its turn increases the difficulty. Much oxygen is set free, causing the corresponding wastes. So far, we now have only the iron anode to consider, as it has been adopted, and is used, at the mines. Practically, the iron anode is oxidised by reason of the current, and it takes a definite amount of electric current to oxidise a definite amount of iron; the iron ampere-hour being 16·3gr. The amount of iron used in the month of August was 1,080lb. This equals $1{,}080 \times 7{,}000 = 7{,}560{,}000$gr. Providing this was all oxidised, the ampere-hours were $\frac{7{,}560{,}000}{16 \cdot 3} = 463{,}803$. According to Von Gernet, the amperes were produced by 4 volts; therefore, there were in a month $\frac{463{,}803 \times 4}{746} = 2{,}487$ H.P. hours. The electric energy was 3½ H.P.; therefore was used $\frac{2{,}487}{3 \cdot 5} = 710$ hours, in a month of 31 days, or 744 hours—a curious coincidence. But Eissler says the pressure was 7 volts; and Butters and Smart say the dynamo used gives 300 amperes at 10 volts. These latter statements, taken with the probable conditions that there are undoubtedly some wastes of iron in the way of unoxidised scrap, and possible intermissions in current, are probably nearer correct. Taking 300 amperes for 700 hours, we have an oxidation of iron $\frac{300 \times 700 \times 16 \cdot 3}{7{,}000} = 489$lb., and a scrap waste of $1{,}080 - 489 = 591$lb. Evidently we need some more exact information for theoretical considerations. For this current—assuming the minimum statement be correct—300 amperes, the gold deposit was 697oz. 15dwt. 15gr. = 335,935gr. According to our gold-ampere-hour equivalent of 38·1, this quantity requires 8,817 ampere-hours to deposit; but to do this $300 \times 700 = 210{,}000$ ampere-hours were expended—about 24 times too much, if the proper association of materials had been made so that all the economic actions went on in the electro-chemical equivalents to the gold. Upwards of 200,000 ampere-hours were expended in decomposing water and setting free hydrogen.

The Cathode is of sheet lead. It was adopted, according to Von Gernet, as best satisfying the following conditions:—

"1. The precipitated gold must adhere to it.

"2. It must be capable of being rolled out into very thin sheets to avoid unnecessary expense.

"3. It must be easy to recover the gold from it.

"4. It must not be more electro-positive than the anode, in order to prevent return currents being generated when the depositing current is stopped. The most suitable metal for the purpose is lead, ... and meets all the requirements of the case."

These four requirements are very good, and should be, with others, carefully attended to. There is no exception to be taken to the first, within practical bounds. To the second, we say the cathode should be as thin as is consistent with mechanical stability, and most assuredly as thin as possible when wasted absolutely, as it is in practice, at the rate of 750lb. per month, in a small plant. A far better cathode is one which does not deteriorate, and practically is not wasted at all.

To the third, we say that it is not "easy" to recover the gold from the lead cathode. The necessary melting and cupellation is an expensive process—much more so than is the recovery of gold from the amalgam from a mercurial cathode, by distillation or "retorting," as is continually practised in the metallurgy of gold. To the fourth, we say that a lead cathode *is more* electro-positive than an iron anode in a cyanide solution, and, therefore, does not fill the requirement. Furthermore, as soon as the lead cathode becomes coated with gold it becomes a gold cathode, which is electro-positive to the iron anode, therefore defective so far as this requirement is concerned. According to Von Gernet, a mercury cathode has been tried, but is impracticable on account of the large amount necessary to carry on the operation—say 80 tons to a small plant. "Sheets of solid metal (as copper) coated with mercury have also been tried, but have been unsuccessful, because the mercury, owing to the action of the current, will penetrate the copper and form a dry amalgam, which does not adhere to the plate." The mercury does not penetrate the copper plate any sooner than it does in the ordinary copper-plate amalgamation of the gold mills. That it forms a "dry" amalgam with the small amount of mercury which a vertically-placed copper plate will alone retain is evident. But the copper-plate cathode could be occasionally refreshened with mercury by sprinkling to the extent of keeping the amalgam plastic, but not so thin as to run off. I prefer to furnish the mercury necessary on a copper-mercury anode by the direct electro-deposition of mercury with the gold from the electrolyte.

The Current.—This is variously stated by the different authors quoted as from 300 to 600 amperes with pressures of from 10 down to 4 volts. Without unnecessary wastes, the current sufficient to deposit 697oz. 15dwt. 15gr., equal to 335,935gr. of gold in 700 hours is $\frac{335{,}935}{700 \times 38 \cdot 1} = 12 \cdot 6$ amperes. Von Gernet says: "In a fixed time a given electric current will deposit a certain quantity of metal, which quantity varies for different metals in direct proportion to their electro-chemical equivalents. This law holds good only for solutions strong in metal; but with dilute solutions, as in use in the cyanide process, the current does not find sufficient of the metallic compound present at the electrodes, and consequently decomposition of water also takes place. For this reason, to make the efficiency of the precipitation as great as possible, constant diffusion of the solution is requisite." This explanation contains the essence of the whole matter. The efficiency is only from $\frac{12 \cdot 6}{600} = 2 \cdot 1$ per cent. to $\frac{12 \cdot 6}{300} = 4 \cdot 2$ per cent. In most of industrial operations we would consider such efficiencies exceedingly low. The waste of energy to produce the current, the waste of cyanide to produce Prussian blue, the waste of iron to make oxide and Prussian blue, the waste of lead to produce oxide of lead, and the waste of labour in handling these unnecessary quantities, add to the *necessary* expense of electrolytic treatment of auro-cyanide solutions at least £130 in a 3,000-ton per month plant, or 10·4d. per ton.

It will be asked, "Why these wastes, and can they be avoided without substituting others equally as expensive?" These expenses are due primarily, and mainly, to the improper selection of electrodes. The anode should be soluble under the electric current in the electrolyte in which it is immersed for at least two reasons —(1) that it may communicate to the circuit the energy due to the combination of the metal of the anode with the anion; (2) that the compound thus formed may be removed by the electrolyte to expose a fresh metallic surface for the continuation of the operation in regular progression.

Iron is not soluble in cyanide of potassium solutions. It is, as I have before stated, strongly electro-negative in such solutions to all other metals which may he met with in the operation. The anode should be electro-positive to gold. Copper is so, but it would enter the solution at the expense of the cyanogen. Besides, it would be deposited on the cathode after a time and render the gold impure. Carbon is not suitable, because in the cyanide it causes the formation of cyanate, and, besides, it is strongly electro-negative to a gold cathode. Zinc is electro-positive to gold in the electrolyte; but, as before stated, there forms upon it an insoluble coating impenetrable to moderate voltage of electricity. With iron it is necessary to raise the pressure of the current to overcome the resistance of the oxide and Prussian blue on its surface. But if it be arranged so that the anode be soluble, the current may be of very low voltage; and even it may contribute energy to the circuit. The way to secúre this *desideratum* is to provide an electrolyte for the anode which will promote its solution. To do this the selected electrolyte must be mechanically separated from the cyanide electrolyte. This can be done by the use of porous cells, such as are used in various of the forms of galvanic batteries. The electrolyte in the porous cell, for convenience called the anode-electrolyte, must be of such a composition that the accidental mixture of it with the cyanide solution, for convenience called the cathode-electrolyte, will not injure the latter, nor confer upon it deleterious qualities. Such an electrolyte is found in aqueous solutions of ammonium salts, such as the chloride, bromide, and sulphate of ammonium. Zinc or iron anodes placed in such electrolytes, in porous vessels immersed in the cathode-electrolyte, will be readily dissolved, by reason of the formation of soluble double salts of the metal with ammonium.

With an iron anode in the cyanide solution it is necessary to raise the voltage to cause the current to pass the oxides, &c. In doing so there is an evolution of much free oxygen, with corresponding loss of electrical energy. But that is comparatively a minor defect. It also sets free a corresponding amount of hydrogen at the cathode. These two gases accumulate, each on its appropriate electrode, until their comparative levity causes them to escape against the pressure of the electrolyte. But they continually cover a very large part of the electrode surfaces, and thus keep from them the electrolyte, which should be in contact therewith. If this action be prevented, the electrode surfaces need not be nearly as large for the same amount of deposition of gold. In order to force the deposition, then, the voltage is raised to from 4 to 10 volts, though one-quarter of a volt is sufficient to produce the necessary actions and reactions under proper assemblages of materials as to quality, size, and position. If the analysis (decomposition) and synthesis (composition) be equal, no energy is absorbed other than to overcome the resistance. As the resistance is small, owing to the large cross-section of electrolyte and small distance between electrodes, a very small electromotive force is necessary when the proper electrode, and electrolyte for it, are used. Take such an assemblage, and the work of depositing 697oz. of gold should be done with the expenditure of $12·6 \times 0·25 = 3·15$ watts, for 700 hours, instead of $300 \times 10 = 3,000$ watts for the same time.

If iron had been used in a proper electrolyte, the iron dissolved would have been as 65·5 : 28 :: 697 : 298oz. of 480gr., equal to $\frac{298 \times 480}{7,000} = 20·4$lb., in place of 1,080lb.—a saving of 1,060lb. But iron would have used, say, about 40lb., including waste, of ammonium sulphate in the anode-electrolyte—worth about 55 pence.

If zinc had been used in a suitable electrolyte, the amount would have been 65·5 : 32·5 :: 697 : 345oz. of 480gr., equal to 23·6lb., with a like consumption of ammonium salt. By the direct zinc precipitation in the McArthur-Forrest process, according to Eissler, there is a consumption of zinc varying from 0·25 to 0·50lb. per ton of ore—say an average of 1,000lb. for the quantity of gold produced (697oz.) from 3,000 tons of auriferous tailings. There is in this item alone a saving possible of £18 sterling per month.

In the *Proceedings* of the Engineers' Club of Philadelphia, for November, 1894, there is a Paper, entitled "The Electro-Metallurgy of Gold and Silver," by A. L. Eltonhead, in which he describes an alleged process of separating gold from cyanide solutions, said to be used in a "small plant" by "the electro-chemical process (patent applied for) on the west side mine of the Tombstone Mill and Mining Company, of Tombstone, Arizona." The writer of the Paper was evidently not fully posted as to the process, and did not mention the name of the "inventor" (?).

The description is somewhat vague and imperfect; but we gather that the "precipitating box is of novel construction;" is 10ft. long, 4ft. wide, and 1ft. high, divided into "five lengthwise compartments." "Under each partition grooves may be cut, a $\frac{1}{4}$in. to $\frac{1}{2}$in. deep, extending parallel with the partitions, to serve as a reservoir for the amalgam, and give a rolling motion to the solution as it passes along through the four [*sic*] compartments. The centre compartment is used to hold the lead, or other suitable anode, and electrolyte." "The electrolyte may consist of saturated solutions of soluble alkaline metals and earths. The sides or partitions of each compartment dip into the mercury, which must cover the 'box' evenly on the bottom to the depth of about $\frac{1}{2}$in. Amalgamated copper strips or discs are placed in contact with the mercury, and extend above it, to allow the gold and silver solution of cyanide to come in contact. The electrodes are connected with the electric dynamo, the anode of lead being positive and the cathode of mercury being negative. The dynamo is started, and a current of high amperage and low voltage is generated, generally 100 to 125 amperes, and with sufficient pressure to decompose the electrolyte between the anode and cathode. As the gas is generated at the anode, a commotion is created in the liquid, which brings fresh and saturated solution of electrolyte between the electrodes for electrolysis, and makes it continuous in its action."

There seems to be a distinction between the "electrolyte" and the "solution of double cyanide of gold and potassium;" but where they are separated and how, if at all, does not appear. There is a "half-tone" picture of the "box," but it gives no more information than does the above description. The anode surface is about 16 to 18 sq.ft., which can be made less by raising with thumb-screws. The cathode surface may be about 40 sq.ft.

With a current of 125 amperes, we should judge that "the gas creates a commotion," and such a commotion that it would be wonderful if the process be speedy, and otherwise than "continuous"

From the principles involved, which we have considered, this "process" may be set aside. Yet it is but one of the many suggestions, or attempts, made by "inventors" (?) unacquainted with the electrical and chemical requirements. We have not the time to consider more of these within the limits of this Paper. We know that oftentimes more is learned through failures than through successes, so we may consider these and the fallacies at some other time.

After thorough experimenting and test I have devised, and patented throughout the gold-producing countries of the world, the following described process for electrolytically obtaining gold and silver from auriferous and argentiferous rocks and ores:—Sufficient solution of cyanide of potassium, of a strength varying from 2lb. to 10lb. of cyanide to each ton of water, with from 2oz. to 10oz. of a soluble salt of mercury, is prepared. The finely pulverised ores, or tailings, are submitted to the leaching process with this solution, as in the other cyanide processes. The electro-positive gold in the tailings decomposes the mercury salt which comes in contact with it, and thereby produces voltaic couples of mercury and the minute particles of gold, thus hastening the solving of the gold.

As the speed of solving is dependent upon the actual contact of the gold and mercury with the cyanide of potassium, it is preferable to keep the solvent in constant motion during the percolation, or leaching, so that fresh solvent, not exhausted of its cyanide, may continually be in contact with the gold. To accomplish this, the whole or part of the solvent is frequently drawn from the leaching vats, or is continuously passed through the tailings, until the solving action is completed. In this way much weaker solutions may be used than is the case where the cyanide solution is allowed to stand for long stated periods in the tailings. The weak solutions are preferable because the losses in material are not so great, and they are equally as good solvents as the strong, though not so speedy.

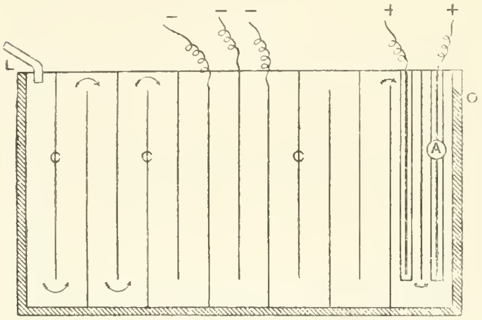
As the solutions come from the leaching vats they are run continuously through electrolytic precipitating or depositing vats, constituted as follows:—Long boxes are provided, say a little over 2ft. deep and 2ft. wide, containing copper plates 24in. square, and crossing the boxes every $1\frac{1}{2}$in. to 2in., but placed so that every alternate plate rests on the bottom and sides of the boxes, and the intermediate plates are raised about $\frac{1}{2}$in. above the bottom of the box.

The number of plates and the length of the boxes are sufficient to permit of the deposition on them of all the metal constituents of the solution without so great a density of current that hydrogen is deposited likewise. If the solution be kept sufficiently in motion, the density may be 0·1 ampere per square foot of cathode surface; but, as the solution becomes much weaker in metal towards the latter end of the vat or box, the density there cannot be so great. But this matter is self-regulating, because the greater tendency to polarisation impedes the passage of the current at the latter and weaker end.

On the average basis of a density of current of 0·06 ampere per square foot, a cathode surface of 800 sq. ft. is ample for a plant treating 3,000 tons of average tailings per month. One hundred plates of the size named supply this amount of surface. These plates are preliminarily amalgamated with mercury, and are each connected with a 'bus-bar, which is connected with the negative pole of the source of electricity.

Between these cathodes are placed porous cells filled with a half-saturated, or other strength, aqueous solution of an ammonium salt, such as the chloride or sulphate. Into each cell is placed a rod, strip, or prism of zinc or iron, and each of these is connected by wire to another 'bus-bar, which is connected with the positive pole of the source of electricity.

I have sketched on the blackboard a diagram showing a longitudinal section of a depositing vat. The auriferous solution enters the vat through the pipe L; it passes under the first copper-plate cathode C, over the second, under the third, and so on, through the vat in the directions shown by the arrows, until it flows out at O. In the spaces between the cathodes C are the porous cells containing rods or other forms of zinc, as at A. In this diagram the parts are not all shown, and the proportions are not the actual ones. The practical vat is much longer. The + and − signs designate the appropriate connections from the source of electricity.



The cyanide solution of gold and mercury is passed continuously through this vat, tank, or box, in a steady stream, and at a rate which ensures the deposition of a greater part of its metallic contents. If the quantity of mercury on the copper plates, together with that which is deposited from the solution, be not enough to keep the amalgam in a sufficiently plastic condition, more mercury solution may be added to supply mercury for that purpose. If it be too soft, the amount of mercury solution may be decreased. No mercury is lost, because recovered by the electrolytic deposition.

Because the gold is deposited in exceedingly attenuated particles, the amount of mercury necessary to form with it a plastic amalgam is much in excess of the quantity of gold—say three or four times as much. This relation varies with the rate of deposition of gold. Take, for example, 12·6 amperes to deposit 1oz. of gold per hour, and 29 amperes to deposit 3½oz. of mercury in the same time, and we have the practical requirement of 11·6 amperes to deposit 1oz. of gold per hour. This for 744 hours per month is enough to more than deposit the 697oz. produced per month by the use of 300 amperes for the same time, in the case illustrated by the authors referred to hereinbefore.

Because the anode is rendered soluble by putting it in a suitable electrolyte, there is no consumption of energy in the actions which there take place. There is no escape of uncombined or free oxygen. A zinc anode is electro-positive to the mercury cathode to the extent of 0·25 volt—in itself sufficient to cause the deposit. When the anode-electrolyte has become exhausted as an electrolyte by the formation of double salts with the metal of the anode, the porous pots have their liquid contents removed and new electrolyte substituted therefor. Porous pots are used an inch or so in diameter and 24in. deep; eight or ten in each space between the cathodes are sufficient.

The cathode, though in its substance mainly of copper, is, electrically, a mercury one; therefore, not as strongly electro-positive in its electrolyte as is a copper one. But the anode is sufficiently electro-positive to it to keep the cyanide solution from dissolving the gold and mercury when the dynamo, or other source of electricity, is unconnected, provided the anode and cathode be connected electrically.

The depositing vat can be, and is preferably, worked continuously. The anode parts are supplied from time to time as fast as dissolved. The anode electrolyte is renewed from time to time, as necessary, by the use of a hand pump. The amalgam is removed whenever desired from the cathode plates. For this purpose they can be disconnected from the 'bus-bar one by one, removed from the vat readily, the amalgam scraped off, and the plates returned to the vat. There is, necessarily, no wholesale removal of electrodes, as, for instance, in the previous case, when the iron-plate anodes become full of ragged holes from corrosion, or when the lead cathodes were removed to be melted and cupelled. The amalgam is "retorted," as in the usual routine of gold amalgamation—a much simpler and less expensive operation than melting and cupelling. Practically no mercury is lost; but lead cathodes are lost.

The electromotive force necessary to carry out this process does not exceed one-half volt. Whatever there be more than that would be expended in decomposing the water of the electrolyte, thus unduly oxidising the anode, and setting free hydrogen at the cathode to no good effect; but, rather, cover the cathode with hydrogen films, and to that extent reduce the surface available for receiving the metal deposit, thus increasing the resistance and lessening the current. In the effort to increase the metal deposit by raising the voltage we would meet the same difficulty as is experienced with the said Siemens and Halske process, and find, as Von Gernet says, "a better effect is gained by doubling the surface than is obtained by increasing the current ten-fold."

The expense of working 3,100 tons of tailings in August, 1894, at the Worcester Mill, in Johannesburg, by the Siemens and Halske process, as stated by Eissler, was, in detail, as follows:—

——	£ monthly.	d. per ton.
Filling and discharging leaching vats	125	10
Cyanide	75	6
Lime	15	1·2
Caustic soda	6	0·5
Lead	14	1·1
Iron	28	2·2
White labour	65	5·2
Natives' wages and food	20	1·9
Coal	57	4·6
Stores and general charges	41	3·2
Total	£450	or 3s. per ton.

By the improved electric process at least £130, or 10·6d. per ton, can be saved in expense in the following items:—One-half of the cyanide, all of the lead and iron, 10 per cent. of the labour, and three-quarters of the coal.

There would be wasted by the new process, say, 25lb. of zinc, worth at the mines about 19s., and about 5s. to 10s. worth of ammonia-salt—about 0·11d. per ton.

The use of strongly alkaline solvents is desirable during the dissolving stages of a cyanide process, because the alkali serves to decompose various salts and oxides, such as ferrous sulphate and oxide, ferric sulphate, and sulphates of aluminium and magnesium, &c., which would otherwise decompose the cyanide.

But alkali is inadmissible when zinc precipitation follows, because of the increased waste of zinc caused thereby in the formation of zincate of the alkali.

The alkali is inadmissible when chlorine, iodine, bromine, and such like "cyanicides" are used, because they expend their action on the alkali instead of where desired.

By my electrolytic process the solvent may be very strongly alkaline without detracting from its desirable solvent action; but, rather, adding to its efficiency, and decreasing what would otherwise be the solvent action on other constituents of the ores.

Speakers whose remarks are prefaced by an asterisk have returned their proofs revised.

DISCUSSION.

Mr. VAUTIN said he had listened with the greatest possible interest to the Paper, but he was afraid he would have to cross swords with Mr. Keith. The author was very unkind to other inventors, for in several places in his Paper he referred to them as having no knowledge of electrical or chemical facts, so it must be taken that Mr. Keith himself posed as a high authority on the subject. The Paper, besides dealing with Mr. Keith's process, contained a description of other processes well known to most of them, and they were given a lot of details of well-accepted chemical facts which, perhaps, it was refreshing to have repeated now and again. Then they came to a statement which he questioned very much. The author said: "I have discovered that mercury is electro-negative to gold in a solution of cyanide of potassium." If he had built up his process upon that "discovery," he (the speaker) was very sorry to have to say that Dr. Gore, in the *Philosophical Transactions*, proved that in 1860. Mr. Skene, in a most interesting Paper published in New Zealand, referred to cyanide of potassium as a means of assisting in the amalgamation of gold in association with iron pyrites, and pointed out that gold was so electro-positive to mercury that it was dangerous to allow gold to come into contact with mercury, for the gold was dissolved and the mercury was not. He (the speaker) had furthermore found that the very process described here, of an attempt to dissolve gold and silver from ores with mercury in cyanide of potassium, had been used in a mine in Hungary for the last two years. Experiments had also there been made with the same ore with and without the mercuric cyanide, and the results were in favour of mercury cyanide alone. Further, Mr. Keith's Paper was absolutely devoid of any data. He would like to know what was the result of passing, say, ten tons of solution, containing 2dwt. per ton, through the apparatus described by the author. He was horribly practical, he was afraid; and of all the methods suggested there was not one, he thought, better than the method now in practice in simply using zinc. He wanted to know if the author could give them any data to substantiate the statement—"The solvent may be very strongly alkaline without detracting from its desirable solvent action, but, rather, adding to its efficiency." Surely, if there were any free alkali at all, there would be a great risk of forming alkaline sulphides. He was speaking with the best possible feeling, but the author had been finding fault with other people, without giving one iota of information by which they could compare the process now brought before them with others that had gone before. Personally, he should be delighted to get away from the zinc precipitation, but he wanted very much more information than had been laid before them. He wished Dr. Keith had simply given them some results of his own work.

Dr. RIDEAL said it seemed to him that the essential novelty of Mr. Keith's process consisted in the introduction of this mercuric cyanide into the solution, and Mr. Vautin's criticism was important in that connection. Still, at the same time, looking at it from the theoretical point of view, one would think that the addition of mercuric cyanide to a solution would facilitate the solvent action of cyanide of potassium on the gold. Then, with regard to the recovery of gold from such a solution, in the process described it would seem that, theoretically at any rate, no extraneous source of energy would be required; the zinc plate would be connected up with the amalgamated copper, and the zinc anode, being in the porous pot, would in itself be sufficient to ensure the deposition of the gold on the mercurised copper. With regard to the removal of the zinc from the gold solution which the porous pot effected, Becquerel described, in his classical book on electro-chemistry, much which one saw in these modern ideas, in a crude form, but still there in the germ.

*Mr. J. SWINBURNE said a comparatively small portion of the Paper touched them as electricians. He thought it really amounted to a comparison between using zinc shavings in gold recovery and using some electrolytic means. They ought to consider first the advantages and disadvantages of zinc shavings. The advantage was obvious—it was very simple. The disadvantages were, first, the cost of the zinc, and second, that a great deal more was used than ought to be used theoretically. He supposed that was due really to the oxygen getting into the solution and acting on the zinc. He had little doubt that the zinc would not be consumed if closed in from the air, just as gold was not taken up by the cyanide, and that if they gave the zinc the same forethought as they gave the gold, the cost of the zinc might be reduced. Turning to electrolysis, the first thing one noticed was the extraordinary data, or want of data, given. He did not want to insult anybody; but he really thought people working so loosely as that were not in the least likely to give either zinc or electrolysis a fair chance, and while they succeeded in a way, he did not doubt that their success was due to their mistakes, and not to any rational way of tackling the subject. If they were going to have such a complicated arrangement as a porous pot and zinc anode that was going to be dissolved in ammonium salts, and a dynamo to make the whole thing practicable, it was surely better to come back to simple zinc shavings without all the complications. And after all, the zinc shavings was at least equivalent to an electrolytic process, and surely all the other drawbacks due to the zinc would come into the electrolysis. It did not seem to him, therefore, at first sight, that electrolysis was going to do much good in the recovery of gold. Of course, as an electrician he was keen that electrolysis should have as extended a use as possible, but he must confess that this was one case where electrolysis was not very important.

*Mr. DESMOND FITZGERALD said he wished to offer a few observations from the point of view of the student and the inventor. One of the several reasons for thankfulness to Mr. Keith for his Paper was that he had attacked very vigorously the idea which had been very prevalent amongst both students and inventors, that cyanate of potassium was the active agent in the solution of gold. It had been pointed out that evening that K Cy O was quite ineffective in dissolving gold. The voltaic relations of the metals in cyanide of potassium were so different from those in ordinary solutions, that very many of the younger members present would be interested in having the electro-chemical order of the metals in these solutions, and also the usual potential differences obtained. The order of the metals in a ·139 per cent. solution of K Cy, temperature 12·75 C., was as follows:—Mg, Zn, Al, Cu, Sn, Pb, Au, Ag, Sb, Ni, Hg, Fe, Pt, C.

The PRESIDENT requested that Mr. FitzGerald would communicate his further remarks in writing, as the hour was getting late.

Mr. PICARD wished to say a word or two in defence of Rae's specification. He was sorry to see one of the earliest pioneers run down in this way on the score of ignorance, because he did not possess so much knowledge as was possessed now. He agreed with much of Mr. Vautin's criticism, and he thought the term cyanide was used wrongfully.

The PRESIDENT (Mr. R. E. Crompton) said he was very loath to close such an interesting discussion. He had had some experience in the deposition of metals, but he would only ask a question. That was, when porous materials were used, as proposed by Mr. Keith, did he not find considerable difficulty in keeping those porous diaphragms or pots in order? A very important copper depositing process, with which he had considerable connection, was practically not a success principally from that cause. He must join with other speakers in saying that the Paper would have been of greater advantage to them if it had been a little more quantitative in character, and if they had known what was the saving in materials and labour, and so forth.

Mr. KEITH said he expected to acquire more knowledge, and some day he should offer it to the Institution of Electrical Engineers. He must say that he did not enter into this matter in a captious spirit. He did not find fault with the old without the idea of offering something that was better. They could never offer anything better without finding fault with the old, directly or indirectly. He used the description of the electrolytic process of Siemens and Halske which had been carried on for some considerable length of time in South Africa, and with considerable success, as a text for illustrating the subject. It was not his fault that he found fault with it; it was the fault of the thing itself. He wished to say, in reply to a question, that he had never yet passed one hundred tons through the process, but he had carried out sufficient to be satisfied that the thing was a practically feasible operation. He should be very glad if Mr. Vautin would, when he came to revise his written remarks, make them a little more definite and precise, so that he might be able to answer them in full. The reason for using a separate current of electricity was to somewhat hasten the process. He quite agreed with Mr. Swinburne as to the loose methods which were practised in electro-metallurgical operations at the mines, especially in the matter of gold; and he could say that the McArthur-Forrest process, the cyanide zinc precipitation process, had brought more forcibly to the gold metallurgist the necessity of exact and precise treatment and determinations of his quantities and actions than any other method of gold metallurgy. As to the expense of using zinc, they used about fifty times as much zinc in the zinc precipitation as was necessary in the electrolytic method from the theoretical point, and this was worth saving, especially in some mines where zinc cost so much. There seemed to be an impression that he set himself up as an exceeding great authority in this matter, and that he thought everybody else who had preceded him an absolute ignoramus. He did not mean to assume that position, and he did not think he had done so. Those who had preceded him in these matters were all learned men, and he certainly did not wish to question their ability. In answer to Mr. Crompton's question about keeping the pots in order, the solution was an alkaline solution, and the action which tended to make the pots imperfect conductors and to fill their pores with insoluble deposits, an action which took place in many electrolytic operations and in batteries, did not prevail in this case. The solution was an alkaline one; cyanogen was set free at its surface, came into contact with the alkali, and was immediately recombined. The ammonium passed into the outer electrolyte, and was there, if the current were pushed to an exceeding density, set free as ammonia gas, which was detected by smell. The cyanogen did not combine with the zinc or zinc salts to form insoluble salts in the pores of the porous cells.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, March 22nd.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Royal College of Science. The following Papers will be read: (1) "The Objective Reality of Composition Tones," by Prof. A. W. Rücker, F.R.S., and Mr. Edser; (2) "Some Acoustical Experiments," by Dr. C. V. Burton; (3) "The Use of an Iodine Voltameter," by E. T. Herroun.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting at 28, Victoria-street. The following Paper will be read: "Lead Covered Cables," by Mervyn O'Gorman.

SATURDAY, March 23rd.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture (IV.):—"Waves and Vibrations," by the Rt. Hon. Lord Rayleigh, F.R.S.

TUESDAY, March 26th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper will be discussed: "Steam Engine Economy: Condensing Engines," by Henry Davey.

WEDNESDAY March 27th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read: "Modern Photogravure Methods," by Horace Wilmer.

THURSDAY, March 28th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting at 25, Great George-street. The following Paper will be read: "The Employment of the Electric Light for Railway Purposes," by W. E. Langdon

FRIDAY, March 29th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Structure of the Sugars, and their Artificial Production," by Prof. H. E. Armstrong.

The Electrician.

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ELECTROLYSIS AND GOLD.

Most electricians have a vague hope that there is soon to be a large and rapid development of electrical industry in the direction of chemical manufacture. We believe their hopes will be fully realised; but in order that that happy state of things may come about as soon as possible, electro-chemistry must advance steadily and quietly, being applied first to those processes for which it is specially suitable, and what is much more important, being avoided in those cases where it is not likely to be successful. A few ill-advised applications of electricity to processes where little advantage is to be gained, or where failure is likely to follow, will do harm to the industry, which will not be wiped out by several successful developments.

In developing such an industry, it is important that the best fields should be worked first. Among the most obvious and simple are such cases as the electrolytic refinement of copper, and what the Germans expressively call the "winning" of aluminium. The field for electro-chemistry appears very extensive; but nearly all the processes need working out, not only on the laboratory, but on the commercial scale. This is a matter of no small difficulty, as it is by no means easy to get at the cost of chemical processes as at present carried out commercially, and it is thus often impossible to form a correct estimate of the working expenses of a new process. In such cases as electrolytic soda and bleach, the electrical power is only one consideration, and the other items of manufacturing cost—even handling, for example—are proportionally great. The soda industry is so enormous that a great deal of energy, and, what is more serious, of money, has been spent on perfecting processes. The percentage profits cannot be so high as in the case of chlorate of potash, and we have never quite understood why people put down plant for caustic and bleach when the chlorate market still gives them a much better opening. This is a case of departure from our maxim that we should attack the paying process first, and while the price of the product is being lowered we should work out the details of the next process to be developed. Thus, while a works is making chlorate, it can also be making caustic and bleach on a working scale, and finding out the details necessary to secure the best working on a large output, before finally determining what forms of vats, and what pressures and current densities give the best results for permanent use. There are many other cases, such, for instance, as the recovery of tin from scrap, that are hardly worth tackling until processes apparently more remunerative, such as the winning of sodium, have been thrashed out.

Gold mining, and all that appertains to it, has a special attraction for speculators. The average investor, whether a clergyman, a widow, or a stockbroker, has generally acquired an ignorance of economics sufficiently developed to enable him to read newspaper articles on social questions without suffering; to such a person gold is wealth, and, therefore, the easiest way of getting rich is obviously to invest in companies whose delightful occupation it is to pick up nuggets. It is stated that in fertile climes small nuggets grow to large ones. Whether they grow at a small logarithmic rate, or whether they swell 1½ per cent. at the end of every half-year, we do not know. Any investor will tell you that money grows of itself. What can be more tempting than to apply the magic of electricity to the romance of the gold mine?

There are two processes to which electricity may be applied in mining—namely, to dissolve the gold, and to deposit it from its solution. In treating gold ores, the particles of gold cannot be brought against the anodes properly. The solution of the gold can therefore only be helped by its being immersed in an electrolyte where there is a slope of potential. The fall over a particle of gold must be so minute that we can hardly believe any current can exist in the particle itself against the polarisation it would cause. Mr. Crookes has, we believe, experimented on an alternating current of low frequency for chlorine treatment, and his process is said to be successful; but we cannot give any trustworthy opinion on that process, not having asked Mr. Crookes for it, or on the action of a current during the leaching of gold ores with cyanide solution. It may assist the solution, but the process appears to have been tried at random, and with a continuous current it seems unlikely that there can be any benefit. There is obviously a drawback, and that is that the cyanide is used up at the anode, forming cyanate, or a cyanide of the metal employed. The second process, the precipitation of gold from a solution such as the cyanide, looks more promising at first sight. In the case of cyanide the rival method is passing the solution through shavings of zinc. The gold is deposited and the zinc dissolved. Some people may say there is a local battery formed; others that the zinc develops nascent hydrogen, which in turn reduces the gold salt. The simple fact, which is all that concerns us, is that the zinc is exchanged for the gold. A great deal more zinc is dissolved, however, than is accounted for by the gold deposited. In the discussion on Mr. Keith's Paper, it was suggested that this was due to access of air, so that the cyanide could attack the zinc. Nothing can well be simpler than the zinc process. If electrolysis is used instead, we might get the same result by using zinc anodes, and a current just sufficient to deposit the gold. In order to prevent waste of gold, a much larger current must be used. This means waste of cyanide, and if a metal anode is used, waste of anode too. Even if the zinc is put in a separate anode chamber, so as to dissolve in a suitable electrolyte, there is waste of cyanide by transfer through the partition, as well as of consumption of zinc and anode solution. When it is borne in mind that these processes are carried on in out-of-the-way places, where chemicals are dear, there seems little chance of electrolysis replacing the simple zinc-shaving reduction, and we have, therefore, "right here," as the Americans would say, just one of those processes which may not only cause waste of money, but may also bring electrolysis into commercial disrepute.

We have not discussed the use of the dynamo in amalgamation. It is an obvious way of preventing "sickening," and of keeping the mercury in a state to wet the gold directly it touches it. It is refreshing to have a change of subject at the Institution; we can have too much about dynamos, transformers, and central stations. The question of the extraction of gold is also very refreshing to the electrical engineer. The recovery of gold opens an almost limitless vista to those who have been pecuniarily concerned in the development of the electrical industry. We have had nothing so encouraging since the learned President discovered that he could recover gold from secondary batteries.

ELECTRIC LAMPS IN COAL MINES.

Portable electric lamps for use in coal mines seem to be making but slow progress. A considerable number of different kinds have been tried; but they have not been adopted for regular work.

A simple lamp and battery is not perhaps sufficient for the ordinary miners, since the Davy lamp, besides giving light, gives warning of the presence of both fire-damp and of choke-damp. Electrical indicators have been proposed to meet this deficiency, and it is possible that these have not been practically successful. One of these, depending on the heating of a platinum wire, requires a rather large current; and others, depending on diffusion through porous partitions, do not sufficiently discriminate between the different kinds of gases present But even if electric lamps are at present not quite ready for everyday use, there are occasions on which they should prove to be of great value to managers, overseers, and inspectors.

As a branch of the subject of respiration, on which he has been engaged for several years, the chemistry of the gases of coal mines is being studied by Dr. John Haldane, of Oxford, whose Paper on colliery explosions at the last meeting of the British Association attracted a good deal of attention. Dr. Haldane recently visited an old pit for the purpose of collecting and analysing some of the poisonous and asphyxiating gases. Along with an exploring party, he advanced along a low heading in a 2ft. seam into an atmosphere which analysis on the spot showed to contain large quantities of "black-damp." When the percentage of oxygen had fallen to 17·64 an upright candle was extinguished, at 17·23 a lamp went out, at 17·05 per cent. a candle held horizontally, with the wick spread out, failed to burn. Pursuing his investigations by aid of the electric lamp, he found that at 15·3 per cent. of oxygen and 3·38 per cent. of CO_2 his respirations began to be deeper, and at 9·6 per cent. of oxygen and 7·32 per cent. of CO_2 there was violent panting; at 7 per cent. of oxygen consciousness would probably have been lost. Dr. Haldane thus proves that there is a wide margin between the point of extinction of a lamp and the point of danger to life; but it must also be observed that if all "black-damp" is similar to that which he has examined, there is a fairly wide margin between the point at which panting begins, and the real danger point. A miner, provided with an electric lamp, could therefore penetrate with impunity, or escape through atmospheres containing at least thrice as much black-damp as would extinguish a lamp or candle, and the difficulty of respiration would give ample warning even if the electric lamp did not. An old miner, who accompanied this party, was of opinion that the danger of the extinction of a lamp in "black-damp" goes far towards counterbalancing the advantages of the warning given by the extinction, for without a light a man is very helpless, even in a mine with which he is very familiar.

In another expedition Dr. Haldane was accompanied by the manager and a Government inspector. They went into old workings in which nothing but an electric lamp would burn, and by its light samples of "black-damp," were analysed and collected. In the pursuit of his investigations on the physiological effect of "black-damp" on the respiration, Dr. Haldane applied his mouth to a tube connected with one of the further workings, and by the light of a Lithanode hand lamp, the manager and inspector watched his face become blue and afterwards regain its natural colour as soon as air was again breathed. Even if miners are not equipped with electric lamps, these appliances ought to be very useful for inspectors and for such intrepid experimenters, if indeed there are any others.

THE SULLIVAN UNIVERSAL GALVANOMETER (DEPREZ-D'ARSONVAL TYPE).

It is claimed by the designer, Mr. H. W. Sullivan, that his is the only form of moving coil galvanometer which can be used at sea, and the only one which answers every testing and speaking requirement. Its sensibility is variable within wide limits, and it can be damped at will to any desired deadbeatness. It is alike adapted for testing or receiving messages through any length of cable or non-inductive line down to one mile—a point of convenience more especially on board cable-repairing steamers.

A general view of the instrument is shown in Fig. 1, and the parts are clearly indicated in Fig. 2. The magnet is C-shaped, with a narrow core-less coil, covered with a copper shield and having a very small moment of inertia. The suspension frame carrying the coil system is readily removable. A sleeve or tube at its back fits over a cylindrical upright, which is planted upon a sliding base plate, this base plate being movable forward and backward by means of a brass head projecting behind through the cover of the instrument. Thus, by pushing or pulling the brass head, the position of the coil in the field, and consequently the sensibility of the instrument, may be varied without taking off the cover.

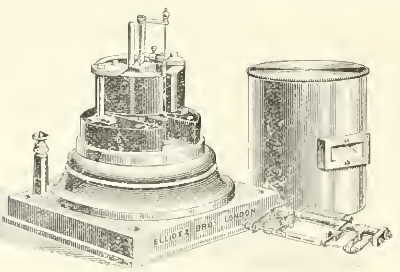


Fig. 1.—General View of Galvanometer and spare Suspension Frame, with Cover Removed.

The coil is suspended above and below with wire, the upper torsion head being in metallic connection with the suspension frame, whilst the lower one is insulated therefrom with vulcanite. The current is led to and from the coil through the suspension wires, which are in permanent connection through their torsion heads with two insulated platinum studs on the lower arm of the suspension frame. These studs are so placed, that when the frame is pushed down into its position, they press upon two independent springs fixed in the hollow base of the instrument, and permanently connected with the terminals. This dispenses with outside wire connections, and allows the suspension frame to be changed in a few seconds. The coil ends are soldered to the rigid rods projecting from it, and in order to prevent the coil from falling out and sustaining damage in case of breakage of the suspension, the frame is provided with two adjustable tongues, pierced at their ends with apertures through which these rods pass without touching. It will be seen that, should the suspension break, the lower tongue takes the weight of the coil, thus holding it in position.

The difficulty which has always precluded the application on board ship of galvanometers on this principle—viz., the impossibility of balancing the coil for rolling—has been successfully overcome in this type in a simple manner. A radial arm, half an inch in length, of fine leaden wire is soldered at one end to the copper shield of the coil at its lighter side, and by bending this radial arm in the required direction, exact equi-ponderance around the axis of rotation can be obtained in a few minutes to any angle of roll or pitch. Generally speaking, the coil will prove to be too heavy in front owing to the weight of the mirror. The balancing arm must then be attached at the back of the coil. For convenience sake, however, it is made heavy enough to slightly outweigh the mirror, the final adjustment being effected by means of a second but lighter radial arm soldered to the coil in front. In this operation the suspension frame need not be removed from the instrument for each fresh adjustment. It will suffice to raise or push it forward a little, so as to allow of the coil and its front radial arm just clearing the gap and being readily handled. Clear instructions as to the *modus operandi* accompany each instrument.

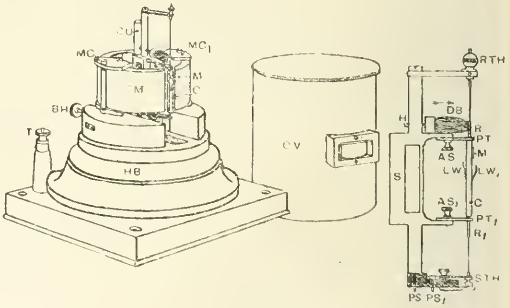


Fig. 2.

Index to Parts.—S M = Steel magnet. C = Coil. S = Sleeve or tube part of suspension frame. C U = Cylindrical upright. B H = Brass head. C V = Cover of instrument. P S and P S_1 = Platinum studs on lower arm of suspension frame. H B = Hollow base of instrument. R and R_1 = Suspension rods projecting from coil. R T H = Rigid torsion head. S T H = Spring torsion head. P T and (P T_1) = Adjustable pierced tongues through which the suspension rods pass. L W and L W_1 = Leaden wire radial arms for balancing coil. D B = Damping brush. H = Hole for brush-holder. T = Terminal. M C and M C_1 = Magnet clamps. M = Mirror. A S and A S_1 = Adjustment screws for tongues.

The damping device consists of a fine camel's hair brush adjustable forward and backward. The holder of this brush fits into a hole pierced in the suspension frame at right angles to the plane of the coil, and at such an elevation that upon advancing the holder the brush is made to cover a portion of the upper suspension more or less closely, according to the degree of damping required.

The figure of merit of the marine type exceeds that of many 'Thomson Marines," but for more delicate measurements on shore, the sensibility of the instrument may be augmented nearly tenfold by suspending the coil from above only, electrical connection being maintained below by a fine non-directive wire spiral.

The double magnet type contains two magnets, semi-circular in shape, and two coil systems. The magnets are so placed in relation to each other that they form two independent and oppositely directed fields, the north pole of No. 1 and the south pole of No. 2 enclosing one field, whilst the south pole of

No. 1 and the north pole of No. 2 similarly enclose the other field, with an independent coil system working in each. In Fig. 3 below, in which the magnets (M, M_1) and the coils (C, C_1) are shown in elevation. This arrangement affords all the advantages of two independent instruments.

Its universality, independence of external magnetic disturbances, and the facility with which it can be adjusted and balanced for rolling, render this a very convenient galvanometer, whether for use on board cable steamers, at cable stations, in cable factories, or for general land line and electric-lighting work. In equal measure these points commend it for employment in connection with the ever-increasing applications of electricity on board war ships, more especially ironclads. The sole makers are Messrs. Elliott Bros.

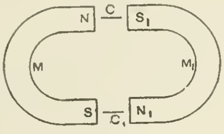


FIG. 3.

THE PHYSICAL SOCIETY.

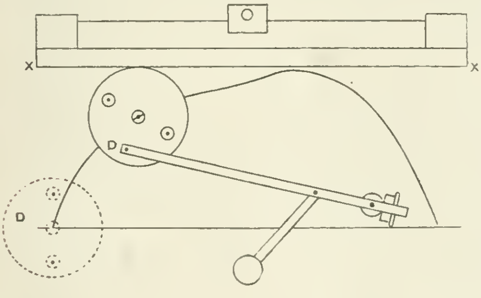
At the meeting of the Physical Society, held on the 8th inst., Mr. Walter Baily, Vice-President, in the chair, Mr. NABER exhibited and shortly described a new form of gas voltameter, which was fully described in *The Electrician*, August 17, 1894. The chief advantages claimed for this instrument are that either the oxygen or the hydrogen can be collected separately, and that the level of the liquid inside and outside the burette can be made the same, thus no correction has to be applied to the volume of the gas on this account. Variations in the temperature and barometric pressure are allowed for by reading an air thermometer, which is fixed alongside the burette. The inventor considers that this instrument will compare favourably in accuracy with the copper and silver voltameters now in general use. Prof. S. P. Thompson considered that now so much care had been bestowed on the design of a gas voltameter, this instrument might come into more general use than heretofore.

Dr. JOHNSTONE STONEY, F.R.S., exhibited (1) the local heliostat; (2) an improvement in siderostats.

A Paper on

"A Simple Form of Harmonic Analyser"

was read by Mr. G. U. YULE. At a former meeting of the Society, Prof. Henrici showed a form of analyser in which the paper on which the curve was traced was given a to-and-fro movement, a planimeter being used as an integrator. The author, being struck with the advantages of the use of a planimeter, both as regards cheapness and simplicity, has devised another form of analyser in which a planimeter is used. The principle on which this instrument works is as follows:—Suppose we have a straight line (X X) which can move parallel to the base line of the given curve, so that every point in this line describes a perpendicular to the base. Further suppose that a disc, the circumference of which is some aliquot part of the base of the curve, say, $2l/n$, where $2l$ is the base length, is capable of rolling on the line (X X) without slip. If the centre of the disc is brought over the initial point of the curve, and any point (D) at a distance r from the centre on a horizontal diameter is marked, then if the centre of the disc is made to describe the curve which is to be analysed, the area of the curve described by the point D is given by the equation



$$R_1 = a + \cos n\pi \frac{r n \pi}{l} \int_{-l}^{+l} y \sin n\theta \, . \, dx,$$

where a is the area of the curve to be analysed. Similarly if the point D is taken originally on a vertical diameter, the area of the curve traced out is

$$R_2 = a + \cos n\pi \frac{r n \pi}{l} \int_{-l}^{-l} y \cos n\theta \, . \, dx.$$

In any practical case it is convenient to take r some multiple of $1/\pi$ units of length, say 10, then the above equations become

$$R_1 = a + \cos n\pi \, . \, 10 \, n \, B_n$$

and

$$R_2 = a + \cos n\pi \, . \, 10 \, n \, A_n,$$

where B_n and A_n are the coefficients of $\sin n\theta$ and $\cos n\theta$ in the former series expressing the equation to the curve. The areas of the curves traced out by the point D (R_1 and R_2) are obtained by allowing the tracing point on an Amsler planimeter to rest in a small conical hole at D. The line X X is the edge of a rolling parallel ruler which has a rack cut along it. A series of toothed wheels give the coefficients of the different terms in the series. In the instrument exhibited there were wheels to give the first four terms, but the author said it was possible to work with wheels which gave the sixth term. The above analyser was the outcome of a simple step-by-step integrator which the author had devised. In this case the base line of the curve having been divided into a number of equal parts, then by means of a scale of sines attached to the instrument, the tracing point of a planimeter is set at a point whose abscissa is $\sin n\theta$, while it is moved parallel to the axis of y through a distance δy corresponding to one of the elements into which the base was divided.

Prof. HENRICI said he had at one time considered the question of constructing an analyser which should employ a planimeter as the integrator, and he was particularly pleased with the instruments exhibited. Since the area required was the difference between the area of the original curve, which is traced out by the centre of the disc K, and the curve traced out by the point D; and since this area is really the area swept out by the straight line K D, if we attach an integrating wheel to the disc with its axle parallel to K D, the required area can be directly obtained from the reading on this wheel. In addition, if a second integrating wheel were fixed to the disc with its axle perpendicular to K D, the coefficients of $\cos n\theta$ and $\sin n\theta$ could be both obtained by going round the curve once. The instrument devised by Mr. Yule was practically the inverse of one he (Prof. Henrici) had invented.

Dr. BURTON pointed out some incorrect signs in the proof which had been circulated. These, however, do not affect the final expressions obtained.

Mr. INWARDS suggested that errors due to back-lash might be avoided by using either a double wheel or a double rack, so that by means of a spring each side of the teeth which were engaged might be in contact at the same time.

Prof. MINCHIN gave a short account of a Paper by Mr. H. N. Allen, entitled

"The Energy Movements in the Medium Separating Electrified or Gravitating Particles."

The object of the Paper is to trace out the equipotential surfaces and lines of flow for two electrified points or gravitating particles, and then to consider the paths along which the "energy cells" move when the charged points or gravitating particles either move towards or away from one another. By energy cell the author understands the small volume of the dielectric bounded by the walls of a tube of force and by two neighbouring equipotential surfaces, which can be looked upon as containing a certain definite amount of energy. The author gives two figures showing the paths of the energy cells (1) when the charged particles come together and meet, (2) when they separate and move off to infinity in opposite directions. Using Maxwell's expression for the pressure along the lines of force, and the equal tension at right angles required by his theory to account for the attraction exerted by the sun on the earth, the author has calculated the energy-density in the medium at the surface of the sun. The value obtained is 16 H.P.-hours per cubic centimetre. Hence he concludes that at a distance from all gravitating bodies a cubic centimetre of ether contains at least this amount of energy. Prof. Minchin showed how by the use of polar co-ordinates the expressions given by the author could be simplified. He also gave a graphical method of obtaining the equipotential surfaces for any configuration. He pointed out that by a similar line of reasoning to that used by the author the energy per cubic centimetre of the medium at the surface of Arcturus must be 8,100 times as great as at the surface of the sun, so that the minor limit given above by the author must be multiplied by 8,100 at least.

THE MONOCYCLIC SYSTEM.*

BY DR. LOUIS BELL.

With this monocyclic system we can compound the generators for any reasonable loss in the line, and can arrange the lighting system without incurring any troublesome questions of balance, so as to give as good regulation even as can be obtained on a direct-current system. Beyond this we have the power of running motors.

So far as the main work of the generator is concerned, its winding is closely similar to that of any well-designed alternator. The armature is of the iron-clad type and the winding is made in machine-wound coils, which are invariably insulated, and can be very readily slipped into place. There is, however, upon the armature a second set of coils of cross section equivalent to that of the main coil, but composed of comparatively few turns, so that the room taken up on the armature is very small, and owing to the shallowness of the slots necessary to accommodate this second or teaser coil, the output of the machine, considered as a single-phase generator, is not affected. Its place on the armature is midway between the other coils, and the electromotive force generated is in a direction at right angles to that of the principal coil. If we connect the terminal of this teaser coil with either of the terminals of the main coil, we shall get an electromotive force compounded of the two and in some intermediate direction. In general, by varying the proportions of the two coils, and hence their electromotive forces, we could obtain a resultant electromotive force between their terminals having any angle we pleased with either the main or the teaser coil. If, then, wires are taken upon the line from the terminals of the main coil and also from the teaser coil, we can obtain from the main line three electromotive forces, two of which are symmetrically situated with reference to the electromotive force of the teaser coil, and bear to it any phase relation that we please. One of the most convenient arrangements, and that which is most generally adopted, involves such a relation of the electromotive force of the teaser coil to that of the main coils that we shall have on the line three electromotive forces approximately 60deg. apart. In other words, the resultant electromotive forces between teasers and main coils are each 60deg. from the electromotive force of the teaser coil. Under these circumstances it is clear that, if one of these electromotive forces were reversed, either in transformers or anywhere in the translating devices, the result would be three electromotive forces 120deg. apart, one of them having been turned through an angle of 180deg. Meanwhile, the relation between the power wire, which is connected to the teaser coil, and the outside wire has no effect upon the electromotive force between these outside wires, since the electromotive force of the main coil itself does not interact with the power wire, except in so far as a portion of it may act with the power wire to form a resultant phase and electromotive force for running motors. Consequently, so far as lights are concerned, the two outside wires behave precisely like the leads from any other alternating generator, while, so far as motors are concerned, we have the power of getting our three electromotive forces 120deg. apart, and hence have the same magnetic effect as with a three-phase system. It is evident that we can take from the outside wires of the monocyclic system either arc or incandescent lights anywhere and to any extent the capacity of the machine permits, working for the incandescents either two or three-wire distribution at option. For a motor two transformers are connected anywhere we please, one between the power wire and each of the outside wires. At this point the resultant phases come into play, and the necessary reversal of one of the electromotive forces is accomplished by the very simple and obvious device of reversing one of the secondaries. To the secondary circuit thus constituted we can connect a standard induction motor, which will start and run as well as if connected to a regular three-phase system, or instead of reversing one of the transformer secondaries we may accomplish the same virtual reversal of the electromotive force by reversing one of the coils in the motor itself. We therefore have a system which, so far as lights are concerned, is a simple alternating system; so far as motors are concerned, the dynamical equivalent of a polyphase system. With a differently-proportioned transformation we could place upon the secondaries two electromotive forces 90deg. apart, if necessary, and then run two-phase motors instead of three-phase motors, if there were any object in so doing. It is, furthermore, interesting to know that one is not confined to the use of either two or three-phase induction motors, since a monocyclic generator connected to the primary circuit makes an excellent synchronous speed without the assistance of a starting motor, in this particular being vastly superior to the pure single phase synchronous machine. The essential point of the monocyclic system, so far as motors are concerned, is the establishing of an electromotive force bearing the same relation to the system as is borne by the teaser coil of the generator. Consequently, in case of a transmission plant, the main generators at the distant station may be simple single-phase machines, the subsidiary electromotive force being furnished by a synchronous motor or similar device at any point in the system. So we might readily have an extensive transmission with a monocyclic machine in the sub-station of such size as is necessary to furnish current for what motors may be upon the system. The power wire would then run only to the sub-station.

Under ordinary circumstances, induction and synchronous motors are wound so that the counter electromotive force affects the system in a perfectly symmetrical manner, and the current flows over all the wires with some degree of symmetry in response to the demands of the motors on the system. It is customary, however, in the monocyclic system to employ motors so wound as to throw a high counter electromotive force into the power wire, when the motor is at speed and loaded, thereby reducing the normal current carried over the power wire to a purely nominal amount, and this can evidently be done without sacrificing much in the matter of starting, since at the start all the counter electromotive forces in the motors are zero. We have, then, a motor system of a type really peculiar to the monocyclic system, in that each motor will start under the same conditions of impressed electromotive force as if it were a polyphase motor; while, when at speed and loaded, it would be operating virtually as a single-phase machine. If, however, it were overloaded so that it would tend to slow down or stop, sufficient energy would flow over the power wire to bring it back to speed, just as if it were a polyphase machine.

DISCUSSION.

Mr. KELLY: The most serious fault with the system is that it did not come soon enough. If it had come before the polyphase systems had been worked out, perhaps we would not have needed any polyphase system; but, coming when it does, it seems to me a step backward. In the first place, the generator, as Dr. Bell explained, is substantially a single-phase generator. Now, in any given generator it is not possible to get the same output and regulation when worked single phase as when worked two phase. Dr. Bell seemed to think that the two phase was in trouble, because of the difficulty of balancing the two circuits. I am more familiar with that system than any other, and my own reason for preferring it is because the regulation is better than if the work was thrown on one circuit. We have found that there is no more difficulty in balancing than in the common three-wire system. When it comes to the lines, I suppose it is in this point that the chief advantage of the monocyclic system is supposed to be; but the system requires at least three wires, and any polyphase system does not require more. Where lights only and not power are required, it only needs two; in practice that is all that any polyphase does. In any district where lights only are required you need only run a pair of wires, so that in this respect there does not seem to be any gain in the monocyclic system. The cost for copper is, at the least, according to Dr. Bell's diagram, higher than it is with the plain single phase, while the cost of copper in the two-phase three-wire system is very materially reduced. Dr. Bell has raised the question as to the periodicity at which motors can be worked. Now there are undoubtedly great advantages in low periodicity in cases of long-distance transmission; but one of them is not the possibility of operating motors. There is no difficulty in making polyphase motors of 16,000 alternations which will have high efficiency and start with large torque. As to the efficiency of the motor in the monocyclic system, there is nothing to be said against it, because the motor is substantially a polyphase motor, and whatever the polyphase motor will do, of course the monocyclic will do.

Mr. STEINMETZ: I have heard with very great interest Dr. Bell's interesting Paper, and with much greater interest Mr. Kelly's remarks. I can, however, not quite agree with his statement that the single phase alternating-current system is antiquated and superseded by the polyphase system, and that therefore the monocyclic system is behind the times. The polyphase system has been before us now for nearly 10 years. The monocyclic system is entirely single phase; that is to say, the total flow of energy issuing from the generator passes through zero and is fluctuating; while the polyphase system shares with the continuous system the common feature that the flow of energy is not zero, but more or less constant. With regard to the statement of Mr. Kelly, that the output of a polyphase machine is larger than that of a single-phase machine, that is a common mistake repeated now for years. It means that on the polyphase armature more wire can be put than on the single-phase armature. However, the output of an alternator is not limited by the amount of wire you can put on the armature, but by the armature reaction, or rather by that amount of armature reaction which you can take care of by the field; and in a single-phase machine you can, by compounding, take care of a very great armature reaction which you cannot take care of in the polyphase machine, where small armature reaction causes unbalancing of the circuit. In consequence of which the output of a polyphaser is less than that of a single-phaser of the same size and speed, or at least not greater.

Dr. BELL: The first question raised may be granted, that the monocyclic system is a modification of something. Is it now to be considered as a single-phase or two-phase system, or a polyphase system of some sort? I think that question was clearly answered by Mr. Steinmetz when he pointed out that you must consider as a polyphase system one in which the energy remains constant—the common characteristic of all polyphase systems, whether evenly balanced or unbalanced. In the monocyclic system we have three currents substantially in phase with each other, and the total energy passes through zero. I fail to see how the widest possible extension of the definition of a polyphase machine could be made fairly to include it. As regards the question of unbalancing, I think I stated with a fair degree of distinctness that, with any polyphase system, though unbalancing may occur, and occur in a serious degree, I do not believe it would be a common occurrence. I think I specifically included the polyphase systems in general. With regard to the question of the reduced capacity of transformers operating on three-phase or monocyclic systems, as a matter of fact there are three plans of working, we will say, with a three-phase system as regards its transformers. In the first place, we may have a composite transformer, including all three legs of the circuits, which has been used with very fair results. Next, we may use three transformers, or, finally, only two transformers. Sometimes it is more convenient to use three and sometimes two. If two transformers are used, the statement has been made that the loss in output in connecting three-phase transformers is about 16 per cent. I would like to see experimental evidence brought up in this case. We have been informed in many well-written technical articles that the output of the polyphase machine was thus and so in connection with a single-phase machine, and we know that the facts do not fully bear out the theory. We are now given similar information in regard to the transformers. While I am not prepared to dispute the fact without having experimented on it, I would like to see some evidence that the difference in output rises to any practical magnitude.

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* Abstract of a Paper read before the National Electric Light Association, Cleveland, February, 1895.

LONDON CHAMBER OF COMMERCE.

MEETING OF THE ELECTRICAL TRADE SECTION.

A meeting of the Electrical Trade Section of the London Chamber of Commerce was held on Monday at the offices, Botolph House, Eastcheap, under the presidency of Mr. Emile Garcke.

The Secretary (Mr. Kenric B. Murray) having read the minutes of the last meeting, which were confirmed by the present meeting,

Major-General Webber, C.B., referring to the first matter of business on the agenda, relating to the proposed telephone Agreement between the Post Office and the National Telephone Company, advocated the propriety of the Chamber being represented at the forthcoming Parliamentary inquiry. He stated that the Agreement, which was the subject of discussion in the House of Commons on the 1st inst., was the one known as the Agreement of August 11, 1892. Its history had been given in various places, but the most important feature of it was that it was entered into at a time when the Post Office were justified in regarding the telephone as being worked by "companies." There were two companies in existence at the time, but immediately afterwards there ceased to be any justification for the word "companies," as they became one body. It was rather a pity that throughout all the speeches of the Postmaster-General, and those who were bound officially to support the Agreement, the word "companies" was used. Considering that some persons might be misled into believing that fair competition was in existence, and was being confirmed by the Agreement in question, he thought it a pity that the expression "companies" was used, because if the proposed Agreement were carried out, there would be practically a monopoly for 16 years with regard to a certain portion of the telephone service of the country. The deputation from the Municipal Corporations Association, which waited upon the Postmaster-General on January 24th last, dealt with the subject entirely from a municipal point of view, and in many ways left themselves open to the very just criticism that they did not even appear to have read the Agreement, and did not understand that there was one proviso in it which, even if the Telegraph Acts of 1868 and 1878 were put in force by the Postmaster-General on behalf of the telephone company, would give municipalities an absolute veto against it as regarded taking up the streets for the purpose of laying the lines underground. The Agreement of August, 1892, while giving the Postmaster-General power to transfer those powers to the "company," had done, and would do, very little to assist them in overhead wires. Practically, as many of them were aware, all these questions turned on the power of taking up the streets. In the discussion on March 1st, when Mr. Benn brought forward his motion in the House of Commons, he could not help thinking that the Chamber would agree with him that Mr. Arnold Morley took a most unhappy view of the future of the telephone. The right hon. gentleman stated that it was useless to think that the telephone could be enjoyed by large masses of the people in their daily life. When they considered that there were only 72,000 subscribers and 582 exchanges in this country, Mr. Morley must have made up his mind for a very limited use of the telephone. He (the speaker), on the contrary, had always believed—and he did so in common with many others—that the telephone should be as useful to the public between individual and individual in the future as communicating by letter was now, and as much at their disposal and as easy. To say that commercial enterprise could not extend the telephone exchange business far beyond the range contemplated by Mr. Morley in his speech, would, he held, be limiting the possibility of engineering science, and everything connected with the exploitation of a great industry such as that in question in a way which ought never to be allowed. He might mention that the difference between what Mr. Benn asked and what Mr. Morley conceded in the House of Commons was not trifling. He contended that the Chamber should try and bring about certain conditions in the next 16 years which should ensure an adequate extension of the telephone service, irrespective of the immediate advantage of the present undertakers. The objections of Mr. Morley's technical advisers—and they must, he said, to a large extent get their information from the National Telephone Company and the Continent, for they managed very few themselves—had never been thoroughly thrashed out. In the first place, the idea of having trunk lines controlled by the State, and areas controlled by a local undertaking or by one great company, was only formulated and brought before the public in 1892; but he maintained that it was absolutely wrong—and that it could be proved to be wrong—for the Post Office to have accepted the position of having only one telephone system at each end of a trunk line. With a little additional correspondence and inconvenience, they might just as easily deal, he contended, with two or more undertakers at either end of a trunk line. He maintained that it had never been proved to be contrary to the interests of the public that two telephone exchanges should exist in one area, or that they could not live. He also considered that the policy of the Post Office, after the 16 years have expired, ought now to be declared; they ought to say whether they would or would not purchase the undertaking of the National Telephone Company at the end of the period in question. If they declared that they did not mean to purchase, then the industry should be thrown open to public enterprise at once. The Agreement, too, ought to be so adjusted that there should be no hindrance to the most complete public competition. He concluded by moving the following resolution: "That, in the interest of the national use of the telephone in the future, the Chamber of Commerce take steps to be represented before the Parliamentary Committee of Inquiry to be held as to the telephone service, and that a committee, Composed of members of the Electrical Section, be named to arrange for and instruct such representation."

Lord Russell seconded the motion.

The Chairman stated that if the resolution was to express the voice of the Chamber, it must go before the Council to be considered.

Mr. Begg thought it very proper that the Chamber should be represented at the inquiry, as there was no doubt that the Parliamentary Committee was going to investigate a most important subject. He quite agreed with the resolution, although not with the reasons which had been mentioned by Gen. Webber. He could not agree in the practicability of such an extended use of the telephone as that indicated by Gen. Webber. The demand that the Post Office should now be called upon, 16 years before the licences expired, to say whether or not they would purchase the undertaking of the National Telephone Company, would be out of all reason, and no Government could be asked to make such an announcement.

Mr. Gaine said that a very complete answer could be given to the arguments of Gen. Webber, but the proper place to give them would be before the Committee. Gen. Webber must forgive him for saying that anyone who was acquainted with the subject knew that competition as regarded the telephone was what the public did not want. What the public wanted, and what they ought to have, was that the Company, or the body in whose control it was, should give adequate protection to the public for an efficient service at a reasonable rate. Gen. Webber had stated that competition had never been tried; but it had been tried on several occasions in this country, and with this result—that the great bulk of the commercial community had had the privilege of paying two subscriptions instead of one. If that was desirable then it was right to have competition. The multiplication of subscribers created a difficulty; but although that was so—and the experience of some other countries, notably America, had proved it to be so—they had not arrived in this country at the point of dislocation, so to speak, and he was only too anxious, as representing the Telephone Company, to take over everyone in this great metropolis who would become a subscriber. When he stated that for £10 a year one could have in his house speaking communication over 630 square miles of territory without extra charge, he did not think they would say that the Telephone Company was asking for anything unreasonable, or was giving very little for the money. He thought that the Electrical Section was one intended for the advantage of all the interests belonging to it; but he could not help regarding the resolution as hostile to one of the interests of the Section, particularly in view of the remarks made by Gen. Webber in proposing it.

After a few observations from Mr. Beaumont,

Mr. Sydney Morse regretted the view which had been expressed by Mr. Gaine as to the resolution being a hostile one. He understood the remarks of Gen. Webber to be rather in the nature of criticism. It would never do for the Committee to refuse to deal with any matter because there was some criticism respecting it, even if the criticism were hostile. Matters had to be discussed by them in the general interests of the Section. He hoped the resolution would be adopted, but it might be desirable to omit the concluding words as to the proposed Committee being "composed of members of the Electrical Section." He understood that the resolution must go to the Council, by whom the Committee would be appointed.

The Chairman said he did not desire to enter into a discussion on the merits of the question, but he wanted to emphasise what Mr. Morse had said as to Mr. Gaine's view that the resolution was prejudicial. The Section represented varied and extensive interests, and it would be too much to expect such a degree of harmony to prevail among them that a resolution would never be brought forward which might be regarded as prejudicial by one part of the Section or by some particular member of it. He did not, however, take that view of the resolution before the meeting, as it was merely one which called the attention of the Council to the desirability of the Chamber being represented before the Parliamentary Committee of Inquiry. One difficulty about the resolution was that it did not give any indication of the kind of evidence to be submitted.

Gen. Webber said that he had kept this matter out of the resolution. If the Committee he suggested were appointed, there would be ample opportunity to bring forward the conditions, for instance, which Parliament might be asked to impose in connection with the carrying on of this matter for the next 16 years. He altogether disclaimed the slightest hostility towards the National Telephone Company, although he admitted that he had always been against there being any monopoly as regarded the telephone service of the country.

Mr. Beaumont said that he regarded the subject into which the Parliamentary Committee was to inquire as being a national one.

Mr. Sellon observed that he failed to see anything in the resolution hostile to the interest represented by Mr. Gaine.

Mr. Gaine remarked that but for Gen. Webber's observations in proposing the resolution, he would himself have been prepared to second it. He had no objection to the resolution, but he had to the remarks with which it was brought forward.

The motion was then agreed to *nem. con.*, the concluding sentence being struck out, as suggested by Mr. Morse.

Other matters on the agenda having been briefly referred to by the Chairman, none of them necessitating any resolution, the proceedings terminated.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

New York, *March 9, 1895.*

The Bate Refrigerator Decision.—A decision in the case of the Bate Refrigerating Company was handed down in the United States Supreme Court on Monday, March 4th, and settled the question as to whether Section 4,887 of the Revised Statutes means what it says or should be construed to mean something entirely different. The clause in dispute reads as follows:—"But every *patent granted* for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent." The appellant contended, however, that the clause must be construed as if it read: "But every patent granted for an invention which has been patented *previous to the application for a patent* therefor in the United States shall be so limited, &c." The Court decided against the latter plea, and thus concluded a litigation which never had the ghost of a show of ending any other way than it did. The judgment appealed from was supported by a long line of decisions covering a period of more than ten years past; no decision at variance with it was ever made, and it was not until electrical interests became involved that it was thought worth while to carry the matter to a final hearing. Notwithstanding the general recognition of the fact that the case was a forlorn hope, the element of uncertainty it introduced adversely affected the telephone and incandescent lamp industries, as there has been a marked reluctance to enter extensively into these businesses pending a decision.

Telephone Legislation.—For years an effort has been made annually before the New York State Legislature to obtain the passage of a law fixing telephone rates in New York State, but without success. It is openly charged that the Metropolitan Telephone Company of New York City has thus far obtained immunity through an annual contribution of $50,000 to a representative of the dominant political party, and other charges of corruption are made. A Bill is now being pressed before the Legislature, fixing rates varying from $27 per year for small cities to $78, for New York and Brooklyn, though the Metropolitan Telephone Company claims that $78 is barely half the average cost of operating a subscriber's station in New York City. At present it seems probable that the Legislature will fix maximum rates, but much higher than those demanded by the advocates of the Bill now before it.

CORRESPONDENCE.

COMPENSATING COILS FOR THE ARMATURE CURRENT REACTIONS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Would you allow me some historical remarks upon the Paper read by Mr. W. B. Sayers before the Institution of Electrical Engineers, and published, p. 567, in the last issue of your esteemed journal?

About eleven years ago I sought means to obviate the sparking at the dynamo commutators. I devised an arrangement for that purpose, and having the intention to patent it, I examined the then recently-issued specifications to see if it was not yet patented. I found it described in the specification "No. 5,127, 1883, T. A. Edison." This patent relates to substantially the same device as that of Mr. Sayers. In the meantime I found another device for the same purpose, and as I thought it (and I think it still) generally much preferable to the former one, I applied for, and obtained, patents for this invention. This device, which I termed "compensating coils" or "compensating windings," as it compensates the cross-induction produced by the armature current, is the same as that mentioned by some of the speakers in the discussion upon Mr. Sayers' Paper, and attributed to Mr. Swinburne, who, "in 1887, was going to patent it." Now, my first patent, that in Germany, is from December 6, *1884*.

My patent covered substantially all those arrangements, such as compensating coils enclosing the armature, or compensating windings on the pole-pieces or on separate cores, &c., which were subsequently tried and described by others.

I may add, however, that during a very long time of nearly continuous illness, alas! I let my patents expire on this and other inventions, so that this letter has no other purpose than to settle my priority of invention.—Yours, &c.,

The Hague, March 14, 1895. C. L. R. E. Menges.

[In order that our readers may judge for themselves as to the exact value of Mr. Edison's 1883 patent as an anticipation of Mr. W. B. Sayers's ingenious device of 1893, we give below some verbatim extracts from the final specification. The italics are our own.—Ed. *E.*]

Patent No. 5,127, October 29, 1883.

Electrical Generators and Motors.

The said invention relates to the construction of dynamo-electric machines and electro-dynamic motors, having continuously-wound bobbins connected at intervals to commutator bars, whereby the sparking at the commutator will be greatly reduced or wholly obviated, thus overcoming the necessitity for changing the current collectors upon the commutator in accordance with variations in the load upon the machines, when used either as generators or motors, increasing the capacity of the machines and decreasing the heat generated in the armature coils, and also diminishing the wear of the commutators and the collectors. This is accomplished by opposing the electromotive force of the coils as they are short-circuited at the commutator (by the bridging of commutator bars by the current collectors) by a counter-electromotive force. This counter-electromotive force is preferably equal, or nearly equal, to the electromotive force of the short-circuited coils, in which case no current will flow in the short-circuited coils, and the sparking will be completely obviated; or the counter force may be somewhat less or even greater than the direct force, but not sufficiently one way or the other to make the spark due to the current produced by the predominating electromotive of practical importance. *The counter force is produced by making the connections between the bobbin and the commutator bars through conductors which pass through the field of* *force, and in which there is a counter electromotive force opposed to the direct force of the short-circuited coils. These connections are preferably in the form of loops upon the armature.*

In machines with continuous windings, the commutator bars have been heretofore connected with the armature bobbin by conductors running directly from the commutator bars to the bobbin. By this invention, however, each connection is made by a conductor which is connected to the bobbin, and is carried back on the armature loop from the point of connection therewith, and follows it one or more times around the armature, and is then connected to a commutator bar. . . .

A counter force equal to the direct force is obtained by giving each extra loop the same length as one loop or section of loops of the main bobbin, or in coostructions where this is not desirable, the extra loops may be placed in advance of the loops of the main bobbin, so that as each main loop, or section of loops, is short-circuited, the opposing extra loop or section of loops is in a stronger magnetic field, and in this way the counter force of the extra loop can be made equal or nearly equal to the direct force of the short-circuited loop. . . . This invention is applicable to all continuous-wound machines, whether of the Gramme, Siemens or other type. . . .

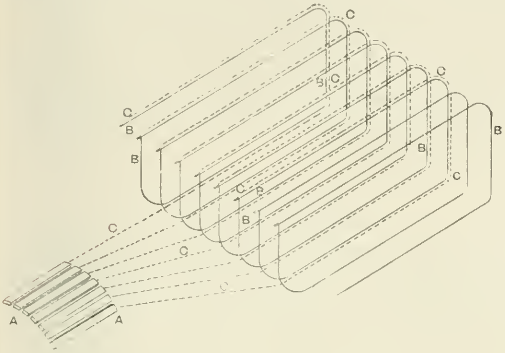

Fig. 1.

Fig. 1 of the accompanying drawings represents a perspective view of a number of armature loops removed from the armature and of a number of commutator bars, the connections between the loops and bars being shown by dotted lines. . . . . Fig. 3 a side elevation of a wound armature of the Gramme type with the commutator in vertical section, all the commutator connections being illustrated. A represents commutator bars, and B the coils or loops of a continuously-wound armature. The field-magnet, the location of which will be well understood, is not shown in any of the figures. C represents the conductors connecting the loops with the commutator bars. These conductors are wound as loops upon the armature, and hence pass through the field of force, and in them is developed a counter-electromotive force which neutralises wholly or partially the electromotive force of the coils as they are short-circuited. It will be seen that each conductor C, instead of extending from the point of connection with B directly to a commutator, is run back upon the coil B, to which it is connected, and follows that coil around the armature, and is then connected to a commutator bar. If the winding B is plural winding each conductor C may also be wound two or more times around the armature. . . .

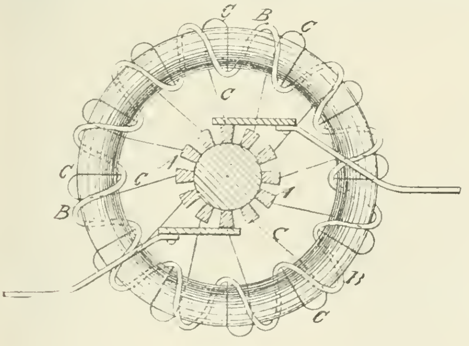

Fig. 3.

The claim is:—In electrical generators and motors, the method of overcoming, wholly or partially, the spark at the commutators, substantially as hereinbefore described and illustrated in the accompanying drawings.

SODIUM IN CULVERTS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In view of Major Cardew's discoveries of sodium in electric light culverts on insulators, an interesting specimen from our Museum of Faults assumes now, in my opinion, some importance.

In October of last year a gentleman complained of his being able to get shocks from the casing covering his wires connected to our network. On sending an inspector to the premises in question, it was found that the "shocky" casing was covered with a furring similar to that noticed on new buildings, and on removing its capping, he discovered every evidence of a serious leak from a badly-made joint on the negative conductor through the casing to a nail in an old flint wall. The casing between this conductor and the nail had been eaten away so as to form a hole about ½in. in diameter. There were no evidences of charring having taken place, as the whole of the casing was saturated with moisture, and the edges of the hole were of a light brown furry nature. On the surface of the capping that had been in contact with this faulty joint, there was a large accumulation of a white pasty deposit, and many of your readers can quite imagine my surprise and incredulity when our inspector stated that he could get "sparks" from this piece of capping by rubbing it with his finger after it had been entirely removed from the casing and wall. I then had the casing and capping containing the faulty joint brought to the works to investigate these mysterious "sparks," and I found, to my great bewilderment, that for several days afterwards we could get brilliant but minute flashes of light from the under surface of the capping by drawing the finger over it.

Having but a mere smattering of chemistry, and knowing that the premises were occupied by a gunsmith, I thought the mysterious flashes or sparks might be caused by some of the chemicals used in the business having got thrown on the casing, or that electrolysis had set free from the decaying and damp wood some form of phosphorous, and therefore relegated this curious source of "electric" sparks to our Museum, where it is carefully preserved in its dried state.

On hearing of Major Cardew's recent investigations, I made further inquiries, and ascertained that it was quite impossible for any gunpowder or any other explosives to have been put on the casing, aud it now seems most probable that this curious phenomena owes its existence to something akin to the presence of some unoxidised sodium or potassium kept in that state by the continued electrolytic action from the neighbouring wires.—Yours, &c., Arthur Wright, Engineer and Manager.

Brighton Corporation Electricity Works.
March 18, 1895.

THE ELECTRIC LIGHTING OF CARDIFF.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your current issue, under the heading Trade Notices, and the sub-heading Cardiff, after quoting from Mr. Massey's recent letter to a local paper, you add the remark: "Some day, perhaps, an explanation will be forthcoming of the cause of this more than usually venomous opposition to the electric light on the part of local journals." My first thought on reading this paragraph was, How striking an instance it affords of the evils of anonymous journalism—who wrote this paragraph? who inspired it? where did the information come from?

When you were good enough to print an article from my pen, dealing with anonymous journalism, and to write an able and courteous leading article setting forth your view of the matter, your reasons for anonymity in your columns; your great argument for unsigned matter was, that it was the joint production of your whole staff. Did your whole staff join in producing the paragraph I have quoted? Did many of them even see it? If so, have they not very short memories? Is not the judicial faculty, the inquiring mind, somewhat absent, seeing that only a week or two before you had a note of the letter I wrote to another journal demanding an inquiry into the whole matter?

Now, as to the subject matter of the paragraph itself. There has been no opposition to the electric light from the local Press.

Great interest has been felt in the matter, because everybody wanted the light, and great disappointment has been felt at the result achieved.

I presume that, as the electric light works are being laid down at the expense of the ratepayers, they have a right to watch the process, to point out where money is being wasted, and to demand that the waste shall cease. When it was first decided to put down an electric lighting station in the town, a sub-committee, consisting of three of the County Borough Council, the Borough Engineer, and the Consulting Electrical Engineer, spent several hundred pounds—of the ratepayers' money—visiting nearly every town where an electric light installation was at work, both in this country and on the Continent, and the result of their joint experience was one gross blunder, from which all the others have sprung. The scheduled area, for present lighting, is very small and compact. It consists of a block of streets in the middle of the town, the greatest length of which is hardly a quarter of a mile. A canal runs nearly through the centre of the block, down which coal could have been brought direct from the collieries. There is a lot of old property on the canal side. Yet, instead of this spot, the site chosen for the station was at the extreme end of the town, *in the opposite direction* to that in which development of demand was likely to occur; two miles from the docks, where, of course, a large demand would have arisen, nearly three miles from the centre of the highest class residential portion, one mile from centre of the scheduled block itself.

The next blunder committed was in the adoption of the "rectifier" for running the street lamps from. This has entailed the use of a valuable cellar under the Town Hall, where its humming noise is a great nuisance, and it has also entailed a very heavy additional charge for attendance. But that is not the worst. The arc lamps have been repeatedly extinguished. On several occasions the whole of the lamps have gone out, on other occasions half of them. Seeing that these lamps are illuminating the busiest streets of a town of 150,000 inhabitants, the matter, I need hardly say, becomes a very serious one. The most serious point, however, is that things get no better. The lights were started in November, yet half of them are stated to have been extinguished for some time on several evenings during last week and the week before. It was announced nearly two years ago that the "rectifier" would be adopted, and in the original specification it was stated that the "rectifier" must work in a chamber under the pavement. At that time the apparatus was barely in the laboratory stage, if it had got as far. The Consulting Engineer was asked to say where it was at work, and it was pointed out in the local Press that it was a dangerous thing to use an untried apparatus under the conditions.

When the chimney of the electric lighting station was finished, and champagne was drunk by jubilant Councillors on the top, it was announced by the then Mayor that "the rectifier" was in use in other towns, and was doing well, and Cardiff was going to reap great benefits from its adoption. This was about August, 1893. Again a challenge was given in the local Press asking where the rectifier was in use, but no reply was vouchsafed.

Finally, after repeated delays, after the Welsbach burner had got a good hold upon the town, the lights were started. So far from opposing it, the local Press sang pæans of praise. Unfortunately it was not successful, and the lights were stopped. Full time was given to put the thing in order. Again they were started, and the result has been what I have described. The details of the rectifier were kept very close. As soon as they were known, however, the Council were warned that its use would entail the possible extinction of all, or a section of the lights, and the reason was given; yet the rectifier is still working and the lamps still going out in a body at uncertain times. The consumers' incandescent lamps have not often gone out, but the supply is at 103 to 105, when it is supposed to be 100 volts, so that lamp renewals are heavy. In the early days the supply varied from 85 to 120 volts.

Meters are only just being put in. There is a large leak from both low-tension cables to the iron containing pipes and to the gas and water services. It is stated that a number of the tubes of one boiler have been burnt, and will require renewing; that the condenser does not work properly, notwithstanding that a huge lake has been constructed in the grounds of the lighting station. Every ton of coal has to be hauled to the station by carts, though it is by the side of a main line. It appears that triple-expansion condensing engines were put in, when there is no possible chance of their having anything beyond the usual 5 p.m. to 7 p.m. load. During the early days of the lighting one could notice a peculiar winking in the incandescent lamps, similar to that which occurs when a dynamo is driven by a very heavy-cranked single engine, when the crank falls over, but not so regular. This, it appears, was due to some new coupling that was used. And to crown all, if the whole of the lamps the station can supply are taken up, the station cannot pay expenses, interest, and sinking fund.

Surely, in the face of all this, the local Press would not be doing their duty if they did not call attention to the matter. Suppose the station had been put down by a private company, how much sympathy would be extended to the shareholders? What shrieks of laughter would greet their pathetic appeal for more custom.—Yours, &c., SYDNEY F. WALKER.

Cardiff Electrical Works.

VIEWS ON CAPACITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of March 15th Prof. Silvanus P. Thompson, in an article on Prof. Nipher's "Views on Capacity," mentions, very kindly, my contributions to *The Electrician* of 1861, afterwards published for me by Messrs. E. and F. N. Spon, in 1862, under the title "A Treatise on the Principles of Electrical Accumulation and Conduction. Part I."

Prof. S. P. Thompson proceeds: "Of this work the *second* part, on conduction, was never published; but the first part is a work to be prized by every student of electricity."

I have to thank Prof. Thompson for his kindly mention of my little work, but I wish to call attention to this fact: the *second* part appeared in your columns under the heading of "The Conductive and Inductive Circuits Geometrically Illustrated," with numerous woodcuts, about thirteen years ago.

For this second part I could not at the time find any publisher, and subsequently the copyright in the books was purchased by "The Electrician" Printing and Publishing Company.—Yours, &c., F. C. WEBB.

LEGAL INTELLIGENCE.

The Direct Spanish Telegraph Company (Limited) v. the Owners of the s.s. "Caloric."

This case came before Mr. Justice Day, sitting with Trinity Masters in the Admiralty Division, on Tuesday last.

The plaintiffs are the owners of the submarine cable laid down between the coast of Cornwall and Bilbao in Spain, and in the action alleged that they suffered damage by the negligence and want of care and skill on the part of the defendants' servants in navigating the steamship "Caloric." On November 14th last, whilst the "Caloric" was on a voyage to Bilbao, she anchored, the plaintiffs alleged, in an improper and unusual place near the cable, neglected to move as she should have done, and improperly refused to take a pilot in contravention of the rules and regulations of the Port and Harbour of Bilbao, and subsequently improperly allowed her anchor to foul with the plaintiffs' cable, causing it to be cut and damaged.

The defendants denied the alleged negligence, want of care and skill and alternately pleaded that if the "Caloric" fouled the plaintiffs' cable, such fouling was occasioned by the steamship while properly lying at anchor in a proper anchorage ground, and encountering a gale of exceptional violence, accompanied by terrific squalls, which drove the steamship across the track of the cable. The defendants also pleaded that the cable was not properly buoyed or marked, and those who were engaged in navigating the ship had no knowledge of and no reason to anticipate the presence of the cable on the anchorage.

Mr. ALFRED BREWER TONKIN, the Resident Superintendent of the Direct Spanish Company's station at Bilbao, gave evidence as to noticing something going wrong with the cable on November 14, 1894, at 3:43 p.m. He noticed that the cable became insulated, and the insulation afterwards gave out entirely. He subsequently found out that the cable had been broken.

Some evidence which had been taken on commission having been read, T. RITCHIE said he was second mate of the "Caloric," and held a master's certificate. He remembered on November 14th being in Bilbao Bay. He had been there before four or five times. When there was a big fleet of ships there a ship would anchor where she could find clear anchorage. It was not a usual place for anchoring in when it was blowing a gale of wind. He remembered that orders were given to heave up the anchor. There was no delay in doing this until the strain came on it. When he went forward he saw that two wire ropes were foul of the anchor. They tried to clear the cable by means of a hook, but this was not large enough. A bowline was used, and a man went over to try and cut the cable. He made two or three chops at it, but was not strong enough to cut it. One of the cables broke, and after that another attempt was made to cut the other. The carpenter was about 25 minutes in cutting the other cable. There was a spare anchor on board the "Caloric." When they passed the pilot cutter the weather was not too rough to allow the pilot to board them. Within an hour the bigger cable had chafed itself, and parted.

Capt. G. PATTISON, commander of the cable ship "Mirror," said that he did not know the particular cable which had been damaged. He knew the particular cable of the Spanish Government; but he could not say how it compared with the Direct Spanish cable, because he had not seen it. The old Spanish cable was probably as old as the Carlist War.

Mr. CH. GERHARDI, Manager of the plaintiff Company, said that he knew Bilbas very well. In 1874 the Spanish Government had an electric cable put down, and in 1894 his Company put down another. The older one was more likely to break. The cable laid down in 1894 was of the strongest type. He should say that the cable was hacked or some violence used on it. On a rough bottom the coating sometimes wore off in six months.

Two Spanish Pilots spoke as to challenging the "Caloric," but the ship went on without taking a pilot.

This evidence concluding the case for the plaintiffs, the defendants called the master of the "Caloric," who said that he had been in Bilbao Bay 20 or 30 times before. He "slowed down" engines, expecting the pilot boat to come alongside, and was surprised to see the cutter steaming westward, and had no idea that the pilot cutter intended the "Caloric" to follow him. He did not know that there were any telegraph cables at the place where he anchored. Seventy-five fathoms of chain were let go. There was a spare anchor forward, but the ship was not provided with standing tackle to get it out. The ship lay safely for some hours, and then the carpenter reported that she was dragging. He at once gave instructions to haul the anchor, and when they got it nearly home he saw two wire ropes over it; one a very heavy one tubed with ropes, and the other much thinner and looking quite rusty. The larger cable was tight and the smaller one was slack, but the position of the cables and the anchor rendered it necessary to get rid of the smaller cable first. The carpenter went over the bows and tried to cut it clear. The ship was all the time riding by the large cable, and this gradually commenced to wear away and ultimately gave way with a snap. The ship then began dragging, and went within two cables' length of the shore, and as there was imminent danger of stranding he ordered the thin cable which was still on the anchor to be cut. He did not move his engines while the telegraph cables were on the anchor. He did not know that there were telegraph cables there. The smaller cable was slack until the larger cable broke. He did not use steam to prevent the ship getting nearer to the shore because he was afraid of getting the cable round his propeller.

His LORDSHIP, in giving judgment, said that what they had to determine in this case was whether the defendants had, by their negligence, violated the rights of other persons. The plaintiffs were undoubtedly entitled to have their cable lying at the bottom of the sea in Bilbao Bay. The defendants, on the other hand, were equally entitled to navigate the waters of Bilbao Bay, and to go in and come out of the harbour; and, provided that each party exercised reasonable care in his acts, he was not responsible for injury accidentally caused by exercising his right. In the present case the defendants were clearly entitled to go into Bilbao Bay, and to enter it very much under the circumstances under which they did enter it. They were not, strictly speaking, bound to Bilbao. The ship was bound to Bilbao if she could not enter another place a little to the westward of Bilbao—Castro. She was to take in cargo there. On arriving at the outside of Bilbao the weather was such that the captain thought he would not be justified by going to the westward of Bilbao, and accordingly he entered Bilbao. Having regard to the state of weather in the bay, and the state of the tide, his Lordship, and with him the Trinity Masters, thought the master had exercised his judgment as a sailor, as he was entitled to do. There was no evidence before them to make them doubt the accuracy of what the master said—that he was unaware of the existence of the cables in the neighbourhood. Their presence was not indicated on the chart produced, or in the book of directions which he had on board. Nor was there any evidence that the cable had been chopped with an axe. The plainaiffs, therefore, failed in the action, as the defendant had done nothing conducive to the misfortune.

Judgment for the defendants accordingly.

Eisler v. Marshall and Another.

This was an action, in the High Court, before Mr. Justice Mathew, to recover damages from the defendants for having failed to underwrite shares in the Scottish House-to-House Electricity Company (Limited), according to the terms of an agreement dated August, 1892, made between them and the plaintiff. The agreement provided that, in consideration of the plaintiff taking 2,000 £5 shares in the Company, the defendants undertook to take and pay for 4,000 shares in the Company, on or before October 31, 1892, and that a penalty of £500 was to be paid by way of damages by the party failing to perform his part of the agreement. On October 31, 1892, no shares had been applied for. On December 15th the Company was advertised, a prospectus issued, and the plaintiff sent in his application for 2,000 shares. On December 23rd the plaintiff withdrew his application before allotment, and went to Scotland to see the Directors, with the result that the plaintiff sanctioned the Company going to allotment and renewed his application, and had allotted to him 2,000 shares, upon which he paid £955. No money was forthcoming from the defendants, and the Company was abandoned. The plaintiff commenced an action for recission of his contract to take shares, which ended in a compromise, the plaintiff being freed from further liability in respect of them. He then commenced this action against the defendants to recover £1,000 damages under the agreement referred to. It was contended by the defendants that the date fixed for carrying out the agreement was October 31, 1892, and that the plaintiff had put an end to the agreement by cancelling his application for shares.

Mr. Justice MATHEW said the action was misconceived and had failed, and there must be judgment for the defendants, with costs.

Wynne v. The Corporation of Bury.

This was an action for wrongful dismissal, heard before Mr. Justice Lawrence and a special jury at Liverpool Assizes. Mr. Wynne was engaged by the Bury Corporation to act as electrical engineer in connection with certain works in that borough. He did not bring the action to put money into his pocket, but in order to see that the circumstances under which he left the Corporation's employ did not result in damaging his reputation as an electrical engineer and as a gentleman. There was a certain vagueness in the advertisement issued, and the resolution adopted as to the exact position of the plaintiff, with the result that a misunderstanding arose as to whether he was to work under the borough engineer or on equal terms with that official. In the end, the Corporation came to the conclusion that it would be better that the Corporation should carry on the work under the engineer without the assistance of the plaintiff.

For the Corporation it was urged that there was no suggestion against the plaintiff's competency as a professional gentleman or against his character. The defendants, therefore, consented to a verdict for the plaintiff for 40s. and costs on the High Court scale, and judgment was given accordingly.

Marshall v. South Staffordshire Tramways Company (Limited).

The hearing of an appeal against the refusal of Mr. Justice Kekewich to appoint a manager of the defendant Company, and to order a sale in a debenture-holder's action, was argued this week before Lord Halsbury and Lords Justices Lindley and A. C. Smith.—Being bound to run a certain number of trams a day, and to carry passengers at certain fares, the Company argue that they have become common carriers, and could not themselves stop their undertaking. For the same reason they could not give anyone else power to put an end to the undertaking, and any clause in the debenture deed giving the debenture-holders a right to enforce their security in any way which would have the effect of preventing the Company from carrying out their undertaking must be *ultra vires*, and could not be enforced. In the view of the Company's counsel not even a manager appointed by the Court would have power to carry on the tramway, and might be indicted for a nuisance for doing so.—At the conclusion of the arguments their Lordships reserved judgment.

Bryson v. Gordon Cumming.

In the Scotch Courts last week Lord Kyllachy closed the record in an action brought by William Alexander Bryson, consulting electrical engineer, of Bothwell-street, Glasgow, against Sir William Gordon Cumming, Bart., of Altyre and Gordonston, Elginshire. The plaintiff sues for £115. 18s. 5d. In March, 1892, he was consulted in connection with an installation of electric light at Altyre House, and alleges that it was agreed that he should be allowed a commission at the rate of 4 per cent. on £3,063, the cost of the installation, and the sum sued for represents the balance of account due. The defence is that plaintiff permitted the contractor to use inferior material in the putting in the light, and by his actings otherwise defendant has suffered damage, which he holds the plaintiff responsible for. He alleges neglect of duty and collusion with the contractors.

General Electric Power and Traction Company v. Roger Dawson (Limited).

Recently, in the Queen's Bench Division, an action was heard before Mr. Justice Wright, in which the plaintiffs' claim was for £68. 3s. 7d., balance of an account for goods sold and delivered and for work done. The defendants, while admitting certain items of the claim, said that the machine which they contracted to purchase from the plaintiffs was not up to agreement, and they counterclaimed for £38. 12s. After hearing evidence on both sides, his Lordship gave judgment for the plaintiffs for £68. 3s. 7d., with costs, and for the plaintiffs also on the counterclaim.

Cables as Thermometers.—The average temperature throughout the year of the water at the bottom of the Atlantic Ocean, as determined by the resistance of the Atlantic telegraph cables, is stated to be 38 deg. Fah. The water at the bottom of the Mediterranean, measured in the same way, is said to be 57° F.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NOW READY.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of **"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY.** In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Although about 100 pages are added to the book, no addition is made to the price, which is 7s. 6d., post free 8s. 3d., abroad 9s.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices:—*

The Large-Sheet Table, giving full particulars of the Electricity Supply Stations throughout the Kingdom, published with our issue of January 4th, can be obtained mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s.—each post free. The Map showing positions of Supply Stations is mounted on the back of the Table. The Coloured Map of Metropolitan Electric Lighting Areas issued with the Jan. 18th number and the Electricity Supply Statistics issued with the Feb. 1st number, are also mounted on some copies, and the price of these, complete, post free, is 5s.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

Laboratory Notes and Forms.—With the above title, we are publishing a set of Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free. The complete set will be ready next week.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"Electro-Chemistry."—This useful work, by Dr. G. Gore, is still on sale, the price being 2s., post free.

Tenders Invited.—At or before 12 o'clock noon of Monday next, the Llanelly Borough District Council will receive plans, designs, specifications, and estimates of cost of providing and fixing electrical plant and machinery, including street lamps and laying down mains for lighting certain portions of the town.

—— The Bradford Corporation invite tenders for the construction and delivery of two steam dynamos for use at their electricity works, Bolton-road, Bradford. Tenders must be sent in by the 28th inst.

—— The Electricity Department of the St. Pancras Vestry are prepared to receive tenders for the construction of a sub-station. Drawings can be seen at the office of Prof. H. Robinson, 13, Victoria-street, Westminster, S.W., and tenders must be sent into Mr. A. E. Pycraft, Chief Clerk, Electricity and Public Lighting Department, Vestry Hall, Pancras-road, London, N.W., not later than 12 o'clock noon on Thursday, April 4th. Some further particulars are given in our advertisement columns.

—— The municipal authorities of Tongres (Belgium) have decided to light the public streets by electricity, and are inviting tenders until May 1st next for the carrying out of the work.

—— The Corporation of South Shields invite tenders for the erection of a central electric lighting station. Tenders have to be sent in to Mr. J. Moore Hayton, Town Clerk, Court-buildings, South Shields, by 10 a.m. on the 26th inst.

Tenders Accepted.—At the last meeting of the Hanley Town Council it was decided to accept the tender of Messrs. S. Z. de Ferranti (Limited), for generating machinery at the electricity works for the sum of £4,036.

—— The following tenders have been accepted by the Ayr Police Commissioners for the work in connection with the electric lighting buildings: R. Hutchison, £3,303. 6s. 4d., for excavator, brick, and mason work; D. and J. Milligan, £1,116. 13s. 4d., for carpenter, joiner, and painter work; and W. Hughet and Son, £356. 10s., for slater and plumber work.

—— The tender of Messrs. A. J. Harrison, Coles and Co., of Hermitage Works, Richmond, has been accepted by the Brentford Urban District Council for supplying and fixing telephones and electric calls in connection with the fire brigade for the sum of £131. 10s. The charge for maintenance for 10 years has been accepted at £100.

Appointment.—Mr. N. Applebee, of London, has been selected by the Cardiff Corporation to fill the post of electrical engineer, at a salary of £200 per annum.

Obituary.—Mr. Lindsay Burnet, of Moore Park Boiler Works, Govan, Glasgow, died last week. The deceased was well known in engineering circles, and made steam boiler construction his special department. He was a student of University College, London, under Prof. A. B. W. Kennedy, and about 12 years ago commenced business at Govan as a boiler maker.

Installation Business for Sale.—The Hastings and St. Leonards-on-Sea Electric Light Company have decided to dispose of their installation business, and invite tenders for purchase. A useful stock of fittings is included. Tenders must be sent to the Secretary of the Company, 20, South-terrace, Hastings, not later than Monday, April 1st.

Bankruptcies.—In the matter of W. J. Kelly, of 43, King's-road, Camden Town, London, N.W., notice is given that a bankruptcy notice has been issued against this debtor at the instance of the Nalder and Harrison Construction Syndicate (Limited). The debtor has acted for some time past as Receiver and Manager in the affairs of Poole and White (Limited).

—— The failure is announced of Samuel Elliott, electric light casings maker, timber merchant, &c., of Broad-street House, E.C., and Albert Works, Newbury, Berks. The liabilities are estimated at about £80,000, with assets valued at £3,500. The debtor states that he is the proprietor of a patent smoke annihilator, which is charged in his statement of affairs for £23,000.

—— The first meeting of the creditors of George F. Rogers, electrical engineers, of 5, Great Winchester-street, London, will be held on Monday next, March 25th, at Bankruptcy-buildings, Carey-street, London, at 2:30 p.m., and the debtor's public examination on the 2nd prox. at the same place at 12:30 p.m.

—— Ernest Albert Browning and Colin Mackenzie Gardner, the individual partners of the firm of Browning and Gardner, electrical engineers, of 122, George-street, Edinburgh, will be examined in the Sheriff Court House, Edinburgh, on Tuesday next, at two o'clock. There is a meeting of creditors in this matter at 51, George-street, Edinburgh, on April 4th, at 12 o'clock.

—— The first meeting of creditors of William Arthur Jones, electrical engineer and works manager, Albert-avenue, Newport (Mon.), was held last week. Deficiency, £101. 14s. 9d.; assets, *nil*. Debtor commenced business in 1891, without capital, and attributes his failure to "want of capital and bad trade."

—— In the observations of Mr. A. H. Wildy, the Official Receiver under a Receiving Order granted on February 26th against Jonathan Lewis Young, it appears that the debtor is an electrical engineer, and joined his brother in partnership in 1891 in an established business at 60, Ludgate-hill, London, paying £400 for a half share. The brother having withdrawn, the debtor traded alone until 1892, when he formed the business into a limited company, receiving £500 in shares and an appointment of manager. In 1893 he opened premises in London and Paris for the sale of Edison phonographs, importing the machines direct from the inventor's factory. The liabilities are returned at £3,108, with available assets *nil*, debts to the amount of £620 being returned as bad. The debtor attributes his insolvency to stoppage of his businesses in consequence of actions brought against him for alleged infringement of patent rights, and a subsequent adverse verdict which involved him in heavy claims for law costs.

Martiny (Limited).—A compulsory order for the winding-up of this Company has been made.

Medical Electrical Institute (Limited).—The petition presented by Mr. J. Willing, Jun., for the winding-up of this Company has been approved by the Court.

Dividends.—In the matter of Young and Buss (in bankruptcy), in order to rank for dividends, claims must be sent in by March 27th to Mr. H. W. Figg, 37, Upper Thames-street, E.C.——In the matter of Moses Humm, electrician, of 8, Westbourne-road, Forest-hill, in order to rank for dividend, claims must be sent in by March 27th to A. Macintosh, of 24, Railway-approach, London-bridge, S.E.

Change of Address.—Messrs. O. Berend and Co. announce that their lease at 61, Fore-street, London, E.C., having expired, more commodious premises have been taken at Dunedin House, Basinghall-avenue, London, E.C. The new address is within two or three minutes' walk of the old.

Removal.—Mr. T. G. Poole asks us to state that he has taken offices, &c., at 11, Queen Victoria-street, London, E.C., where in future all business communications should be addressed.

Hardwood Specialities.—Messrs. Richard Lister and Sons, of Sheffield, send us a copy of their List No. 7, giving illustrations of hardwood handles for telephones, pushes, &c. A large variety is given.

Epstein Accumulator Plates.—The following is issued by the Epstein Company under date March 20th :—

"It having come to the knowledge of this Company that plates are being offered by other makers of accumulators which are essentially Epstein plates, users are hereby cautioned against employing plates which are made by infringing patents owned by this Company. Opinions in support of the validity of the letters patent have been given by Sir Richard Webster, Q.C., M.P., Sir Horace Davey, Q.C. (Lord Davey), Mr. Fletcher Moulton, Q.C., M.P., Mr. Aston, Q.C., Mr. R. W. Wallace. Our solicitors have been instructed to take proceedings against all companies and persons using such plates."

Advertising Devices.—The owners of "Bovril" have adopted, as an advertising medium in prominent thoroughfares, a mass of alternated red and white incandescent lamps. In the neighbourhoood of Trafalgar-square a very ingenious advertisement of "Bovril" is conspicuous.

"The Engineering Magazine."—The March number of this magazine is up to the usual high standard, both as regards matter and illustrations. It contents include :—"Relations of the Railway to its Employees"; "Relations of the Employee to the Railroad"; "Recent Architecture in France"; "Practical Hints for City Officials"; "Electric Wire and the Fire Hazard"; "Mine Management and Superintendence"; "The Causes of Floods in Western Rivers"; "The Conquest of Steel over Cast Iron"; "Electric Power in Southern Cotton Mills"; and the increasingly useful Review of the Industrial Press. The new number, and nearly all back issues, may be obtained at the office of the European Edition, 1, 2, and 3, Salisbury-court, Fleet-street, London, E.C.

The New Berne Vocabulary.—The Bombay Chamber of Commerce is agitating strongly against any steps being taken at the next International Telegraph Conference to make the use of the new Berne vocabulary for code telegrams obligatory between India and Europe. Some apprehension, it would appear, prevails that at no distant date efforts will be made to extend the compulsion for using this vocabulary to India. This action on the part of the Bombay Chamber was taken before the publication of the vocabulary. What the views of the members of that important body may be now that the precious volume is before the public, it would be interesting to learn.——In reply to Mr. Henniker Heaton in the House of Commons, the Postmaster-General said that it had been decided at the last International Telegraph Conference at Paris, in 1890, that an official vocabulary should be compiled, making the words of the vocabulary obligatory for code telegrams in the European system at the expiration of three years from the date of issue of the book. This period would expire on December 31, 1897. As this country and its colonies were parties to the Convention, it would not be possible for any arrangement to be come to by which British merchants would be allowed to continue the use of their own vocabularies, notwithstanding that only words taken from the eight authorised languages were used therein.

Forthcoming Books.—Messrs. Whittaker and Co., of White Hart-street, Paternoster-square, London, announce that a new edition of Poole's "Practical Telephone Handbook" will be ready in a few days. The book has been revised and enlarged by the addition of chapters on electrical measurements and metallic circuit working, &c. The same firm announce the third edition of "Electricity in Our Homes and Workshops," by Mr. Sydney F. Walker, and the addition of a chapter on dry batteries. A new edition of "Electric Light Fitting," by F. C. Allsop, has recently been issued.

"Daily Tenders and Contracts."—This is the title of a new London daily paper devoted exclusively to supplying the latest information relating to current tenders and contracts. The price of the paper will be 2d. There is room for such a journal, and if it is carefully compiled it should prove useful to the commercial community, which is not over well served in journals dealing with tenders and contracts.

The "Journal."—Part 115 of the *Journal* of the Institution of Electrical Engineers is now ready, and can be obtained of the publishers, Messrs. E. and F. N. Spon, price 3s. This part of the *Journal* contains the inaugural address of the new President, and the Paper by Mr. Kingsbury on "The Origin and Development of the Telephone Switchboard."

Catalogue. We have received from Messrs. Jürgens and Martens, of Spaldingstrasse, Hamburg, a copy of their illustrated catalogue sheets, giving prices and particulars of their specialities. The firm manufacture insulators, screws, terminals, lightning conductor attachments, and numerous other electrical supplies.

Smoking Concert.—The Northern Society of Electrical Engineers are doing for the north and midlands what is so efficiently done for the south by the Electro-Harmonic Society—arranging a series of smoking concerts, one of which is to be held this day (Friday) at the Palatine Hotel, Hunt's Bank, Manchester, at 7:30 p.m., to which members and their friends are invited.

Bohemian Concert.—The City Electric Athletic Club, in connection with the City of London Electric Lighting Company, will hold their third annual Bohemian Concert in the Banqueting Hall at St. James's Hall, Regent-street, London, on Tuesday next, the 26th inst., under the chairmanship of Sir David L. Salomons, Bart. The proceedings commence at 7:45 p.m.

Arlecdon and Frizington (Cumberland).—Mr. Brodie, of Whitehaven, who was recently consulted by the Electric Lighting Committee of the District Council, has prepared a report and plan, and these are before the Committee for consideration.

Ballybay (Ireland).—A movement is on foot here to light the town by electricity.

Birmingham.—An adjourned discussion on the question as to the amount to be expended, and the allotment of the tenders for the lighting of the Birmingham Technical School, occupied the attention of the City Council on Tuesday. Mr. Martineau, the Chairman of the Technical School Committee, moved that powers be given to expend the sum of £6,080 in providing electric light fittings and motive power at the school. The Committee had thoroughly considered the matter since the last meeting of the Council, and were unable to come to any other conclusion than that previously arrived at. He understood that Messrs. Fowler, Lancaster and Co., one of the competing firms, had sent a circular to some of the members of the Council. It was perfectly true that the firm sent in the lowest tender on the first specifications. When, however, these specifications were withdrawn and an amended form issued they were twenty above the lowest tenderer. A point had been raised that a capital expenditure of £6,000 would be saved if the Committee took current from the Birmingham Electric Lighting Company; but whoever supplied the current, £3,600 would be required for wiring, apparatus, &c., so that a saving of capital expenditure of £2,400 only would be made, at an extra annual cost of £374, and the school would lose the educational advantages of the installation of the plant within the building. An amendment was proposed that the lowest tender upon the original specifications should be accepted. Mr. Bisseker, in supporting the Electric Lighting Committee, said that the principal change in the specifications was made in the fittings for the engineer's department, which had been condemned as impracticable by Dr. Sumpner and by several experts, to whom they had been submitted. In his judgment it was proper to amend the specification when they found that the particulars given were unsatisfactory. After some further discussion the amendment was rejected by 35 to 17, and the proposal of the Committee was approved.

Bolton.—The Electricity Committee of the Corporation report that the total number of 8-c.p. incandescents connected to their electric lighting system is 5,350.

Brighton.—A Local Government Board inquiry was held at the Town Hall on Wednesday into the application of the Corporation for sanction to borrow £48,100 for electric lighting purposes, £750 for the purchase of a house in North-road for the extension of the electric light works, and £14,000 for other matters. The Town Clerk (Mr. F. J. Tillstone) explained that the sum of £48,100 for electric lighting might be divided into two sums, £42,900 to be expended within the powers of the Electric Lighting Act, and £5,200 for street lighting under the Public Health Act. Their original electric lighting undertaking was commenced in 1890, and from the opening of the station in 1891 the demand for current had increased year by year, and a total of £120,531 had been borrowed for purposes of the scheme. Plans and estimates had been prepared for the extension, estimated to cost £13,449, and the Corporation to lay down additional plant at an estimated cost of £29,451. It had been necessary to carry out portions of the work included in this estimate without waiting for formal sanction, but the work was of a permanent character. Mr. F. J. C. May (Borough engineer and surveyor) gave details regarding the proposed extension of the generating station, and Mr. Arthur Wright (electric engineer) gave details of the proposed extension of plant. The Town Clerk asked that the whole loan for electric lighting purposes should be for a term of 40 years, instead of land for 40 years, and plant for 25 years, as in the case of previous loans. He pointed to the success of the undertaking, and urged that the plant was kept in constant repair and would be as good as new at the close of the period of repayment. There was no opposition, and a report at an early date is expected.

Bury.—On Wednesday last a Local Government Board inquiry was held at the Corporation Offices on the application of the Corporation to borrow £30,000 for electric lighting purposes. The Town Clerk said that power to supply the electric light was obtained in 1890. It had been decided to adopt the low-tension system of supply. With the plant and accommodation at their disposal they would be able to supply 12,000 lamps and leave room for extensions, but machinery for only half that amount of light was now being put in. It was asked that the cost of land should be repaid in 60 years, and the rest of the cost in 20 years. There was no opposition.

Copenhagen.—Particulars as to the construction of the Free Port of Copenhagen are given in a report to the Foreign Office from her Majesty's Minister at Copenhagen, Mr. C. S. Scott. The works have been carried out at a total cost of £575,000. The buildings, warehouses, &c., with the exception of the electric lighting station and plant, have been erected by the Free Port Company (Limited), which has a capital of £225,000. The central lighting station has been built and plant put in at the expense of the Berlin Allgemeine Elektricitäts Gesellschaft, and this Company undertakes the whole management and distribution of electric power in return for such payments on the part of the Free Port Company as are calculated to enable the latter to pay off their debt, interest, and capital in 30 years, when they become owners of the central station building and plant. The receipts of the Free Port Company will consist in the rent of the buildings and land, payments for the use of cranes, light, electric power, and labour.

Cost of Telegrams.—At the meeting of the Associated Chambers of Commerce, held in London last week, a proposal was made that the charge for commercial telegrams, and registration fees for telegraphic addresses, should be reduced and that any shortage on this account should be made up by a revision of the existing arrangements of the charges for Press messages. The proposal was rejected. A resolution calling the attention of the Postmaster-General to the absolute necessity that exists for immediately placing the means of telegraphic intercommunication between all commercial and seaport towns under such conditions as to render its interruption by storms no longer possible was carried without discussion.

Croydon.—The Local Chamber of Commerce has decided to obtain information from traders in the compulsory area as to whether, in the event of the electric light being established in the district, they would be likely to use it, and whether they would prefer the work to be carried out by the Corporation or by a private company. In the course of a discussion on the subject, it was stated that the Corporation, in inviting tenders, which are to be considered at the next meeting of the Town Council, had stipulated that the current should be supplied at 6d. per unit.

Dover.—The Dover Electric Lighting Company's works are approaching completion, nearly all the machinery being in. It has been definitely decided to switch on the public lighting on April 8.

Edinburgh.—A Sub-Committee of the Town Council had before them on Tuesday a report by Prof. Kennedy on the extension of the electric lighting in certain streets of the city at a cost of about £4,000.

Electric Light for Sailing Vessels.—It is stated that the first sailing vessel to be lighted by electricity is the Spanish barque "La Vigusea," an oil-bulk and general cargo boat. This vessel is fitted throughout for incandescent lighting, the generating plant including a small oil engine, which also supplies pumping power for the oil cargo when loading or unloading.

Electric Railway Extension.—The Bill before the House of Commons asking an extension of time until 1900, to enable the City and South London Railway Company to construct the authorised extension of their electric railway from Stockwell to Clapham, has been referred to the Unopposed Bill Committee, a settlement having been effected with the Lambeth Vestry, which was the only opponent.

Exhibition.—A Building Trades' Exhibition opens at the Agricultural Hall, London, N., on Monday next, and the managers have been successful in obtaining a larger number of exhibitors, with more varied exhibits, than in any previous Builders' Exhibition at the Hall. The Royal Institute of British Architects have nominated judges for the Workmen's Handicraft Competition, and five of the City companies representing industries intimately associated with the building trades will also be represented. Messrs. Kirkaldy and Son, of Southwark, will exhibit building materials tested for crushing strain. The offices of the Exhibition are at 222, Strand, London, W.C.

Fareham.—A writ has been issued by the local electric lighting company against the District Council in the matter of the alleged breaking of an agreement to purchase the Company's undertaking.

The Gas Companies.—A Select Committee of the House of Commons has insisted upon the South Metropolitan Gas Company supplying their commodity under the sliding scale, and have reduced their maximum price from 4s. 9d. to 4s. 3d. per 1,000 cubic feet. The occasion for this action on the part of the Committee was the application of the Company for powers to raise additional share and loan capital.

A Good Dutch Custom.—It has been decided by the Dutch Customs authorities that all apparatus for electric light and power purposes shall be admitted into Holland free of duty.

Hampstead.—The recommendation of the Lighting Committee, given in our last issue, was discussed by the Vestry last week, and, after two amendments had been disposed of, was carried, as was a proposal that Mr. Preece be asked to act as consulting engineer to the Vestry until the next annual election of vestrymen. During the discussion Mr. Thwaites, chairman of the Lighting Committee, said that when their installation reached 16,000 private lamps a profit would probably be shown. At present there were 6,194 lamps connected. The Vestry Hall is now brilliantly illuminated by electricity. The lighting of the Board Room is effected by 16-c.p. incandescents, 36 of which are used in groups of three.

Hanley.—At the last meeting of the Town Council, the Electric Lighting Sub-Committee recommended that the street lamps should be charged at the rate of £16 per lamp per annum, and that the past half-year charge should be £170. They further recommended that the borough surveyor and electrical engineer provide in the scheme they are preparing for the extension of the mains, for cables and appurtenances being laid in additional streets of the town. The Committee also submitted a statement of accounts up to December 31st, in connection with the electric light undertaking, which showed receipts £1,574, and expenditure £916, leaving a profit of £658, out of which £627 had been appropriated for interest, and £31 for reserve. The Committee also recommended that application be made to the Local Government Board for sanction to borrow £5,000, repayable in 25 years, for electric lighting purposes. The minutes were approved.

Heywood.—At the meeting of the Town Council, last week, the gas manager presented a report on electric lighting, when Alderman Firth, the Chairman of the Gas Committee, said that inquiries had been made, and that the Committee did not feel justified in recommending electric lighting for Heywood just yet.

Hotel Lighting.—The alterations to the Royal Hotel, Dundee, which are now completed, include the introduction of the electric light, about 413 16-c.p. incandescents being used. The wiring contract was secured by Messrs. J. Maxwell and Son. There is in addition a complete service of electric bells and telephones throughout the hotel, this work being carried out by Messrs. Westwood and Son.

Huddersfield.—At the last meeting of the Town Council the minutes of the Electric Lighting Committee, recommending the putting down of additional plant, and authorising their engineer to obtain tenders for same, were adopted.

Indian Telegraphs.—The telegraph survey party of the new telegraph line from the Southern Shan States to Kyang Cheng, in the neighbourhood of the Siamese Buffer State, have been ordered to begin work forthwith. With regard to the reduction of telegraphic rates between India and England, the report presented to the annual meeting of the Bombay Chamber of Commerce, held on February 27th, points out that, in September last, the Madras Chamber of Commerce submitted a memorial to the Government of India in favour of the reduction of the tariff between India and Europe, and notification was made to the Madras Chamber that the Bombay Chamber had already moved in the matter, and would in all probability, before the assembling of the next International Telegraphic Conference, again address Government on the subject.

Lecture.—Prof. W. Robinson, of Nottingham College, delivered the first of a series of three lectures, entitled "The Work of the Electric Current," at the College on Friday last week. The lecture was illustrated by a large number of experiments, in which the Professor was ably assisted by Mr. A. Hay. The second lecture will deal with "The Application of Electricity to Lighting, Cooking, and Heating Purposes," and the concluding lecture with "Electric Power, and the Magnetic Properties of the Electric Current."——Following Mr. A. P. Trotter's lectures to the *employés* at Arc Works, Chelmsford, on slide rules and other mechanical calculators, Mr. S. H. Brunton, on Monday evening last, gave examples of dynamo calculations, with illustrations by Mr. Trotter's large slide rule.

Leeds.—The work of wiring and fitting up the Town Hall and Municipal Buildings to the system of the Yorkshire House-to-House Company has now been completed. The Corporation are paying the Company 4d. per unit for current, this being about the estimated cost when the supply was generated on the premises.

Light and Heat Exhibition.—The opening of the proposed Light and Heat Exhibition at Woodhouse Park has been postponed for some months. Owing to the recent long frost, it has been found impossible to complete the buildings by the time originally fixed.

The Lighting of City Premises.—Among the many fine buildings erected in the City to the designs of the President of the Royal

Institution of British Architects, are those of the Guardian Assurance Company and the Clydesdale Bank in Lombard-street. Both are, of course, to be lighted electrically. The Consulting Engineers for this part of the work are Messrs. Handcock and Dykes, of 5, Victoria-street, S.W.

Limerick.—The Gas Committee are awaiting a report from Prof. Kennedy before taking further action in connection with the electric lighting project in Limerick. The Town Council are the proprietors of the gas works, and in order to guard against any electric lighting company being establised in the town, some years ago they obtained powers to supply electric current themselves. The period for which these powers were granted will expire this year, and the Council must, therefore, do something in order to preserve their powers.

Liverpool.—A meeting of the Special Lighting Committee of the Corporation was held on Monday. The purchase of the Electric Supply Company's undertaking was again discussed, but no definite decision was arrived at, and the consideration of the matter was again deferred.

Llandrindod Wells.—At the meeting of the Urban District Council, the Chairman called attention to the question of their public lighting, and asked that whatever steps the Council proposed to take on the subject should be at once discussed. They had all agreed that the only system that could be adopted would be the electric light, as no one would be likely to suggest gas. He had paid attention to this matter for some time, but he was quite unaware of any case where it was proposed to start gas works, although in a large number of cases electric lighting works were being established, even in places were profit-earning gas works were already in existence. The only point upon which there might be a difference of opinion was as to whether the scheme should be established by the Council or by a local company. He pointed to the success of the Morecambe Company, and alluded to his visits to several places in the country where electric lighting was established. The late Local Board had had the matter under consideration. It was ultimately resolved that the Chairman should discuss the matter with Mr. Preece, with the view of bringing it forward at a future date.

London County Council.—At its last meeting the Council was busy electing the various committees. The Technical Education Board appointed under the Technical Instruction Act (1889) is constituted as follows:—Mr. R. C. Antrobus, Mr. H. T. Banning, Mr. E. Bayley, Mr. R. M. Beachcroft, Mr. E. Bond, Col. F. Campbell, Mr. W. J. Collins, Mr. W. Crooks, Sir J. C. Dimsdale, the Earl of Dunraven, Mr. E. B. Forman, Col. E. Hughes, Mr. A. L. Leon, Mr. F. W. Maude, Mr. T. A. Organ, Mr. W. Pearce, Mr. W. C. Steadman, Mr. J. Stuart, Mr. S. Webb, and Mr. T. W. Williams.

Macclesfield.—The Board of Guardians, at their last meeting, discussed a letter received, in which the writers proposed to form a company for the supply of electric current to several public buildings in the town. Those who propose to form the company had approached the authorities of the infirmary and asylum upon the subject of lighting by electricity the workhouse and infirmary buildings. It was proposed that an interview should be arranged between the agents of the proposed company and the Guardians. Mr. Carr, while agreeing that no harm could be done in an interview, "viewed with considerable apprehension anything that should come in opposition to the gasworks of the town."

Mansion Lighting.—Messrs. Rashleigh Phipps and Co. are wiring 23 of the new mansions at Chelsea, facing the Embankment, with 50 lights in each, or 1,150 lights in all.

The Metric System.—Mr. Alexander Siemens gave evidence before Sir Henry Roscoe's Select Committee on Weights and Measures, in which he said that his firm (Messrs. Siemens Bros. and Co.) found themselves compelled to adopt the metric system in their export business. Several witnesses said that in engineering and other branches of industry contractors who tender with the metric unit stand a much better chance of having their tenders accepted.

Monmouth.—The Town Council on Tuesday last agreed to apply to the Local Government Board for powers to borrow £20,000 for electric lighting and drainage purposes.

Pemberton.—The District Council, having been asked to give their consent to a licence for putting down certain plant in the West Ward, to enable contractors to supply electric current for light and power purposes, the Clerk has been instructed to lay before the members of the Council the provisions of the Electric Lighting Act, in view, it is stated, of the Council themselves taking action in the matter.

Prescot.—A lengthy discussion took place at the last meeting of the District Council on the Electric Light Provisional Order, and especially with regard to the proposed appointment of an electrical inspector. The British Insulated Wire Company, who are undertakers under the Provisional Order, raise objections to the proposals of the County Council, which has prepared clauses for insertion in the Provisional Order. With regard to the appointment of an electrical inspector, the Council desired to insert a clause to the effect that an electrical inspector shall from time to time be nominated by the Board of Trade, and appointed by the Urban District Council in respect of the area under supply in their district immediately the grant of the Provisional Order is confirmed by Act of Parliament, and that such inspector shall be continued in office during the continuance of the Order, the undertakers to pay to the Council any deficiency between the amount of fees which the inspector may receive from consumers and such sum as the Board of Trade shall fix as the inspector's salary. To this proposal the Company strongly object.

Prestwich.—Members of the District Council complain of the charges made by the Radcliff and Pilkington Gas Company, and recommend that, in the event of the gas company declining to make a material reduction, the question of introducing the electric light into the district should be considered.

Private House Lighting.—Messrs. Drake and Gorham have been entrusted with the lighting of a large new house recently taken by Mr. Bishop at Wimbledon.

Portsmouth.—The Electric Lighting Committee have under consideration important proposals for extending the electric light to Landport and Southsea. The scheme will entail an estimated outlay of £13,000, the expenditure of which sum has already been approved by the Local Government Board. The Committee also have under consideration the advisability of reducing the price for current from 6d. to 5d. per unit.

The River Plate.—*The Review of the River Plate* contains an account of the electric lighting of the Riachnelo Port, which is described as one of the most important improvements undertaken by the Government of Dr. Saenz Peña. The electric light has been installed on both sides of the Port. The work has been carried out by the River Plate Electricity Company, and was successfully inaugurated in February. The neighbourhood of the Port has been for some years past notorious for the crimes committed within its precincts, and it was, doubtless, this notoriety that first appealed to the authorities for a better system of illumination. One hundred and seventy-seven 1,200 c.p. arcs light both banks of the Riachnelo, a total distance of 9,787 yards, the maximum distance between any two lamps being 54 metres, the average about 50 metres. Thomson-Houston direct-current machines are used, the whole of the electric plant being supplied by the General Electric Company of America. The boilers used are of the Babcock-Wilcox type, and are capable of giving steam for double the number of lamps now in use. The arc lamps are improved Thomson-Rics, with double carbons. The engine house has been entirely built on piling, over 200 piles of hardwood, 8in. by 8in., having been used. Some of these piles were driven to a great depth before hard bottom was reached. The foundations of the machinery have been built up upon massive concrete embedded between piles. The foundation work proved extremely costly, and the work of construction occupied nearly four months. Mr. W. B. Bassett Smith was the architect for the work, and the installation was let by contract to the River Plate Company for the sum of $54,016 gold and $66,500 paper. The whole of the work was carried out under the superintendence of Mr. W. R. Cassels, the Company's manager, who has been successful in giving the clients of the Company, the Government, entire satisfaction.

Shop Lighting.—The extensive shop premises of Messrs. Palmer Bros., of Market-place, Norwich, have been lighted by electricity, the contract being entrusted to Messrs. Lawrence, Scott and Co.

Southend.—At the last meeting of the Town Council a committee was appointed to consider the desirability of introducing the electric light.

Southport.—A special meeting of the Town Council was held on Tuesday evening to consider the resolutions passed by the Electricity Committee recommending that application should be made to the Local Government Board for sanction to borrow £6,000 for electric lighting purposes. Mr. Councillor Hesford, Chairman of the Committee, said that the machinery at their command only enabled them to use 19 per cent. of the capacity of their cables. In July, 1893, the cost of certain works was estimated at £13,297, with an additional £1,208 for contingencies. They had since expended £18,738. The original sum sanctioned by the Council was £28,000, of which they had rather over £9,000 unexpended. They wished for powers to borrow an additional £6,000, which would give them £15,262 available. Alderman Griffiths recommended that a larger sum than £3,000 should be provided for arc lighting, as he considered their requirements in the next four or five years would be greatly in excess of what this sum would provide. Councillor Hulme thought the town could have no better advertisement than the lighting of their streets by electricity. It was ultimately agreed to sanction the application for power to borrow £3,500 for street lighting and £12,000 for extension to private lighting in the town.

Suez Canal Lighting.—The number of ships navigating the Suez Canal in 1894 was 3,352, and the number of vessels effecting a portion of their journey by the aid of the electric light was 3,180, or no less than 94·87 per cent. of the whole. The nationalities of the ships passing through the Canal by the aid of the electric light were—English 2,304, German 287, Dutch 188, French 170, Austrian 69, Italian 58, Norwegian 36, Russian and Spanish each 26, Ottoman 9, Japanese 5, Egyptian 2. Comparing these results with those of the last four years, the following will show the general use of the electric light by vessels navigating the Canal :—

Year.	Total ships passing through Canal.	Ships navigating by day.	Ships navigating by night by aid of electric light.
1890	3,389	357 or 16·44 per cent.	2,832 or 83·56 per cent.
1891	4,207	496 or 11·79 ,,	3,711 or 88·2 ,,
1892	3,559	323 or 9·08 ,,	3,236 or 90·92 ,,
1893	3,341	259 or 7·75 ,,	3,082 or 92·25 ,,
1894	3,352	172 or 5·13 ,,	3,180 or 94·87 ,,

In 1894 the average of the total journey through the Canal (day and night) fell to 19 hours 55 minutes per vessel, against 20 hours 45 minutes and 21 hours 16 minutes in 1893 and 1892 respectively.

Telephonic Extension in Java.—Telephonic communication is about to be established between Batavia, Samarang, and Soerabaga.

Telephonic Extension.—The Cleckheaton subscribers to the National Company have been officially notified that it has been decided that Cleckheaton shall be a joint area as between Bradford and Dewsbury, and that the Cleckheaton subscribers may have the option of electing to be in either the Bradford or Dewsbury area, free connection being granted in the chosen area. The arrangement, which will prove a boon to a large majority of the Cleckheaton subscribers, comes into force on April 1st.

Uruguay.—A translation of the message presented by the President of Uruguay at the opening of the Legislative Chambers, appears in a recent issue of the *Monte Video Times*. After dealing with political matters, the message states that a work of great public convenience and importance is being accomplished in Uruguay, in the form of the establishment of a complete telephonic network. A sum of no less than $450,000 is being expended on this work, and the President claims that his Government deserve the thanks of the citizens for securing them a rapid means of communication throughout the territories of the Republic, and he compliments those who have by spontaneous support helped the Government to complete their task. There are many matters mentioned in the President's address which, if true, should gladden the hearts of investors in Uruguayan stock.

Wells.—We announced last week that a concession had been granted to Mr. A. D. Dixon Brown for lighting this town by electricity. At the meeting of the Town Council at which the concession was granted a resolution, "That the future public lighting of the city be by electricity, and that the gas company be asked to continue their present contract for another twelve months from June, 1895," was passed. The terms upon which the Council are to purchase Mr. Brown's undertaking at the expiration of five years from June, 1896, are the payment of a sum of £1,000 in addition to the valution under section 2 of the Electric Lighting Act ; if purchase is made at the end of 14 years, £500 ; if at the end of 21 years, the amount of valuation under the section. A Special Committee is to be appointed "to decide any question in opposition to the electric light."

Whitechapel.—On Monday the District Board discussed the report of the Streets Committee on electric lighting, recommending that the powers possessed by the Board under the Order obtained in 1892 should be put in force forthwith. A station is to be erected at the dust destructor yard in Wentworth-street, the scheme to be followed being generally that described in the reports to the Board by Prof. H. Robinson. The appointment of Prof. Robinson was also recommended, to advise the Board in the carrying out of the work upon terms to be agreed. A lengthy discussion followed, and the debate was adjourned to the next meeting of the Board. ——At the meeting of the Board of Guardians it was reported that the South Grove Workhouse Committee had considered the question of the possibility of utilising the labour of able-bodied male paupers in the generating of electric current for the partial lighting of the establishment, but had come to the conclusion that at present the scheme was not a practicable one.

Worcester.—At the last meeting of the Worcester Board of Guardians the recommendation of the Building Committee that their architect (Mr. Rowe) be authorised to prepare specifications for the lighting of the male ward block and workshops by electricity, and to obtain tenders, was agreed to.

Yarmouth.—In presenting a report with regard to the electric lighting of the town, the Borough Surveyor stated that customers were now being rapidly connected ; that the accounts in connection with the scheme would soon balance, and contribute towards the interest and reduction of the capital account. The total number of lamps now connected was 3,095, which was sufficient to pay the whole of the present working charges. Their borrowing powers for electric lighting purposes would be exhausted before the present contracts were completed, as large sums had been expended in providing meters, transformers, and additional mains, of which a considerable quantity would be required in the near future. The report recommends the Council to apply to the Local Government Board for powers for a further loan of £2,000.

NATIONAL TELEPHONE COMPANY.

On Friday evening last, in the King's Hall of the Holborn Restaurant, London, an important gathering of the staff of the National Telephone Company took place, the occasion being the second annual dinner. In addition to many of the Directors and chief officials of the Company, the gathering was notable for the guests invited and present. These included Lord Kelvin, Prof. D. E. Hughes, Sir Robert Hunter, Mr. John Gavey, Mr. John Ardron, Mr. F. Edwards, M.P., Mr. John Munro, Mr. J. E. Kingsbury, Mr. James Taylor, Mr. M. Binswanger, Mr. J. T. Crowe, Mr. George Sutton, and many other gentlemen well known in electrical circles. Mr. W. H. Preece, Mr. J. C. Lamb, Mr. J. Staats Forbes (President of the Company), and Mr. Albert Anos (the Secretary) were absent through illness. In the absence of the President, Mr. W. E. L. Gaine, the general manager, occupied the chair, and was supported by Lord Balfour of Burleigh (Vice-President), Sir A. K. Rollit, M.P., Mr. W. A. Smith, Mr. G. H. Robertson, Mr. C. S. Agnew, Mr. Dane Sinclair, Mr. A. Calder, Mr. C. J. Phillips, Mr. P. P. Kipping, Mr. T. Fletcher, Mr. C. B. Clay, Mr. A. E. Cotterell, Mr. J. Macfee, Mr. C. Moorhouse, and a large number of other members of the staff, both London and provincial.

After the usual loyal toasts, and during the Chairman's toast of "The National Telephone Company," an opportunity was given to the members of the Press to listen to a brief speech by telephone from Mr. Forbes, who was at Folkestone recruiting his health. Mr. FORBES pointed out that the National Telephone service might in some sense be considered a part of the national service of the country, and that, therefore, a high standard of conduct was expected of the staff, and he was pleased to feel that these expectations had been fully met in the past. He asked for special appreciation of the arduous services of the lady members of the staff, who were more directly in contact with the telephoning public than were those whose names were more intimately associated with telephone work.—Mr. Forbes's remarks were conveyed to the gathering by the Chairman, and met with hearty applause, which was heard and acknowledged by Mr. Forbes.

The toast of "The National Telephone Company" was given by the CHAIRMAN, who, in the course of his remarks, referred to the development that had taken place during the past few years in exchange work. With regard to monopoly, the essence of the telephone service was a monopoly, and, whether owned by the State or by a company like the National, a monopoly it must remain. It might fairly be termed, even now, a State monopoly, from the fact that the National Company were licensees of the State under Act of Parliament.

Lord BALFOUR, in reply to the toast, referred to an experiment in which he was a participator on the previous day. Many of those present were aware that the Post Office had recently completed a large part of the important trunk line between Glasgow and some of the southern towns which would shortly be completed to London. By permission of the Post Office, he had with Mr. Gaine had an opportunity of speaking along this line, which had been connected to his residence in Scotland, and he (Lord Balfour) had had the pleasure of carrying on a conversation with Lady Balfour, who was at present in Scotland. Lady Balfour and himself were, therefore, the first two persons who had ever conversed between London and Scotland by the telephone, a distance of about 450 miles, and he was able to hear Lady Balfour's voice as clearly and as perfectly as he would have heard it had he been present in the same room. He referred with pleasure to the presence of many of the leading men of the Post Office, and thanked them for that proof of their good feeling towards the staff of the National Company. The closer the two bodies were drawn together the better, he felt, for the public service. Those who were responsible for the management of the National Company were glad that a Committee of the House of Commons had been appointed to inquire into telephone matters. There was a great deal of misconception as to the position of the Company and the service which it gave, and he hoped and believed that the inquiry now about to be entered upon would result in removing a great many of these misconceptions, and in instructing the public upon a subject upon which he thought they needed information.

Mr. DANE SINCLAIR, the chief engineer to the Company, proposed the toast of "Telephony." Naturally most of those present were interested in the application of the telephone service to practical work, and the first question likely to be present to their minds was, "Was there anything new in telephony ?" There was not much new, but there was something : and since their meeting last year there was one point which, although not scientifically new, had been brought newly into practice. He referred to the introduction of what is known as duplex telephony, by which a double conversation could be held in opposite directions on the same wire without the confidences of those who took part in the conversation being mingled.

Lord KELVIN, responding to the toast of "Telephony," said that Mr. Sinclair's remarks regarding the telephone called to his memory the Centennial Exhibition of Philadelphia in the year 1876 when Graham Bell first spoke to him on the subject of the telephone. The question, "To be or not to be," was the question for the telephone in those days, and these words Mr. Bell spoke through the telephone to the late Emperor of Brazil, who was present on the occasion, and it took only a few years to answer that the telephone was "To be." He (Lord Kelvin) had had the great privilege, in connection with the origin of telephony, to be charged by Graham Bell to bring all the points of the telephone to this country, and to speak regarding them at the meeting of the British Association at Glasgow in 1876. What he had to say was thought to be a wild dream of the scientific imagination, and the public could not realise it; but a very few years had passed when Graham Bell, himself perfecting his invention, with the assistance of Edison and with the assistance of their friend who was there to-night, Prof. Hughes, began to do wonders, until now in this, the nineteenth year of its existence, they heard of social conversation taking place over telephone lines between the south and the north. The telephone had been worked out by a national company of the United Kingdom, and it was only such a Company who would do this kind of work, whether you call it a monopoly or no. The time for district telephone companies was passed, and the work of a telephone was a monopoly whether in the hands of a Company or of the State. Mr. Sinclair, the able head of the scientific department of the Company, and his assistants had helped to bring about the united action which had made the National Company what it had now become. Lord Kelvin regretted that Mr. Preece, who had done so much for long-distance telegraphy, was not able to be with them to-night. Duplex telephony, of which Mr. Sinclair had spoken, was a very young and most beautiful result of the working of the telephone, and the Company were to be congratulated that four people could now carry on a quartette of two duets along telephone wires, one speaker and one hearer being in Glasgow, and one speaker and one hearer in Birmingham.

Sir ROBERT HUNTER, who replied to the toast of "The Post Office," referred to the immense work carried out by that department. He much regretted the absence of Mr. Preece and of Mr. Lamb through ill health, but he was pleased to be able to refer to the pleasant relations which existed between the officials of the National Company and those of the Post Office. Whoever in the future had the management of the telephones, they would have to supply what was fast becoming an absolute necessity of civilised life.

Sir ALBERT ROLLIT delivered a powerful speech in support of the action of the directorate, and claimed for the National Company that it had done all that it was possible to do under prevailing conditions. He regretted the absence of their President, who was the man of all others to place the Company's policy in its right light before the public. They had heard of multiplex telegraphy, but this evening they had heard something of duplex telephony, which was, he believed, destined in the near future to prove a great advantage to the telephone service.

The toast of "Our Guests" was received with cordiality, and the remarks of Prof. HUGHES in response, which form an interesting retrospect, will be found in another part of this issue.

The gathering proved a most successful one.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

February 22, 1895.

3,809. J. B. Torres. London. Improvements in electric and galvanic batteries and accumulators.

3,812. M. H. Goldstone and J. H. Ward. Manchester. Improvements in electrical switches or circuit closers.

3,821. J. Finlayson. Glasgow. A new form of alternating current dynamo electric generator.

3,864. E. A. Sperry. London. Improvements in power gearing and current-controlling apparatus for electric cars. [Date applied for under Patents, &c., Act, 1883, Sec. 103, July 24, 1894, being date of application in United States.]*

3,866. R. W. H. Newington and R. Hewlett. London. Improvements in electrical switches.

3,874. A. L. Fyfe. London. Improvements in adjustable electric lights.

February 23, 1895.

3,903. H. D. Fitzpatrick. Glasgow. An improvement in electrical conductors. (The Electric Bell and Resistance Company, United States.)*

3,954. S. Berditschewsky (called Apostoloff) and M. Freudenberg. London. Improvements in and relating to telephone systems.

February 25, 1895.

4,019. S. M. Eardley-Wilmot, W. T. W. Thackeray, S. Hoare, and K. R. Mackenzie. London. An improvement in electric apparatus for engine-room signalling and like purposes.*

February 26, 1895.

4,065. S. Z. de Ferranti. London. Improvements in electric tramways and apparatus connected therewith.

4,085. W. W. Martin. Kidderminster. A device for switching off the current from an incandescent electric lamp by a movement of the lamp itself, without its removal from the holder.

4,106. A. E. Jones. Princes End. Dynamo-electric generators and motors.*

4,111. G. F. Chutter. Birmingham. Improvements in electric insulators.

4,119. C. Méray-Horvath. Manchester. Improvements in electric contact strips.*

4,120. J. Emory Meek. Glasgow. Electric heaters for applying artificial heat to the human body, and also for the purpose of artificially heating apartments, cars, furniture, and such like.*

4,153. J. Y. Johnson. London. Method of, and apparatus for, insulating electrical conductors. (L. W. Downes, United States.)*

4,160. H. H. Lake. London. Improvements in electric transformers or converters. (Thomson Electric Welding Company, United States.)*

February 27, 1895.

4,182. D. Urquhart and F. Wynne. Westminster. Improvements in electrical furnaces, and in regulating and working the same.

4,215. H. Herberts. London. Improvements in electricity meters.

4,245. G. Laura. London. Improvements in electrical galvanic batteries.*

4,255. G. Laura. London. A rheotome, or novel apparatus whereby a battery of great internal resistance is rendered capable of generating an induction current in coils of low internal resistance.*

4,257. W. P. Thompson. Liverpool. Improvements in, or connected with, electric arc lamps. (W. A. R. Mathieson, Germany.)*

4,260. A. Custodis. London. Improvements in electric apparatus for indicating or recording at a distance the position or motion of a primary mechanism.*

February 28, 1895.

4,303. Hugo Nöhmer. Berlin. Electric signalling arrangement for locks and the like.

4,323. W. C. Johnson. London. Improvements in cases for accumulator batteries.

4,330. J. Y. Johnson. London. Improvements in electric arc lamps. (Suddeutscher Rödrendampfkesselbau Simonis and Lang, Germany.)*

4,352. L. B. Atkinson. London. Improvements in dynamo-electric machines and motors.

4,357. R. Berglund. London. An improved electrical apparatus for reproducing images of distant objects.*

March 2, 1895.

4,458. F. A. Langen. Newcastle-on-Tyne. Improvements in or relating to apparatus for electrically steering ships.*

4,466. E. J. Paterson and C. W. Hill. London. An improved arrangement of lenses for search-light projectors.

4,490. S. Z. de Ferranti. London. Improvements in dynamo-electrical machines.

4,497. O. von Morstein. London. Automatic current permutating device for electro-magnets.*

4,525. H. H. Lake. London. Improvements in electrically operated stringed musical instruments. (W. S. Reed, United States.)

March 9, 1895.

16,156A B. Lebrun. London. Improvements in electric locomotives chiefly designed for use in mines. [Date claimed under Patents Rule 19, August 24, 1894.]

March 4, 1895.

4,551. E. A. Claremont. Manchester. Electrical cut-outs.*

4,557. L. C. Pressley. London. Conduit electric railway.*

4,565. W. C. Morton and E. Franklin. London. Improvements in the construction of fences, and the apparatus for straining and tightening the same, and the posts and pillars for the same, which improvements are also applicable to all hauling, straining, and tightening purposes, and to telegraph, signal, and similar poles or posts.

4,576. A. H. Brintnell. London. Improvements in electric motors.

4,577. W. Ackroyd and W. Best. London. Improvements in or connected with apparatus for electrically lighting miners' safety lamps.

4,593. H. W. Cobb. London. The pen's electric illuminator.

4,610. W. A. Boese. Liverpool. Improvements in or relating to secondary batteries or electric accumulators.*

March 5, 1895.

4,623. G. W. Davey. Bristol. Electrical method of closing the air-exhaust apertures of hermetically-sealed canisters and like vessels.

4,658. C. Houlgrave. Leeds. Improvements in demagnetising apparatus.*

4,660. A. Hiorns. London. Improvements relating to the electro-deposition of iron on copper or other metallic surfaces.

4,670. O. von Morstein. London. Improvements in electric apparatus for igniting and extinguishing gas jets simultaneously from a distance.*

4,672. H. H. Lake. London. Improvements in telephone and telegraph systems. (C. A. Shea and F. F. Raymond, United States.)

4,685. F. H. L. Blanken. London. Improvements in commutator brushes.

4,697. G. A. Lyncker and A. Schropp. London. Improved electric signalling apparatus for railways.*

March 6, 1895.

4,716. H. J. Heinge. London. Improvements in and relating to phonographs and similar sound-recording and sound-reproducing instruments.

4,770. E. H. P. Humphreys. London. Improvements in apparatus for measuring electricity.

March 7, 1895.

4,851. W. Cole. London. Automatic replacement fuse for electric lighting.

4,873. I. P. Wiggins and G. H. Wiggins. London. Improvements in connection with electrical insulating materials.*

March 8, 1895.

4,939. E. Androli. London. Indirect electrolysis.*

4,941. R. J. Dale. London. Improvements in pushes for electric bells.

4,979. H. W. Young. London. Improvements in wall plugs for electrical connections.

4,980. L. B. Atkinson. London. Improvements in dynamo-electric machines and motors.

4,987. J. J. Rathbone and The "Harp" Arc Lamp Syndicate (Ltd.). London. Improvements connected with arc lamps.

March 9, 1895.

5,003. S. Z. de Ferranti. London. Improvements in electric condensers.

5,004. H. Dickinson. Leeds. Improvements in apparatus for regulating and controlling electrical circuits.

5,031. F. J. Yeatman. Reading. Improvements in electricity meters.

5,041. Siemens Bros. and Co. (Limited) and G. S. Grimston. London. Electric steering gear.

5,053. R. J. Rae. London. Improvements in or applicable to electric arc lamps.

5,059. A. Oblasser and C. Théryc. London. Improvements in and relating to electric accumulators.

March 11. 1895.

5,069. J. M. Bradford. Maine, U.S.A. Method of and apparatus for regulating circuits.

5,086. H. S. Cowx. Manchester. Improved means for connecting the branch wires of an electric lamp to the main conductors, or for other similar purposes.

5,099. F. M. Kass. Glasgow. An improved electric gas-lighter.*

5,131. W. B. Robeson. London. Improvements in and relating to telephone apparatus.

5,137. S. Z. de Ferranti. London. Improvements in the construction and working of electrical transformers.

March 12, 1895.

5,189. T. Tomlinson. Bray. Improvement in telephone communication.

5,196. H. B. Cox. London. Improvements in thermo-electric generators.*

5,199. C. Jackson. London. Improvements in telephone transmitters and telephone receivers.

5,205. C. Luckow. Cologne. Process for the production of electrode plates for electric collectors.*

5,231. F. G. Baily. London. Improvements in or relating to the automatic regulation of the current-carrying capacity of fuses for electric currents.

5,236. H. W. Ravenshaw, and Easton, Anderson and Goolden (Ltd.). London. Improvements in apparatus for starting electric motors.

5,254. A. Imschenetzky. London. Manufacture of fireproof and insulating compounds.

5,260. C. J. Reed. London. Improvements in mechanism for forming battery plates. [Date applied for under Patents, &c., Act, 1883. Sec. 103. September 12, 1894, being date of application in United States.]*

March 13, 1895.

5,309. W. Taylor. Enfield. Electric alarm for clocks.

5,313. C. W. S. Crawley and A. Soames. London. Improvements in ohmmeters and other electrical measuring instruments.*

5,326. W. Carter and The Hydraulic Engineering Company (Limited). London. An electrical safety stop for hydraulic motors.*

5,331. J. Devonshire. London. Improvements in recording wattmeters. (W. C. Fish, United States.)*

5,336. A. B. Blackburn and T. L. Coyden. London. Improvements in armatures of dynamo-electric machines.

March 14, 1895.

5,385. M. Kotyra. London. Improvements in telephony and telephonic apparatus.

5,392. The Birmingham Small Arms and Metal Company (Limited) and W. H. Greenwood. London. Improvements in treating metallic tape used in the manufacture of submarine electric telegraph cables and for other purposes.

5,410. J. A. Kingdon. London. Improvements in or relating to the means of protecting electrical conductors, water-pipes, and the like.

5,428. F. N. Denison. London. Electrical transmitting thermometer.*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1893.

21,714. Williams. Electrical exchange systems, &c.

22,053. Doubleday (Sussmann). Secondary batteries.

1894.

3,469. Pöschmann and Hanisch. Dynamo-electric, &c., machines.

5,508. Muirhead. Transmitting signals through submarine cables.

6,057. Edmunds. Electrical conductors.

6,721. National Telephone Company (Limited) and Eggar. Signalling between police stations, and call-boxes.

7,080. Oulton. Phonographs.

7,155. Higgins. Electric cut-out.

7,165. Clubbe and Southey. Secondary batteries.

7.240. Bersey. Electrically-propelled vehicles.

7,801. Kellner. Electrolytical apparatus.

7,955. Thomson. Electric measuring instruments.

7,994. De Pass (Thofehrn). Electrolytic cell.

8,813. Siemens Bros. and Co. (Limited), and Dieselhorst. Electric conductors.

11,069. Muirhead. Submarine telegraph cables.

23,970. A. and J. M. Anderson. Electric conductors.

24,625. Orcutt. Electric safety appliance for railroads.

1895.

545. Dorman and Smith. Electrical switches.

1,000. Dulany and Shaw. Electric railways.

1,088. Siemens Bros. and Co. (Limited) and Hird. Electric fuses.

1,164. Damaskinos. Telegraph apparatus.

1,544. Lewis. Electrical conductors.

COMPANIES' MEETINGS AND REPORTS.

Scarborough Electric Supply Company (Limited).

The annual meeting of this Company was held on Tuesday at the Grand Hotel, Scarborough. Mr. George Alderson-Smith presided.

In moving the adoption of the report, the CHAIRMAN said the report was an extremely satisfactory one, considering that it contained an account of their first year's working. During the first six months of the year they lost month by month, but during the last six they had not only cancelled that loss, but a profit had been left, as shown on the balance-sheet. Looking at the capital expenditure for the past year, there had been an increase of £5,385. In the revenue account the rent of meters was only £60, whereas the cost had been £960; but many of these meters did not come into use until the last quarter of the year, and, consequently, the rent from them in the coming year would be materially increased. They charged very low rates for their meters—far too low in the opinion of some people—but as he believed the gas company were not going to make any charge in the future, it was very desirable that they should put their charge as low as possible. The Directors recommended that the balance should be carried forward. Depreciation had not been dealt with—the proper time to do so would be before they declared a dividend. It was advisable, in view of probable extension, to seek new capital, and he had no doubt this could easily be obtained.

In reply to several shareholders, Mr. A. A. CAMPBELL SWINTON said it was desirable that they should make the price per unit as low as was compatible with a profit. In most towns the charges were 7d. and 8d. per unit, but at the present time the charges at Scarborough were 6½d., 6¼d., 6d., and 5¾d. per unit, according to the quantity consumed, and 5 per cent. was allowed for cash. These prices were lower than those charged by any other company of the same size. There were 79 shareholders in the Company.

The report and balance-sheet were adopted, and after the re-election of Directors and auditor, the proceedings closed with a vote of thanks to the Chairman.

Eastbourne Electric Light Company (Limited).

The following report of the Directors of this Company is issued. The general meeting takes place at the Gildredge Hotel, Eastbourne, on Monday, the 25th inst., at three o'clock:

The Directors congratulate the shareholders upon the extremely satisfactory progress of the Company. At the close of 1894 the number of lamps in circuit was—arcs 35, and incandescents (equivalent to 8 c.p.) 12,056, being an increase for the year of 8 arc and 2,179 incandescents. The number of units supplied during the year was 147,348. The gross earnings for the year amounted to £5,910. 10s. 9d., and the expenditure (including £400 carried to the depreciation fund account) to £3,337. 0s. 9d.—giving a gross profit upon the actual working of the Company of £2,573. 10s. After adding £295. 13s. 8d. from last year's profits, and providing for all mortgage and debenture interest, a balance of £1,540. 11s. 4d. remains, out of which the Directors propose to set apart a sum of £300 to form the nucleus of a reserve fund for meeting any contingency which may arise, which may also be applied in part from time to time to the reduction of the debenture issue. This leaves £1,240. 11s. 4d., and the Directors propose that a dividend at the rate of £7. 10s. per cent. per annum, free of income-tax, absorbing £798. 15s., be declared upon the share capital of the Company, the balance of £441. 16s. 4d. to be carried forward. The depreciation fund account now stands at £1,825.

Since the last annual meeting the Company's circuits have been extended to Upperton, the capital for which extension was provided by the issue of debentures, all of which were privately subscribed. The Company's machinery, circuits and mains are in excellent condition.

Mr. James Arthur Skinner offers himself for re-election as Director, as do Messrs. Hart Brothers, Tibbetts and Co., the auditors.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1895, pages *304-332, &c. &c.*]

L. ALWYN (LIMITED).—The annual return of this Company, made up to December 27th, has been filed. Out of a nominal capital of £2,000 in £1 shares, 1,514 have been taken up, and 500 of these are considered as fully paid. The full amount has been called and paid on the remaining 1,014 shares. . Luis Alwyn, electrical engineer, holds 1,506 shares.

ELECTROPHONE (LIMITED).—An agreement dated February 18th, between Charles J. Abud, George H. Ashton, Harry A. Freeman, Neville E. Maltass, Henry E. Barnes and Harold S. J. Booth (the vendors) and the Company provides for the sale to the Company of the business of the Electrophone Syndicate, carried on at Pelican House, Gerrard-street, London, W., including letters patent No. 13,057 (1890) for "an apparatus for giving temporary use of telephones in exchange for coin," patent No. 11,817 (1893) for "improvement in the means of distributing telephonic currents to the atrophones and other similar apparatus," and patent No. 5,528 (1892) for "improvements in coin-freed telephonic apparatus," in consideration of £14,800, payable £11,550 by the allotment as fully paid to Harold S. J. Booth or his nominees of 2,310 Ordinary shares of £5 each, Nos. 1,641 to 3,450 inclusive, and £3,250 by the payment of that sum in cash. 500 fully-paid shares have been previously allotted. The sale includes several agreements for the erection of the Company's apparatus in the Lyric, Grand, Criterion, Olympic, Empire, Alhambra, Royal, Gaiety, Prince of Wales, Trafalgar-square, and other theatres, St. Margaret's Church, Westminster, and several leading hotels.

ELMORE'S PATENT COPPER DEPOSITING COMPANY (LIMITED).—The annual return of this Company, made up to January 11th, has been filed. The nominal capital is £200,000, divided into 91,195 Ordinary and 8,805 Preference shares of £2 each, and all the former and 8,560 of the latter have been issued. The full amount has been considered as fully paid on 23,300 Ordinary shares. £152,910 has been received in respect of calls; 15 Ordinary shares, with £7. 10s. paid, have been forfeited.

ELMORE'S WIRE MANUFACTURING COMPANY (LIMITED).—The annual return of this Company, made up to January 11th, has been filed. The nominal capital is £300,020, divided into 133,500 Ordinary, 16,500 Preference and 10 Founders' shares, all of £2 each. Of these, 67,278 Ordinary, 15,000 Preference and 10 Founders' shares have been subscribed for and allotted, and the full amount per share called; 1,610 Ordinary shares have been forfeited, and £565 has been paid in respect thereof.

INCANDESCENT ELECTRIC LAMP COMPANY (LIMITED).—The annual return of this Company, made up to December 17th, has been filed. The nominal capital is £25,000, divided into 2,000 Ordinary, and 500 Deferred shares of £10 each; 1,200 Ordinary and 100 Deferred shares have been taken up, and the latter have been issued as fully paid. Calls amounting to £8. 10s. per share, have been made on the Ordinary shares, resulting in the payment of £10,140.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return of this undertaking, made up to March 1st, has been filed. The nominal capital is £350,000, divided into 50,000 Ordinary, 10,000 First Preference, and 10,000 Second Preference shares of £5 each. 15,000 Ordinary, all the First Preference, and 2,460 of the Second Preference, have been taken up, and 5,000 of the Ordinary shares have been issued as fully paid. The full amount has been called on the remainder, resulting in the total payment of £112,300.

SHEFFIELD ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—A further call of £1 per share has been made on the new issue of shares in this Company, payable on or before April 8th. This will make £2 paid on the £7 shares.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LIMITED).—The annual return of this Corporation, made up to March 6th, has been filed. Out of a nominal capital of £400,000 in £5 shares, 68,000 have been subscribed for and allotted. The full amount per share has been called on 60,000, and a call of £2 has been made on each of the remainder. The calls paid have realised £315,986.

CITY NOTES.

BIRMINGHAM CENTRAL TRAMWAYS COMPANY (LIMITED).—An order has been made by Mr. Justice Stirling confirming the special resolution recently approved by the shareholders of this Company for the reduction of its capital to £300,000.

BRITISH INSULATED WIRE COMPANY (LIMITED).—The ordinary general meeting of this Company was held at the offices of the Company, Prescot, on March 13th, Mr. W. Marriner Brigg presiding. The Directors, in their fourth annual report and balance-sheet, stated that the amount of the net profit, including the balance of £363. 14s. 4d. from last year, was £5,751. 2s. 9d., after writing off £3,500, balance of formation expenses, and making a liberal allowance for depreciation of buildings, machinery, patents, &c. Out of this sum the Directors recommended a dividend of 7 per cent. on the Ordinary shares, absorbing £5,067. 12s. 8d. (a dividend of 7 per cent. on the Preference shares having already been paid to December 31st last), leaving a balance of £683. 10s. 1d. to be carried forward to next year.—The Chairman said that during the year the turnover of the Company had more than doubled, and the Company now numbers amongst its customers a large proportion of the principal cities and towns, and some of the chief railway companies in the kingdom. The report was adopted, and Mr. T. Snape, M.P., was elected a Director.

BRUSSELS TRAMWAYS COMPANY (LIMITED).—The report of the Directors of this Company for 1894 states that the adoption of electric traction on several of their lines has met with the approval of the public, and that the results obtained are encouraging, and have induced the Company to consider the question of adopting electric traction on other lines.

CHELSEA ELECTRICITY SUPPLY COMPANY (LIMITED).—Letters of allotment and regret in the recent issue of 4½ per cent. debenture stock of this Company have been posted. It is stated that the applications were largely in excess of the amount available for allotment.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this railway for the week ended March 17th were £912, as against £926 in the corresponding period of 1894, being a decrease of £14. The total receipts for the half-year were £10,823, against £10,400 for the corresponding period of 1894, an increase of £423.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have decided to recommend the payment of dividends at the rate of 10 per cent. per annum on the Preference shares, and at the rate 4 per cent. per annum (free of income tax) on the Ordinary shares, for the half-year ended December 31st last.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announce the payment on April 11th next of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum, on the Preference shares of the Company for the quarter ending March 31st, and the usual interim dividend of 2s. 6d. per share on the Ordinary shares (free of income tax) in respect of profits for the quarter ended December 31st last. The register of transfers will be closed from April 4th to 11th inclusive.

ELECTRICAL ENTERPRISE IN GERMANY.—A Company has been formed at Dresden with a capital of £100,000 to be called the Actien-Gesellschaft für Electrische Anlagen und Bahnen. The new Company, in which Messrs. Kummer and Co., of Dresden, are largely interested, has been formed with the object of acquiring, financing, and operating electric lighting stations and electric tramways.

GANZ AND CO. (BUDAPEST).—The report of the managers of this Company of the past year states that, although the value of the total production of the works during the year increased, yet there was a falling off in the profit made as compared with 1893. It is proposed to pay the same dividend of 85 florins per share. The proposal to convert the electrical engineering branch of the business into a separate company appears to have been dropped, at least for the present.

GREAT NORTHERN TELEGRAPH COMPANY.—The ordinary general meeting of this Company will be held in Copenhagen on Saturday, April 20th, at 3 p.m., at the Exchange. The Directors' report and statement of accounts will be presented. From April 6th the accounts will be open to the inspection of the shareholders, at the Company's offices.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended the 17th inst. amounted to £975. The amount in the corresponding week last year was £707.

ROYAL ELECTRIC COMPANY OF MONTREAL.—Coupons of the Four and a-Half per Cent. Debenture Loan of £120,000 in this Company, due April 1st, will be paid by the Bank of Montreal, Abchurch-lane, London.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a special settling day for the 10,000 Ordinary and 10,000 Preference shares of the County of London and Brush Provincial Electric Lighting Company (Limited), and for the quotation in the Official List of the 30,000 Ordinary and 10,000 Preference shares.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended March 15th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,605.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the two weeks ended March 15th were £3,092, as compared with £2,827 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Mar. 13.		Price Wednesday, Mar. 20.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Mar. 20.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£1,012,880	Stock	14 0	Anglo-American	41	42	41½	42½	4 14 2	Jan., Apr , July, Oct.	..	..
£2,993,560	Stock	28 0	Do. Preferred	78	79	78½	79½	5 0 8	" "	79½	77¼
£2,993,560	Stock	6/0	Do. Deferred	6	6½	6¼	6¾	..	..	6¾	6 1/16
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 17 8	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	12¼	12¾	12¼	12¾	5 2 0	Mar., June, Oct., Dec.	12½	12⅜
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	109	113	109	113	4 9 6	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock xd	148	152	148	152	4 12 1	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	13⅝	13½
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	20½	..
12,931	5	1/8	Direct Spanish (fully paid)	4	4½	4	4½	4 8 11	April and October –	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9½	10	9½	10	5 0 0	" "	..	–
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8½	9	8½	9	5 0 0	Jan., Apr., July, Oct.	8½	8¾
400,000	10	2/6	Eastern	16¼	16½	16½	16¾	3 18 9	" "	16 7/16	16⅛
70,000	10	6%	Do. 6 per Cent. Preference	17½	18	17¼	17¾	3 7 7	" "	17⅜	17 5/16
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	124	127	124	127	3 3 0	May and November	125¼	–
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	108	105	108	4 13 0	February & August	..	..
250,000	10	2/6	Eastern Extension	17⅛	17⅜	17⅛	17⅜	4 0 8	Jan., Apr., July, Oct.	17⅜	17¼
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	123	126	123	126	3 3 6	February & August	125¼	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	107	103	107	4 14 4	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	103	107	4 14 4	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106	109	106	109	3 13 7	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 4	May and November	..	..
180,227	10	1/0	Globe Telegraph and Trust	9¾	10	9¾	10⅛	4 8 1	Jan., Apr., July, Oct.	10 1/16	9¾
180,042	10	6%	Do. 6 per Cent. Preference	16⅝	16⅞	16⅝	16⅞	3 11 3	" "	16⅞	16 11/16
150,000	10	5 0	Great Northern	21¾	22¼	21¾	22¼	3 16 7	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 13 6	March & September	106½	106¼
17,000	25	12 6	Indo-European	52	54	52	54	4 12 7	May and November	53	–
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	105	109	105	109	5 10 1	March & September	..	–
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	105	108	3 14 11	..	..	–
11,839	8	4/0	Reuter's	4	5	4	5	..	April and October	..	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	119	124	119	121	4 16 9	" "	123½	121
15,609	10	5/0	West African Telegraph	4	6	4	6	..	January and July	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	101	104	4 16 2	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	98	103	7 15 4	June and December	..	..
88,321	10	6d.	West India and Panama	⅜	1⅛	⅜	1⅛	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	6 6 8	May and November	11¼	11
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	" "	9⅝	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 11 1	June and December	..	..
64,242	15	3/0	Western and Brazilian	10	10½	10	10½	5 4 6	May and November	..	..
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	–	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	4	4½	4	4½	..	..	4⅜	4⅛
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 14 10	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 14 10	" "	..	–
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115	120	115	120	5 18 11	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	101	103	101	103	5 16 6	March & September	..	–
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	–	..	3⅛	..
224,850	10/0	2⅝d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
171,504	£1	..	Oriental Telephone and Electric (fully paid)	9/16	1⅛	9/16	1⅛	..	Yearly	–	..
484,597	5	2/6	National	5¼	5½	5¼	5½	4 10 11	June and December	5⅜	5 5/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	16	15	16	3 15 0	" "	16	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	15½	14½	15½	3 17 5	" "	15¼	15¼
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅜	5⅞	5⅜	5⅞	4 5 1	..	5⅝	5½
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	104	106	3 6 0	January and July –	105½	104½
58,000	5	1/0	United River Plate	1	2	1	2	..	" "	..	–
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	85	90	85	90	5 9 11	" "	..	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	13	14	13	14	1 15 8	–	13⅞	13⅜
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15	15½	15	15½	3 17 5	..	15⅝	15½
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 0	June and December	134	133⅞
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	..	..
£30,000	£5	2 6	Charing Cross and Strand Electricity Supply Corp.	5	6½	5	6½	3 17 9	–	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	..	–
8,322	£5	..	House-to-House Electric	..		..		..	–	..	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		–	–	..	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		–	January and July –	–	–
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7½	7⅝	7⅜	7⅝	–	–	..	–
111,000	5	..	London Electric Supply	..		..		–	–	..	–
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	10½	11	10½	10⅞	2 6 0	..	10⅞	10 9/16
£150,000	Stock	4½%	* Do. 4½% Debs.	118	120	118	120	3 15 11	June and December	118½	–
6,452	£10	2 0	Notting Hill Electric	7¼	7¾	7¼	7¾	..	..	..	..
19,980	£5	4 6	St. James and Pall Mall	7½	8	7½	8	..	..	7 11/16	7 9/16
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8½	9	3 17 9	–	8⅝	..
59,900	5	5%	Westminster Electric Supply (fully paid)	7⅜	7⅞	7⅜	7⅞	3 3 6	–	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅜	2⅝	2¼	2⅝	6 0 7	–	2½	..
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2⅛	2⅜	5 1 1	–	2⅝	2⅜
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	113	116	113	116	3 17 7	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref	3	3½	2¾	3¼	–	January and July –	..	..
12,139	5	..	Edison and Swan United	–		1⅜	1⅞	–	–	–	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	–		–		–	–	–	..
120,000	2	..	Electric Construction	¼	¾	¼	¾	..	–	–	..
12,845	2	2 9⅜	Do. 7 per Cent Cumulative Pref.	1⅛	1⅜	1⅛	1⅜	–	–	..	–
91,195	2	10/0	Elmore's Patent Copper Depositing	1⅛	1⅜	1⅛	1⅜	–	–	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	¾	1¼	¾	1¼	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	22½	23½	22	23	4 6 11	February & August	22¾	..
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	103	105	103	105	4 7 7	March & September	..	–
15,995	£10	..	International Okonite Ordinary	..		..		–	–	..	–
16,000	£10	..	Do. 8 per Cent. Preference	–		–		–	December and June	..	–
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	–	¾	–	¾	–	..	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	39	41	39	41	8 15 7	March and July	41	40
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 14 1	January and July –	103½	..
37,514	£5	–	Woodhouse and Rawson Ordinary (£3 15s. paid)	–		–		..	–	..	..
41,098	£5	..	Do. Preference (fully paid)	–		–		..	–	..	..
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	10	11	10	11	4 10 11	–	..	..
£30,000	10	..	Do. Preference	..		..		..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1¼%	City and South London Railway	45	47	45	47	2 13 2	May and November	45	..
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	–	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	130	133	130	133	3 0 2	May and November	..	..
37,500	£10	2%	Liverpool Overhead Railway	8¼	8⅝	8¼	8⅝	2 0 4	..	–	..
0,296	10	5%	Do. 5% Preference	13½	14	13½	14	3 11 5	..	–	–
125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July ..	–	–

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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NOTES.

The first evidence tendered before the Telephone Committee was that of Mr. J. C. Lamb. The violent oscillations of policy experienced by the Post Office are at once evidence of the desire of that Department to put the best face it could on the bad business brought about by the arrival on the scene of that pestilent little infant prodigy of Graham Bell's, and of the inability of the Department to decide what was the best face to put on. In 1881 the order of the day was "one licensee one town." In 1881 it was "the whole country to every licensee." In 1892 it became "one country one company," with a benevolent Post Office presiding to see fair play. The only question now of interest to the public is, What will be the policy in the year of grace 1912?

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On another page will be found Major Cardew's Report on the Southwark Bridge explosion of February 1st. As to the *fons et origo malorum*, the Inspector "can confidently assert" that it had no connection with the electric light. He is inclined to accept the dropped-match hypothesis, but nevertheless puts forward one of his own, to wit, "a spark struck by a horse's foot or a wheel close to the gulley grating, out of which the gas was issuing freely." In Major Cardew's opinion the Southwark Bridge accident gives more serious cause for anxiety than that which occurred a little while previously in Cannon-street, owing to the proof it afforded of the great distance a series of explosions may travel, and the object lesson it gave of the insufficiency of any ordinary system of ventilation, unless it be accompanied by measures tending to render the boxes and conduits gas-tight. As the Inspector pertinently points out, the very thorough ventilation of the culvert did not prevent it from being the *locus* of a serious explosion when once gas found free access to it. The Report concludes with a reiteration of the recommendations made in connection with the Cannon-street explosion, plus a more or less new one.

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The City of London Electric Lighting Company is somewhat severely rated for having done very little in the direction of carrying out these recommendations; but its reluctance to adopt the Inspector's remedies wholesale is, it would seem, amply justified. The experience he gained by the Southwark Bridge mishap causes the Inspector "to put the filling up of the boxes first, as the most simple and certain method of preventing danger of explosion," to insist on thorough plugging of the pipes at each street box, and to relegate mere ventilation to a very distant realm. If a radical alteration of policy is to be brought about by every fresh explosion, a company may well be excused from expending in hot haste its shareholders' money the very moment a new Board of Trade ukase is issued. Had the City Company hurriedly carried out the Inspector's recommendations about thorough ventilation contained in his Cannon-street Report, would the Board of Trade have provided the money for abolishing the ventilators and buying the "incombustible material" now ordered? The fact is we are all, the Board of Trade included, daily gaining experience, and under the circumstances it is too much to expect a big company to commit itself hastily to an expensive remedial policy, be the urgency "for doing something" what it may.

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In another column will be found a brief description of the latest development of Prof. Ewing's charming molecular magnet model. When the Ewing theory was first given to the world at the Leeds meeting of the British Association, it was shrewdly objected by Mr. Swinburne that, if the theory were correct, a dynamo armature should exhibit very little, if any, hysteresis. Rarely has the captious critic better justified his existence. The theorists straightway set to work to experiment, and at the last meeting of the British Association at Oxford, Mr. F. G. Baily described some pretty experiments, proving the validity both of Mr. Swinburne's objection and the Ewing theory. And now, at a recent meeting of the Cavendish Physical Society, Prof. Ewing put a model, illustrating Mr. Baily's experiments, through its paces. But this is not all. The model shows that in a moderately strong magnetic field the magnet groupings break up exceedingly spasmodically, and consequently the turning effort required is equally spasmodically varied, and may, indeed, sometimes actually become temporarily negative. Now about two years ago Prof. Ewing and Mr. Wilberforce were engaged on some experiments with a view of determining the forces required to keep an iron cylinder slowly turning about its axis in a magnetic field, and were much disconcerted by the sudden and then inexplicable changes of resistance to motion. To complete the chain of evidence, we only want some figures as to the fields employed both by Mr. Baily and Prof. Ewing. When we talk of armature hysteresis disappearing in strong fields, it must be recollected that the field in many a dynamo armature is 20,000 strong.

An obliging scientific man arranges to die on Saturday or Sunday, thus allowing ample time for the preparation of his obituary for the technical journals; important scientific discoveries ought, on the other hand, to be announced on Wednesdays or Thursdays, in order that technical journals may be among the first to present an accurate account to the public. This we were able to do in the case of argon. Had the news of the discovery of helium in clevite not leaked out viâ Paris into the daily papers, much confusion would have been saved. Prof. Ramsay has been examining all possible sources of nitrogen to discover whether argon is found associated with it in any other case but that of the atmosphere. He turned his attention to a rare mineral called clevite, which was supposed to yield nitrogen. He announced on Wednesday last, at the anniversary meeting of the Chemical Society, that when clevite is treated with sulphuric acid a gas is given off, but it is not nitrogen. Spectroscopic examination shows a bright yellow band resembling that of sodium, but not resolvable and of a different wave length. The band has been definitely identified by Prof. Crookes with that of helium, a hitherto hypothetical element observed in the sun's corona, but never before handled by man. A trace of argon and nitrogen accompanied the helium, but until something more is known of its chemical properties it cannot be separated from argon. The news was telegraphed to the Académie des Sciences, and quickly came back to our daily papers. Whether the aurora borealis was confused in the telegram with the corona, or what grounds there are for supposing that helium is a constituent of argon, and, therefore, of the atmosphere, remains to be learned. We strongly suspect that journalistic "expansion" of the too brief message will be found to account for the long dissertations which have already appeared on the subject.

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One of the difficulties experienced in connection with the building up of "Harveyised" or other forms of case-hardened armour plates occurs in drilling and tapping holes. To form an effective resisting skin, the degree of carburising of the outer surface of the plate must be so great that cutting tools are unable to bore through it; and it is necessary to locally anneal or "let down" the plate in order that the drilling may be done. An electrical process for locally annealing armour plates for this purpose is described by Prof. Elihu Thomson in an article which we reprint this week. It consists in the heating and very gradual cooling of portions of the plate, by properly-directed electric currents passed through those parts where tools are required to be used. The apparatus is worked on the same principle and is constructed nearly in the same form as the well-known Thomson-Houston welding plant. The process has already been tried in the U.S. Navy, and appears to have given very satisfactory results. There can be no doubt about the suitability of the process, so far as rendering the plates easy to work goes; but it would be interesting to know if any experiments have been carried out to ascertain whether this local heating of armour-plate is or is not liable to develop permanent internal stresses and incipient faults which may subsequently give rise to fracture at the seams.

Magnetic Maps.—The Paris Geographical Society has awarded M. Moureaux a gold medal for his magnetic map of France.

"Labour-Saving" Apparatus as an Instrument of Education.—We regret that owing to illness Prof. Ayrton has been unable to contribute a final letter on this subject.

Northern Society of Electrical Engineers.—This Society, which was founded on December 20, 1893, with a membership of 80, now numbers 122 members and 3 associates.

The Force of Alliteration.—A writer in *Engineering*, discussing Tyndall's experiments on sensitive flames and jets, says that "not only special words, but every word, and every syllable of a stanza of Spenser, tumbles a really sensitive smoke-jet into confusion."

Newport.—It is stated that the tests of the small day-load plant at the Newport (Mon.) electric supply station have proved satisfactory. This plant comprises a semi-portable type of steam engine of 50 H.P., driving a small alternator by a belt, and is designed for about 800 lamps.

The St. Pancras Mains.—The statement which has been recently made, that in future the laying of bare copper strip in culverts would be discontinued in the St. Pancras district, and armoured cables and "naked wires in cast-iron pipes" substituted, is, we are informed, not correct.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
Martinique—Paramaribo	Feb. 21, 1895.	Mar. 21, 1895.
Latakia—Cyprus..................	Nov. 27, 1894.	—
Cadiz—Teneriffe..................	Feb. 23, 1895.	—
St. Louis—Noronha	Mar. 12, 1895.	—

Liquefaction of Hydrogen.—Our readers will be interested to learn that Prof. Olszewski, of Cracow, has succeeded in liquefying hydrogen. He finds that its critical point, as measured with a platinum resistance thermometer, is −233° C., and its boiling point at atmospheric pressure is −234° C.

Quite Fair.—An American contemporary states that recently a court in New York decided that money dropped upon the floor of a street car, although by falling between the slats of the wooden mat it had become entirely hidden, was a lawful tender of fare, which the conductor must not only accept, but supply the required change.

Lock-to-Lock Electrical Communication.—The *Engineer* states that a committee of the Thames Conservators have resolved to consider a suggestion that the locks of the Thames valley should be connected either by telephone or telegraph. The suggestion is, of course, chiefly designed to meet the need for promptly dealing with storm water.

American Power Station Burned Down.—The electric power house of the Chicago and North Shore Electric Railway, at Edgewater, has been burned down. The dynamos and most of the motor cars were destroyed. The offices of the Company were also located in the building. The loss is estimated at £30 000.

A Narrow Gauge Railway.—Sir George Newnes's scheme for constructing a railway, with a gauge of 2ft., between Lynton and Barnstaple, has been passed by a committee of the House of Lords, which threw out an alternative scheme, of which the principal supporter was Earl Fortescue, for constructing an ordinary gauge line from Filleigh to Lynton.

Search Lights for the English Channel.—The Guildhall Battery site and buildings, for many years occupied by the head-quarter staff of the South-Eastern District, is shortly to be vacated, and the staff offices removed to more convenient quarters. It is proposed to utilise the site for an electric light station to enable the Channel round about Dover to be under the observation of search lights.

Electricity in Mining.—The application of electricity to mining purposes continues (says Mr. Robson, the inspector for South Wales) to make steady progress, especially as a means of transmitting power, and there seems no reason to doubt that, with due care in the erection of plant and especially in the insulation of cables, electricity will afford a large measure of safety, while within certain limits its use will be found economical.

The Electric Lighting of Port Adelaide.—We learn from Australia that the proposal to light the Port Adelaide River by electricity, and to provide for "leading lights," seems likely to be realised. The river has recently been deepened, and the proposal to adopt electric lighting would enable vessels to navigate the river both night and day. It is stated that the Government has decided to carry out the scheme, and that instructions have been given for the preparation of the necessary specifications.

The Electric Motor in Post Office Work.—A writer in the *Electrical Engineer* of New York describes an interesting application of electric motors to Post Office work. At the Los Angeles Post Office a ¼-H.P. Crocker-Wheeler motor works the post-marking machine through which the letters delivered from the office are passed. The letters are post-marked at the rate of 600 per minute, and the contrast between the old hand work and that given by the motor is striking. Since June last 6,000,000 letters have gone through the machine.

The Indo-Chinese Line.—The Secretary of State for India received the following telegram from the Viceroy on the 21st inst.:—"Junction of Chinese and Burmese telegraph lines effected March 16th last, one and a-half months earlier than latest date fixed. This result due to successful efforts made by Telegraph Department to effect connection as quickly as possible, and to promptitude with which Chinese officers have responded to those efforts. We trust that establishment of telegraphic communication through India to China by this route will tend to promote friendly relations of Great Britain and China, and that it will prove of commercial advantage to both countries."

Electrical Power Transmission in Austria.—An electric power transmission plant has recently been put down at the Ziegler mine of the Blattnitz Stone Coal Company at Nürschau, near Pilsen, this being the first plant of the kind in the district. The plant, which has been put down by Messrs. Siemens and Halske, of Vienna, comprises a 120-H.P. engine, a large continuous-current dynamo for power transmission purposes, and a smaller one for lighting purposes. The electrical energy is conducted down the shaft, where it is made to operate two windlasses, the winding gear, a large ventilator, two portable pumps, a cable tramway about 500 metres long, and a large pumping engine.

Electrical Patents in the United States.—According to the tabulated statement included in the annual report of the United States Commissioner of Patents, there were 22,145 patents issued during 1894 that were classified by the department as electrical. In the opinion of the *Western Electrician*, "no better evidence could be desired of the growing importance of the electrical industry than this excellent showing in the report of the Patent Commissioner." In England, only some 1,200 electrical patents were *applied* for in 1894, so that, judged by the proposed patent office test, the electrical industry is 20 times as important a business in the United States as it is in England—an arithmetical deduction not likely to be admitted by anyone but an incurable statistician.

Argon.—M. Berthelot has communicated to the Académie des Sciences the fuller details which he promised concerning his experiments upon argon. The action of the silent discharge upon a mixture of argon and benzene vapour is, he states, accompanied by a feeble violet luminosity visible in the dark. In one experiment he found that a fluorescent substance was produced, which developed a magnificent greenish light and a peculiar spectrum. M. Berthelot has effected the combination of 83 per cent. of the argon under experiment. As to the products, he is able to say that they resemble those produced when nitrogen mixed with benzene is submitted to the silent discharge. That is to say, they consist of a yellow resinous matter condensed on the surface of the glass tubes employed.

The Cost of Storage Plant.—In the course of the discussion on one of the Papers at the recent Cleveland Convention, Mr. C. L. Edgar, of the Boston Illuminating Company, said that his Company had been operating for the past year one of the largest storage battery plants in the world. This battery, which was procured in Germany, is guaranteed for 10 years, and maintained in condition by the makers at 6 per cent. on the cost of the cells, which is about 4 per cent. on the cost of the installation. The Company is saving 10 per cent. on its coal bill through the employment of the storage battery, which cost about £10 per horse-power to put in, or only one-half as much per horse-power as the present steam plant. The battery is only in service during 1½ hours at each discharge, taking care of the maximum load. The total investment in the station, with half batteries and half steam, is only three-fourths of what it would be with all steam.

The "Empire" Economic Steam Producer.—Since the publication of the article on "Cheap Fuel" in our issue of March 1st, we have had an opportunity of judging more fully of the merits of the "Empire" Economic Steam Producer, to which reference was made in that article. We are able to confirm our former statement that this plant has been tried with success at several important works; indeed, we find that it has been at work at some of these places for many months. We are assured that there is no trouble in dealing with the clinker, but that the construction of the perforated grate is such that much of the heat of the clinker is imparted to the blast of air which is forced through the perforations. The draught is one of only moderate force, and it is so uniformly distributed over the grate that little or no dust is carried over into the flues.

Electric Power in Gem Cutting.—A writer in the *Electrical Engineer* of New York states that in Los Angeles, in a jewellery store, a 3-H.P. motor is used in the cutting of precious stones. The machine worked by the motor is a new invention, and is the only one of the kind in the country. In the old method of cutting, the stone was centred on the end of a stick or piece of brass, and held by the end on the grinding lap. In the electrically-driven machine the stone is held by a quadrant, which is adjusted by a set screw to its required position on the lap. As many as 60 stones can be cut at one time, and the method of adjustment is so accurate that in no case would there be the slightest possibility of overgrinding, even if an attendant were to leave the machine, to look after other duties. This enables the cutting to be done with certainty and minuteness. The quadrants are all indexed to cut any style of stone.

Useful Approximate Units.—In our leading article this week, two approximate electrical units are mentioned, and it may interest some of our readers to know how far these approximations differ from the truth. The ohm is uncommonly close to the resistance of a pure copper wire 10 mils in diameter and 10in. long. It is only about 0·54 per cent. greater than this; that is to say, if constructed of 99½ per cent. conductivity copper, the wire would be different from the legal ohm by only a negligible quantity. The temperature at which this holds true is 15·5°C. or 60°F. A volt is given in the leading article as being approximately equal to seven-tenths of the electromotive force of a standard Clark cell. This is not so near the mark as the approximate ohm, being as much as about 1·9 per cent. too large. In this connection it may be interesting to know that 687 standard cells will give closely 1,000 volts.

Gas Engines in the United Kingdom.—In a recent article in the *Safety Valve*, Mr. Dugald Clerk estimates that in the United Kingdom alone upwards of 20,000 engines of the compression type are now in operation. By far the greater number of these are constructed on the well-known "Otto" cycle, and use ordinary coal-gas. Of these engines the sizes vary from 2-man up to about 40 I.H.P.; the majority, however, being under 20 I.H.P. At such powers, gas-engines using illuminating coal-gas compete favourably with steam engines, notwithstanding the expensive nature of the fuel. Many 4-H.P. gas engines, for example, operate a considerable establishment for 60 hours per week on a total expenditure of 10s. for gas and all other expenses. Even for powers as high as 40 I.H.P., coal-gas competes advantageously with steam, especially when the load is variable. The introduction of Dowson gas, however, has widened the limits of competition; and at the present time gas engines of 200 I.H.P. are at work, consuming less than 1lb. of solid fuel per indicated horse-power per hour.

Rotation of a Magnet and its Field.—There are, we expect very few electrical students who have not tried to discover in what way the rotation of a magnet on its axis affects its field. Herr E. Lecher, in the *Wiener Berichte*, gives an account of an experiment he has performed to test whether, when a magnet turns about its magnetic axis, the lines of force remain at rest or turn with the magnet. A magnet is divided by an equatorial plane into two parts, which can turn independently. Under these circumstances it is possible, by means of suitable contact brushes, to obtain from the two extremities of the magnet an induced current of such a magnitude as cannot be explained by the cutting of the rotating lines of force by the extremely short brushes employed. These currents can be explained if we suppose, as did Faraday at one time, that a rotating magnet cuts its own lines of force which remain fixed in space. On the other hand, it is difficult to imagine how the lines of force can remain fixed when the whole magnet is turned, especially if the magnet is a flat bar or other non-circular shape.

Electric Traction in Europe.—The following is a summary of an electric traction table recently published by *L'Industrie Electrique*:—

Countries.	In operation			In progress.
	Length in km.	Power in kw.	No. of motor cars.	Length in km.
Germany	366·17	5,264	652	94·59
England	68·80	3,443	125	34·20
Austria	44·90	1,639	129	3·75
Belgium	21·70	1,130	48	—
Bosnia	—	—	—	5·60
Spain	14·00	210	12	—
France	96·26	3.610	152	46·00
Italy	18·85	870	33	22 80
Sweden and Norway	6·50	146	11	—
Portugal	—	—	—	12·80
Roumania	5·43	140	15	—
Russia	10·00	540	32	—
Servia	10·00	150	7	—
Switzerland	37·40	1,008	40	2·74
Totals	700·01	18,150	1,236	212·48

Obstruction of Electric Cars in Washington.—An undertaker in Washington, says the *Street Railway Gazette*, was recently charged with seriously obstructing the cars of the Columbia Railroad Company. Commenting on the law, Judge Kimball said that ample provision was made for funerals, and there was no reason why they should interfere with the movements of street cars. Funerals crossing car tracks and street crossings had the right of way, and vehicles were not permitted to pass through them, but when funerals and street cars were going the same direction the cars had the right of way, and were not to be obstructed in any manner, except as provided by law. The defendant demonstrated to the satisfaction of the Court that he had not been responsible for the obstruction of the cars in the particular case covered by the charge, as he did not have supervision of the carriages. The Court warned him of the dangers of the practice, and said that had he been shown to be responsible a fine would have been imposed.

The Bate Refrigerator Case.—Judging possibly from the great interest aroused in electrical circles in America by this patent case, many of our readers may be under the impression that the patent involved is actually an electrical one. The facts are as follows: A patent was applied for on February 1, 1876, by one John J. Bate; this patent (No. 197,314) was issued on November 20, 1877. Between the date of application and the date of issue a Canadian patent was applied for and granted, and it is this Canadian patent which afforded an opportunity to the Supreme Court for a definite decision upon the important point as to whether, in limiting the life of an American patent by a similar foreign patent *previously* obtained, the date of *application* for the American patent, or the date of *issue* should be taken as the starting point. It will be remembered that the Court decided that an American patent commenced its legal existence from the date of issue. The Bate Refrigerator patent related to the enveloping of meats intended for transportation in a covering of fibrous or woven material, and subjecting the same to the action of a continuous current of air at a suitable temperature. The Bate action was fostered by the Bell Telephone Company in order to obtain a decision in the hope that the result would favourably affect certain telephone patents held by them, notably that on the Hunnings telephone transmitter.

Rejected Contributions.—It is always a difficult task to decline an unsuitable contribution at once firmly and politely. As usual, however, the thing has been done in China these thousands of years. We are given to understand that the following is the regulation Chinese form of reply under these painful conditions:—"Illustrious Brother of the Sun and Moon—Behold thy servant prostrate before thy feet. I kowtow to thee, and beg that of thy graciousness thou mayst grant that I may speak and live. Thy honoured manuscript has deigned to cast the light of its august countenance upon us. With raptures we have perused it. By the bones of my ancestors, never have I encountered such wit, such pathos, such lofty thought. With fear and trembling I return the writing. Were I to publish the treasure you sent me, the Emperor would order that it should be made the standard, and that none be published except such as equalled it. Knowing literature as I do, and that it would be impossible in ten thousand years to equal what you have done, I send your writing back. Ten thousand times I crave your pardon. Behold, my head is at your feet. Do what you will. Your servant's servant.—The Editor."

The Rowland "Immersed" Electrostatic Voltmeter.—Prof. Henry A. Rowland has designed an electrostatic voltmeter immersed in a fluid. Prof. Rowland finds it works admirably, a rough one having been in use in his laboratory for over a year. The great electrostatic force which is developed, together with the perfect damping, make it a very practical instrument adapted to rough usage. The form which Prof. Rowland finds best, says the *Electrical Engineer* of New York, is that where only the quadrants are immersed and the pointer is free in the air. The liquid then comes up only to the axis of suspension. In one case, in using 1,000 volts on the voltmeter, a contact occurred under the liquid. The liquid was not disturbed in the slightest degree, but about a yard of connecting wire outside the instrument was deflagrated with a loud report. The instrument itself was not injured in any manner. The constant of the instrument remains unaltered with time, provided the same fluid be used. Fluids can now be obtained with specific inductive capacities up to 30 or more, but they are generally poor insulators and have other defects. In ordinary oil the spaces can be so much smaller than in air that the forces are immensely greater, while good insulation is maintained. The instrument can be made very large and can be used as an engine-room indicator.

Fire Statistics in New York.—"The statistics of fires in New York for 1894," says the *Electrical Engineer* of that city, "are of more than ordinary interest, as they show that in spite of adverse circumstances the losses by electricity are greatly on the decline. The fires for the year 1894 from the various causes were as follows:—

Kerosine oil	347
Gas	230
Matches	273
Electric light and power	48
General	2,150

The number of general fires includes all fire alarms, a certain number of which are false alarms, but as they are recorded as fires in the official reports, the number is, therefore, stated as 2,150. A comparison with the report of all fires from the above causes, from 1888 to 1893 inclusive, shows an increase from all causes, electricity as well as the others. But if a comparison be made as to the relative loss by fires from electricity, and those caused by kerosene oil or gas, an entirely different aspect is placed upon the matter from that which a casual glance at statistical figures alone would indicate. For instance, the number of fires for the year 1894, caused by electricity, with the exception of the central station fire of the United Electric Light and Power Company, did not incur a money loss or waste of $500; whereas the money loss or waste from kerosene oil fires alone, it is safe to state, amounted to over a million dollars."

Boiler Explosion at Denver Power Station. The *Electrical Engineer*, of New York, states that on Wednesday, January 30th, a boiler explosion occurred in the Grand-avenue power station of the Denver Tramway Company, causing the death of two employés, the injury of a number of others, and the wrecking of the entire plant. The direct cause of the explosion is still undetermined. The boilers, 12 in number, were of the horizontal tubular type, 125 H.P. each, built by the Variety Iron Works, of Cleveland, and were provided with Murphy stokers. The boilers, it is said, were all directly connected, and the explosion of one was followed by that of the others in succession. The electrical equipment of the station consisted of 12 Thomson-Houston 80-H.P. and two 400-H.P. generators. The circuits fed from this station have been connected with the other power stations of the Denver Tramway Company, and traffic was only temporarily interrupted. In the emergency the superintendent of the station resorted to a very novel expedient. A 60-ton steam locomotive was brought upon the site of the ruins, and its boiler connected to two high-speed engines of 150 H.P. each, running four 62-kilowatt generators. In this way the cars were kept running until more substantial arrangements could be carried out, and the ingenuity of the plan speaks well for the resourcefulness of the staff. The damage due to the explosion is estimated at £20,000.

Electric Towage on Canals.—*Engineering* states that the towage of canal barges by electricity has proved most successful on the summit level of the Canal de Bourgogne. This portion of the waterway is about 3¾ miles long, and is partly in a deep cutting and partly in tunnel. To reduce construction expenses the canal was made as narrow as possible, and a towpath dispensed with, the haulage being effected on the submerged chain principle, a steam tug hauling on to this chain and dragging the barges after it. M. Galliot conceived the idea of replacing the steam tug by an electric one, since, ample water power being available, the working expenses could be materially reduced, and, moreover, the atmosphere in the tunnels would also benefit considerably. A generating house has been fixed at each end of the upper reach, where a fall of from 23ft. to 26ft. is available. The amount of water available is on the one side about 7 cubic feet a second, and on the other about 11. The dynamos at the two stations, though 3¾ miles apart, are coupled in series with each other. There are thus three mains laid alongside the upper reach, viz., the one connecting the two dynamos, and the positive and negative mains from which the tow-boat takes its supply. These mains are suspended on rubber insulators from the tunnel roof, and in the cutting from suspender wires spanning the canal. Trolley arms of the usual type are used for picking up the current from these mains. The tug motor is of 19 H.P., and runs at 900 revolutions per minute, driving the hauling pulley by means of a belt and spur gearing. During the passage through the tunnel the current is also used for lighting the boat, as also during night work on the open portion of the reach. The cost of the plant was £5,400, the odd £400 being for a set of accumulators which have never been used. The saving is stated to be about £160 per annum, which does not appear to be a high return on the outlay, but it is stated that the plant is less trouble to work than the steam tugs, and the speed attained is somewhat greater.

Electrical Haulage in Collieries.—At the meeting of the Institution of Civil Engineers on March 5th, Mr. Robert Robertson read a Paper on "Electrical Haulage at Earnock Colliery," The arrangements of the shafts and the capacities of the cage and coal-hutches were such that the daily output amounted to 1,200 tons. The electrical generating plant comprised a dynamo for supplying power to the electrical hauling-engines, capable, at a speed of 620 revolutions per minute, of an output of 100 amperes at 490 volts. It was driven from a shaft coupled direct to two single-acting Westinghouse engines. The conductors were placed in iron pipes in the shaft and supported upon insulators in the workings. The two electrical hauling engines were next described. The motor of the engine in the Ell coal seam, when running at a speed of 770 revolutions per minute, developed 35 H.P. with a current of 76 amperes at a pressure of 400 volts. It was geared, through an intermediate shaft, to two pulleys with Hurd clips, each provided with a friction-clutch and brake, by which the cables were driven at a speed of three miles per hour. The two cables were of stranded steel wire ¾in. in diameter, and, after passing over balance-wheels placed in recesses near the engines, operated circuits of 2,160 yards and 1,020 yards in length respectively. The cables were supported at intervals of about 30ft. along the roads by rollers 4½in. in diameter; and at the corners were passed over wheels 5ft. in diameter, mounted upon vertical axes below the level of the rails. The gradients were so arranged at the corners that the trains of trucks could there travel without aid from the ropes. In the Main coal seam a cable operated similarly a circuit 1,580 yards in length. The efficiency of the plant as compared with the horse-traction, which it had replaced, was then considered. The electrical haulage system in the Ell coal seam was capable of a daily output of 400 tons. The daily output by horse-traction had been 180 tons, and to increase this to 400 tons, 30 or 40 horses would have been required, a number which could not have been employed in the available space without confusion. The daily output of the electrical haulage system in the Main coal seam, which was not yet working at its full capacity, was between 150 and 200 tons. The yearly working expenses of the two systems were compared upon the results of one and a-half year's working, and were found to be £4,130 and £1,990 by horse-traction and by electrical haulage respectively, showing that an annual saving of £2,140 had been effected by the latter. The total cost of the electrical installation had been £3,500.

An Electrical Drawbridge.—The new bridge that spans the South Branch of the Chicago river is, says the *Western Electrician*, of exceptional interest to engineers. It is a rolling lift bridge, and is wholly dependent on electric power for operation, being equipped with 200 H.P. in motors. A rolling lift bridge is a drawbridge consisting of two halves, which are rolled back and tilted up on either shore abutment when it is necessary to open for a passing vessel. This is accomplished by a train of gearing actuated by four electric motors, two on each side, the machinery for each half being in duplicate. In each pier were formed three pockets, each to receive one of the tail girders of the movable portion of the bridge when revolved into the vertical position. To remove the seepage from these pockets an electric pump was placed in a sump, one on each side of the river. Directly upon the masonry of each pier were placed three very heavy castings, each of which forms the bearing for one segmental girder. The machinery and motors are two 50-H.P. ironclad Westinghouse motors on each side of the river, hung on the same shaft, and wired to operate in unison or separately. Current at 500 volts for these motors is brought from the Market-street station of the Chicago Edison Company by underground cables leading up to the west side of the bridge, where they enter a junction box. From this box two cables go to the operator's house, and there connect with the controlling system for that side, and three submarine cables—for it was deemed wise to lay one reserve cable for emergencies—cross the river in a trench 5ft. below the bed of the stream, and are brought up to a similar house on the east side. Westinghouse controllers, of the street car type, are used. On each end of the motor shaft is an automatic brake wheel. The brakes on these wheels are actuated by compressed air, the compressors being operated by an eccentric on the end of the motor shaft. If at any time during the motion of the bridge the current is cut off, these brakes are automatically applied. In addition to these brakes there is an emergency brake, intended to be used only in case of an accident. As the lamps in the signal are on the same circuit as those in the house, the operator is instantly notified of a breakage. This system makes the use of the electric light safe for signalling purposes. A 10in. electric gong attached to the signal stand takes the place of the old form of bell used on swing bridges for announcing to drivers and pedestrians that draw is about to be made. In order that the two operators may be able to communicate with each other—for when both sides of the bridge are up they are isolated—a telephone with bell is placed in each house to the operator's right, connection being made by a lead-covered cable laid in the bottom of the river. The total cost of the bridge, including the approaches, the electric equipment, and cables to the power house, was £33,940.

ELECTROMAGNETIC THEORY.—LXV.*

BY OLIVER HEAVISIDE.

(Continued from page 601.)

§ **251.** We have hitherto usually supposed that the potential at the beginning of the cable is produced by an impressed force there, and the potential and current anywhere have been derived from it. We may, however, regard the matter differently; as, given V_0, find C_0 (and V and C); or, given C_0, find V_0 (and V and C); in all cases on the understanding that the state of the cable depends entirely upon the state at the origin due to a cause acting there. This dependence upon the state at the origin implies that V and C are initially zero except at the origin, and that the cable is not subjected to impressed force or allowed to receive electrification anywhere else. The state at the origin need not, however, be due to an impressed force there, but may result (for instance) from its connection with a continuation of the cable on the other side of the origin, this continuation being initially charged. Thus, the case of a steady impressed voltage e between line and earth at the origin may be imitated by having the whole of the imagined continuation on the negative side initially charged to the uniform potential $2e$, and allowing it to discharge freely into the cable on the positive side. For the assumed distribution is equivalent to the combination of two distributions, one expressed by $V=e$ constant all over, and therefore not subject to change, whilst the other consists of $V=e$ on the negative and $V=-e$ on the positive side of the origin, with a node between them at the origin itself. So the potential at the origin will be made permanently equal to e, and the current is uncontrolled save by its natural connection with the potential, therefore the result on the positive side must be the same as that due to e considered as an impressed force acting at the origin between the line and earth.

But suppose it is the current at the origin that is controlled and led through a sequence of values. Then we may find the potential that results there and elsewhere. Thus, we have in general

$$V_0=(R/q)C_0 \tag{26}$$

at the origin. So, by taking C_0 conveniently, we can immediately find V_0. If, for example, C_0 is proportional to $q1$, that is, to $t^{-\frac{1}{2}}$, the q in the denominator of (26) is cancelled, and V_0 comes out constant. We found before that V_0 constant made C_0 vary as $t^{-\frac{1}{2}}$. So now we solve the inverse problem; that is, if C_0 is zero before $t=0$, and is then made to vary as $t^{-\frac{1}{2}}$, the potential V_0 will be suddenly raised to and be maintained at a constant value. Furthermore, since C and V are derived from C_0 and V_0 by the operator ϵ^{-qx}, we see that the state of things everywhere is determined as well by the condition $C \propto t^{-\frac{1}{2}}$ as by the other condition $V_0=$constant. They are equivalent under the circumstances mentioned.

Again, suppose C_0 varies as $q^2 1$. Then C_0 is impulsive, as before seen, so that we may call it pQ, where Q is constant, being the charge in the impulse. The V_0 that results is therefore

$$V_0=\frac{R}{q}pQ=\left(\frac{Rp}{S}\right)^{\frac{1}{2}}Q=\left(\frac{R}{S\pi t}\right)^{\frac{1}{2}}Q. \tag{27}$$

This is the inversion of the problem beginning § 249, equations (11) to (16), which was, given V_0 varying as $t^{-\frac{1}{2}}$, to find C_0. The result was that C_0 was initially impulsive, and zero later.

Next, suppose that V_0 is impulsive, say

$$V_0=pf, \tag{28}$$

where f (when regarded merely as a constant) is the measure of the impulse, that is, the time-integral of V_0. The result is

$$C_0=\left(\frac{Sp}{R}\right)^{\frac{1}{2}}pf=fp\left(\frac{S}{R\pi t}\right)^{\frac{1}{2}}=-\frac{f}{2t}\left(\frac{S}{R\pi t}\right)^{\frac{1}{2}}, \tag{29}$$

which indicates the current coming out of the cable after its initial charging.

The reader may have noticed in the above, and perhaps previously, that we change the order of operations at convenience, as in $f(p)\phi(p)1=\phi(p)f(p)1$, and that it goes. But I do not assert the universal validity of this obviously suggested transformation. It has, however, a very wide application, and transforms functions in a remarkable manner. Reservations should be learnt by experience. The present example is, of course, elementary.

Observe that the current due to impressed e when it is made impulsive is got by writing pf for e, f being the time-total of e. This process is general. If we have worked out the solution arising from a steady impressed force, or a steady source, we obtain that for a momentary force or source by differentiating the former solution to the time, and substituting the strength of the impulse for the intensity of the former force or source. Or, in another form, if $C=Ye$ is the primary operational solution, giving C in turns of any e through the operator Y, then $C=Ypf$ is the operational solution when e is impulsive of total f, the moment of time of the impulse being $t=0$.

It is generally better to work out a solution due to e constant than that due to an impulse, because the former leads, as above, to the latter by a simple differentiation, whereas there might be some trouble in rising from the developed impulsive solution by integration to that for a steady force. But, knowing the developed impulsive solution, either directly, or by derivation from the other, the solution for a continued force varying anyhow with the time is at once expressible by a definite integral, because the continued force may be regarded as consisting of an infinite series of successive infinitesimal impulses. The definite integral, however, is of little use unless the integration can be readily effected in the case of the special function of the time that e is chosen to be. Moreover, it is not uncommon for the result of the integration to be obtainable more easily directly from the operational solution itself. The simply periodic solution is an obvious example, and others may be given.

§ **252.** Returning to the mutual dependence of C and V and the inversion of operators, let C_0 be made constant. That is, there is to be no current before, and a steady current after $t=0$, at the origin. Clearly this would be impossible were it not for the permittance of the cable, which allows of any amount of electrification being sent in, practical limitations arising from the finite strength of the dielectric being nowhere in a theoretical discussion. Of course the potential rises infinitely, if sufficient time be allowed. The potential at the origin is

$$V_0=\left(\frac{R}{Sp}\right)^{\frac{1}{2}}C_0=2C_0\left(\frac{Rt}{S\pi}\right)^{\frac{1}{2}}, \tag{30}$$

by using the known value of $p^{-\frac{1}{2}}1$.

Inversely, we may put it thus:—Given that there is an impressed force at the origin between line and earth varying as $t^{\frac{1}{2}}$, what is the resulting current? The answer is, the current is steady. This contrasts well with the case of a steady e, which leads to zero final current, though it is initially infinite, varying intermediately as $t^{-\frac{1}{2}}$. For in our present case we get a steady current from the first moment by an e rising from zero to infinity according to $t^{\frac{1}{2}}$.

As a typical example, it is worth while algebrising fully the solutions when the current at the origin is steady. From

$$C=\epsilon^{-qx}C_0, \tag{31}$$

we see that C follows the same law as was worked out for V due to steady e, as was exemplified in Fig. 1. Those curves now show how C distributes itself in the cable. From there being initially no current anywhere save at the origin, where it is C_0, the final state that is tended to is a constant current everywhere. The formula being the same, it is unnecessary to repeat it. The operational form (31) is fully explicit and understandable.

As regards V, we have to develop

$$V=\frac{R}{q}\epsilon^{-qx}C_0. \tag{32}$$

Here reject, as in previous cases, the even powers of q, and we get

$$V=-RxC_0+\frac{R}{q}\cosh qx\,.\,C_0, \tag{33}$$

where the term involving the first power of x comes from the term in the previous equation which is independent of q:

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that is, it would express the final steady state were such a state possible, which is obviously not the case in the present problem. There is nothing new in the way of operations in equation (33). Written fully, it is the same as

$$V = -RxC_0 + \left(1 + \frac{RSx^2p}{\lfloor\underline{2}} + \frac{(RSx^2p)^2}{\lfloor\underline{4}} + \dots\right)\left(\frac{Rt}{S\pi}\right)^{\frac{1}{2}} 2C_0, \qquad (34)$$

which only requires the complete differentiations to be effected to give the full development, namely,

$$\frac{V}{C_0} = -Rx + 2\left(\frac{Rt}{S\pi}\right)^{\frac{1}{2}}\left\{1 + y^2 - \frac{y^4}{3\lfloor\underline{2}} + \frac{y^6}{5\lfloor\underline{3}} - \frac{y^8}{7\lfloor\underline{4}} + \dots\right\}, \qquad (35)$$

where $y^2 = RSx^2/4t$, as before. This formula shows the infinitely great ultimate increase of V, and how it spreads into the cable. As a check, obtain the current by differentiation to x. We get

$$\frac{C}{C_0} = 1 - \frac{2}{\pi^{\frac{1}{2}}}\left\{y - \frac{y^3}{3} + \frac{y^5}{5\lfloor\underline{2}} - \frac{y^7}{7\lfloor\underline{3}} + \dots\right\}. \qquad (36)$$

Comparing with (10), we confirm the previous statement about the law followed by C now being the same as that followed by V when e is steady.

If, on the other hand, we should start with the last formula for C, and attempt to obtain that for V by integration with respect to x, there might be some difficulty initially. The indefinite integral is the formula (35) without the term independent of x. Now

$$V = \int_x^\infty RC\,dx, \qquad (37)$$

so to get the missing term (that involving $t^{\frac{1}{2}}$) we require to evaluate a series for an infinite value of the argument, which is inconvenient. But instead of that we may note that

$$V_0 - V = \int_0^x RC\,dx, \qquad (38)$$

so by this formula we get what we want from the value of V at the origin, which is already known. That is, it is known by the operational method; otherwise it would have to be specially obtained. The operational method usually avoids auxiliary evaluations of this kind, as we may see by the way (35) was got. The work is done automatically, as it were, and V is made to vanish at $x = \infty$ for any t, and also when $t = 0$ at any x.

Fig. 1 serving to show how the current spreads, the new formula (35) requires calculating to show how the charge spreads. Without making a fresh table fully, like that for the "error function," the following special results which I have calculated may be quite sufficient to allow the reader to draw the curves roughly, should he care to do so. Write (35) in the form

$$\frac{V}{C_0} = \left(\frac{2Rt}{S}\right)^{\frac{1}{2}} z, \qquad (38\text{A})$$

where

$$z = -y\sqrt{2} + \left(\frac{2}{\pi}\right)^{\frac{1}{2}}\left\{1 + y^2 - \frac{y^4}{3\lfloor\underline{2}} + \dots\right\}. \qquad (38\text{B})$$

Then z is a function of the former $y^2 = RSx^2/4t$, and the values of z corresponding to some of those of y^2 are as follows :—

y^2	0	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	1	$1\frac{1}{2}$
z	0·798	0·528	0·394	0·281	0·166	0·071	0·034

Since y varies with x as well as with t, the last equation and the numbers in the table will allow the form of the V curve to be traced for a series of values of the time. But this case of steady impressed current is by no means so important as that of steady impressed potential, although interesting and instructive enough in its way.

§ 253. We have already considered the cases of an impulsive V_0 and an impulsive C_0. Those impulses were simple. But we may also have multiple impulses, to understand which it is best to take a special case. We know that

$$C = \epsilon^{-qx} C_0 \qquad (39)$$

expresses the current due to C_0 arbitrary at the origin, or to a source of strength $2C_0$ at the origin when it is free to spread both ways equally, as if an auxiliary wire supplied electrification to the middle point of a doubly infinite cable without earth connection. Also, if C_0 is impulsive, say pQ, then

$$C = \epsilon^{-qx} pQ, \qquad (40)$$

as before examined, § 250, equations (23), (25). Now, if this impulse be followed at time Δt later, by the impulse $-pQ$, the negative of the former, it will nearly undo the effect of the first one. If Q be finite, the differential effect will decrease with Δt, and become zero when it does. But if, whilst decreasing Δt, we simultaneously increase Q in the same ratio, the differential effect is maintained of finite size, and in the limit, where Δt vanishes and Q is infinite, whilst their product $Q\Delta t$ is finite, the result takes a special simplified finite form.

It is like the old way of making the magnetic force of a magnetised molecule out of the combined magnetic forces of two equal poles of positive and negative magnetism. If the poles are kept of finite strength, their joint effect vanishes when they are brought to coincidence. But if the product of strength of pole into distance apart, or the magnetic moment, be maintained finite, the resultant magnetic force is finite, and takes a special form in the limit. This is the way to form a solid harmonic distribution of potential, and Maxwell showed how to carry on the process with multiple poles, so as to generate solid harmonics of any order.

In our present case, however, it is not a space distribution of poles that we are concerned with, but a time distribution. The "moment" of the differential impulse is $Q\Delta t$, where $\pm Q$ is the strength of the poles (or impulses), and Δt is their distance apart in time. The finally resulting C is

$$C = \epsilon^{-qx} p^2 (Q\Delta t), \qquad (41)$$

where Δt is infinitesimal. Or, if $Q_1 = Q\Delta t$,

$$C = \epsilon^{-qx} p^2 Q_1 \qquad (42)$$

is the current due to a differential impulse of the first degree. It is clear that we may extend the above to impulses of any degree, say

$$C_0 = pQ_0, \text{ or } p^2Q_1, \text{ or } p^3Q_2, \text{ \&c.},$$

but at present let us keep to the middle one.

The potential corresponding to (42) is obtained in the usual way by multiplying by the operator R/q. This makes

$$SV = \epsilon^{-qx} pqQ_1, \qquad (43)$$

from which we see that the impressed force at the origin between line and earth required to produce the same effect is given by

$$Se = pqQ_1. \qquad (44)$$

This, however, needs close and literal interpretation. Let $Q_1/S = 1$ for simplicity, then, by algebrising $pq1$ we get

$$e = pq1 = p\left(\frac{RS}{\pi t}\right)^{\frac{1}{2}} = -\frac{1}{2t}\left(\frac{RS}{\pi t}\right)^{\frac{1}{2}}. \qquad (45)$$

Now this merely represents the dregs of e, acting when t is finite, and, as before explained with respect to the impressed force $e = q1$, serving (in Poggendorff's way) to prevent current at the origin. But we must understand $pq1$ more literally. Thus, $q1$ is the function of the time which is zero before $t = 0$ and is $(RS/\pi t)^{\frac{1}{2}}$ later. So $pq1$, which is its rate of increase, is zero before $t = 0$, then jumps to ∞, then jumps through zero to $-\infty$, and lastly rises to zero again gradually. Of course it is only the last part that is explicitly represented by the developed time-function in (45). On the other hand, $pq1$ represents it all. Similarly, p^2q1 is to be interpreted as the rate of increase of $pq1$ just considered; and so on. And, going back to the impulses without any residual effect, pQ_0 has been already interpreted as a simple impulsive current; next, p^2Q_1 we see is the time-rate of increase of pQ_1, and is therefore a double impulse, first positive and then negative; and so on.

As regards the charge in the cable produced by the impulse p^2Q_1, just after the first moment it is confined practically to the region close to the origin, and consists of a positive wave followed by a negative one. These tend to neutralise and do neutralise one another by mutual diffusion to a large extent. But since at the same time the positive charge in front diffuses itself forward into the cable, there cannot be a complete neutralisation. The result is that the region occupied by the charge is continuously enlarged, the node between the positive and negative charges advancing along the cable, all to the right thereof being positive and to the left negative, whilst the density rapidly attenuates to zero. Since the formulæ (43) and (42) for V and C are derivable from previous formulæ by simple time differentiation, viz. (43) from (8) or (6), and (42) from (20) or (19), it is unnecessary to write the full developments. Moreover, since the operator RSp is equivalent to a double differentiation to x, as is indicated by the characteristic of the potential and current, the new curves of V and C may be found by making their ordinates be proportional to the curvatures of the old ones. Similar remarks apply to multiple impulses of higher degrees, as regards their development by differentiation; so, as we do not want them at present, it is sufficient merely to point out, as above, how they may be got.

(To be continued.)

A NEW MODEL OF MOLECULAR MAGNETISM.

At a recent meeting of the Cavendish Physical Society, Cambridge, Prof. Ewing exhibited a model which he had made to illustrate the molecular action which occurs in iron when caused to revolve in a weak or strong magnetic field. This action has acquired particular interest in regard to the molecular theory since Mr. F. G. Baily's experiments (the *Electrician*, August 31, 1894) have shown that in a sufficiently strong field the hysteresis of revolving iron disappears. In Prof. Ewing's original model, as exhibited at the Leeds meeting of the British Association, the table carrying the pivots of the little magnets was fixed, and hysteresis was shown only by varying the current in the field-coils. In the new model (Fig. 1) the table is free to revolve about a vertical axis between the field-coils, so that the action may be made to resemble that which occurs in a dynamo armature or in the iron of Mr. Baily's experiment. The magnet pivots are carried by a glass plate which rests on another glass plate below it, and between the two, partly imbedded in a conical hole ground in each plate, is a small shot (Fig. 2). This serves as a pivot about which the upper plate can turn on the lower one smoothly and with very little friction, the shot being big enough to keep the two plates from touching, except lightly at a couple of points. One advantage of the construction is that such a pivot obstructs practically no light, so that the arrangement is well adapted for use in the lantern. Plates carrying various groups of many or few magnets were exhibited. The one shown in the illustration is a hexagonal arrangement, and the grouping of the magnets in Fig. 1 is one which they assume in the absence of any directing force on the part of the field-coils. When a directing field of moderate strength is caused to act, the group takes up a new configuration, corresponding to partial magnetisation of the iron which it represents, and if, under these circumstances, the plate carrying the pivots is caused to revolve slowly, it is seen that the lines in which the magnets tend to arrange themselves become strained and break up, new lines being formed, which in their turn have to break up as the plate goes on revolving. This breaking and rearrangement of the grouping involves dissipation of energy, which is shown by the violent swinging which the little magnets undergo each time the lines break up; the process here is associated with hysteresis, and corresponds to the case of an ordinary dynamo armature. But when the directing field is made quite strong, so that the magnets assume the grouping shown in Fig. 3, corresponding to magnetic saturation, there is no longer any violent breaking of molecular ties as the plate revolves, and, consequently, there is no dissipation of energy. Each molecule points steadily in one direction, and is no longer thrown into oscillation as its neighbours pass by it in the revolution of the group.

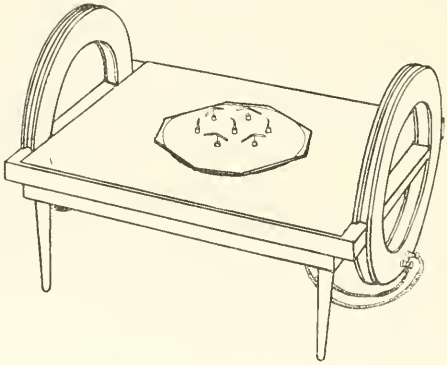


Fig. 1.—New Ewing Molecular Magnet Model. Grouping Assumed when no Current is Traversing the Field-coils.

When a numerous group of magnets turns in a comparatively weak field, so that there is hysteresis, the model shows that the expenditure of work takes place not continuously, but in a series of spasms. The lines which are formed at any stage in the process become gradually strained as the plate turns through a certain angle, but at first without breaking up or giving rise to dissipative movements. Then, when a particular angle is reached, the lines simultaneously give way, energy is dissipated, and a new grouping is assumed. When this happens the moment of the couple required to turn the group against the forces exerted on it by the field-coils becomes suddenly diminished in consequence of the new lines assumed by the magnets being more nearly parallel to the field than the lines were immediately before their rupture took place. Then as the plate continues to revolve these lines again become more and more inclined to the field, and the moment required to turn the group increases until the lines are again broken and another rearrangement ensues. It sometimes even happens that the new lines assumed by the magnets immediately after breaking away from an earlier grouping are so inclined to the field that the action of the field tends to continue instead of to oppose the rotation of the group; in other words, at such phases of the process the moment needed to turn the group becomes negative. Prof. Ewing mentioned that a spasmodic action, apparently resembling that which could be traced in the behaviour of the model—whether or no it was due to the same cause—had, in fact, been noticed by Mr. Wilberforce and himself in the experiments which they made two years ago on the forces required to keep a cylinder of iron slowly turning about its axis in a magnetic field. The sudden changes of resistance to motion which they had observed had proved a serious obstacle in the way of measuring the work done in keeping the cylinder revolving. In Mr. Baily's experiment this difficulty had been avoided by maintaining a tolerably rapid rotation, so that a

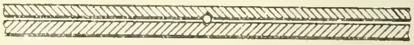


Fig. 2.—Method of Pivoting Rotating Glass Plate.

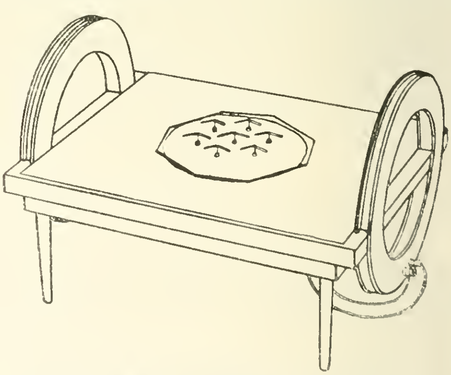


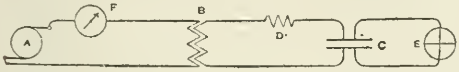
Fig. 3.—New Ewing Molecular Magnet Model. Grouping Assumed under Influence of Strong Directing Field.

general average of the resistance was obtained. With a strong field the model showed a remarkably complete disappearance of hysteresis: the glass plate carrying the supporting needles could be spun round even rapidly without causing the magnets to take up any oscillation.

ELECTRICAL CONSONANCE.*

BY M. J. PUPIN.

The writer points out that the conditions which determine electrical resonance are often confused with those which are fulfilled when the self-induction of a circuit is neutralised by capacity. In a complex electrical circuit traversed by alternating currents it is possible for the current to be in phase with the impressed electromotive force, although the natural period of oscillation of a subsidiary circuit containing self-induction and capacity may not be the same as that of the alternating current actually passing through the conductors. The writer suggests the name electric *consonance* for representing phenomena in which the phase of current and electromotive force is the same, reserving the name *resonance* for cases in which the natural period is the same as the impressed period of oscillation. He discusses a case of this kind illustrated in the accompanying figure. Let A be an alternator, B a transformer, C a condenser in series with the secondary of the transformer, and D an inertia coil of adjustible self-induction. F is an electrodynamometer, and E is an electrostatic voltmeter.



Let L_1 and R_1 respectively be the self-induction and resistance of the primary circuit.

Let L_2 and R_2 respectively be the self-induction and resistance of the secondary circuit.

Let C be the capacity of the condenser.

Let M be the coefficient of mutual induction between the circuits.

Let $E \sin pt$ be the impressed electromotive force of the primary.

The author then shows that the current in the primary is given by

$$x = \frac{E}{\sqrt{L^2 p^2 + R^2}} \sin (pt - \phi)$$

where $$L = L_1 + \frac{p^2 M^2 \left(\frac{1}{p^2 C} - L_2 \right)}{p^2 \left(\frac{1}{p^2 C} - L_2 \right)^2 + {R_2}^2},$$

and where $$R = R_1 + \frac{p^2 M^2 R_2}{p^2 \left(\frac{1}{p^2 C} - L_2 \right)^2 + {R_2}^2},$$

and where $$\tan \phi = - \frac{Lp}{R}.$$

The condition for resonance is $L_2 = \frac{1}{p^2 c}$, which gives

$$L = L_1, \quad R = R_1 + \frac{p^2 M^2}{R_2}, \text{ and } \tan \phi = - \frac{Lp}{R}.$$

But for consonance we must have $\phi = 0$; that is, $L = 0$.

Now, if the expression given above for L be equated to 0, and the resulting equation solved for either L_2, C, or p, there are in each case two values for the unknown quantity (which under certain circumstances may be imaginary). Hence for a given frequency, primary coefficient of self-induction, and secondary resistance, there are two values of the capacity, and also two values of the secondary coefficient of self-induction, for which the current and electromotive force of the primary circuit will be in phase with one another. Also, if the current frequency be the variable, there will be two values of it for which there will be no lag of the current behind the volts. For the two states of consonance there will be two corresponding values of the primary current, and these in certain cases may differ considerably from one another.

A numerical example will assist one to see this interesting relation more clearly. Let

$L_2 = 1$ henry.
$M = \cdot 5$ „
$L_1 = 2$ „
$R_2 = 20$ ohms.
$R_1 = 50$ „
$p = 2\pi \times 110 = 700$ (very nearly).

The capacities in the secondary circuit at which the apparent self-induction of the primary circuit is neutralised will be

$C_1 = 2 \cdot 3$ microfarads.
$C_2 = 2 \cdot 03$ microfarads.

There is only about 12 per cent. difference in the two capacities. But if we examine the corresponding apparent resistances of the primary circuit we find the two values of R are 358 ohms and 5,945 ohms respectively. Hence, the ratio of the two possible currents in the primary circuit when its inductance is zero will be 1 : 16·6 (about).

We see, then, that the neutralisation of the inductance does not necessarily increase the primary current. On the contrary, it may diminish it very much, and it will do that whenever this neutralisation increases the impedance of the primary circuit. In fact, a moment's reflection will convince us that the physical meaning of the existence of the two values for each, the secondary self-induction, the capacity, and the frequency, each of which will neutralise the primary reactance, is simply this. One value will make the primary impedance a maximum and the other will make it a minimum.

The following experimental method was employed for the purpose of testing the validity of the theory just given.

An alternating current of 133 ∿ was sent through the primary turns (No. 12 B. and S.) of a small hedgehog transformer, B (*see* figure). The secondary was connected to a coil, D, of adjustable self-induction, and to two large condensers, C, in series with each other. The extreme poles of the condenser battery were connected to a Thomson electrostatic voltmeter, E. A Siemens electro-dynamometer, F, was employed to measure the primary current. The capacity was gradually varied, and for each particular capacity the primary current and the difference of potential in the condenser were read and recorded. The following table records the results of one of the series of these experiments.

The rise of the primary current is gradual, just as the theory indicates it. Mr. Pupin states that he was not able to produce a very large increase, although considerable effort was made to do so. The capacity at which the primary impedance is reduced to a minimum is always greater than the one at which the impedance is made a maximum. Both these capacities are always greater than the capacity which produces resonance in the secondary circuit. The two capacities can be made to approach each other as near as we choose to make them. When $p^2 M^2 = 4 {L_1}^2 {L_2}^2$, then the two capacities coincide. In this case, however, there is neither a maximum nor a minimum in the impedance when the phase difference of the primary current is reduced to zero by the variation of the capacity. As a rule the capacity which makes the impedance a maximum is near the capacity which produces resonance in the secondary circuit. Such a case is illustrated in the table given below.

Capacity in microfarads.	Primary current.	Difference of potential in the condenser.
4·94	11·3	Below the lowest reading.
4·36	11·4	„ „
3·68	11·45	„ „
3·10	12·00	„ „
2·48	11·95	„ „
2·12	11·6	„ „
1·96	11·2	500
1·49	9·5	925
1·19	2·5	1.135
0·48	6·5	Below the lowest reading.

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* Abstract of a Paper appearing in the *Electrical World* for February 9, 1895.

This class of capacity effects does not present those very interesting features which electrical resonance presents. The author observed them several years ago; but, failing to detect in them any purely scientific interest or technical importance, he did not pay very much attention to them. This brief note, however, seemed necessary in order to draw a clear distinction between them and electrical resonance.

ELECTRICITY ON SHIPBOARD: ITS PRESENT POSITION AND FUTURE DEVELOPMENT.*

BY S. DANA GREENE.

When the enormous increase in the practical applications of electricity on land during the last ten years is compared with what has been done in the same direction, and during the same period, on shipboard, one is inclined, at first thought, to conclude that the naval architect and engineer are behind their professional brethren on shore in appreciating and utilising a new and exceedingly flexible form of energy.

Location of Plant.—On war vessels the plant is properly considered as one of the vitals of the ship, and is always located below the protective deck, in a compartment by itself, near the boilers, and as near the centre of the ship as possible. These compartments require artificial ventilation, and even then are often uncomfortably hot (aboard the "San Francisco," for example, the temperature ranges from 120°F. up). In some of the larger war vessels abroad there are two plants, located in different parts of the ship, one for ordinary service (above the protective deck), and the other for service in action (below the protective deck). The practice of dividing the plant, however, is more expensive in first cost, as well as in operation and deterioration, and is bad on general principles; it has never been adopted in our service. In some merchant vessels and yachts the plant is located in the main engine room, to save expense in piping and in extra supervision and attendance. The presence of moisture, live steam, or flying oil in the main engine room, however, is very injurious to electrical apparatus, and where possible the plant should always be located in a compartment by itself, near the boilers (to insure a short lead for the pipes) and near the engine room, so that the engineer on watch can, with a few steps, see that the plant is receiving proper attention.

Character of Generating Units.—Engine and dynamo should always be direct coupled; that is, the armature shaft of the dynamo should be directly connected to the engine shaft. A reserve capacity should always be provided, if space allows. In the navy the present practice seems to provide a reserve of from 25 per cent. to 33⅓ per cent. of the full load duty of the plant, a separate unit furnishing the reserve. Thus the full load service of the "New York" requires about 85 H.P. dynamo capacity, which is supplied by two units, while a third, of 21 H.P., furnishes the reserve. In some recent marine installations the reserve capacity is even greater (50 per cent. or more of full load duty).

Engines should be of the open type, compact and strong, with rigid frames, large bearing surfaces, and liberal clearance in the cylinders. Vertical engines occupy much less deck space than horizontal, and are better adapted for ship service. There should be special provision for relieving the cylinders quickly of water, since a broken cylinder head or a cracked cylinder may cripple the plant seriously; both hand and automatic relief valves should be provided. Engines should be fitted for atmospheric and vacuum exhaust, and should be able to operate satisfactorily with considerable variations in pressure, since they may have to take their steam from either the main or auxiliary boilers.

The multipolar type of dynamo should be used, since it permits of slow armature speed, less weight, greater compactness, and closed magnetic circuit. The naval specifications are very rigid in respect to heating, the maximum temperature rise being only 50°F.

Wiring.—This is the most difficult and expensive, as well as the most important, part of the installation. Probably the best example of the highest grade wiring to be found is in our own naval vessels, and the specifications of the Navy Department are very rigid and complete. In Europe, and especially in England, it was the practice for several years to use what is known as the "single conductor system" of wiring, where one conductor only is run from the dynamos to the lamps, the hull of the vessel being utilised as the return conductor. The practice, however, has never found favour in this country, and it has a number of serious faults, with the single argument of cheapness in its favour. Recent practice abroad, evidently based upon unfavourable experience, does not favour it, and the system generally used is the two-conductor insulated metallic return system. In England experiments have recently been made with a concentric cable, where one conductor is placed concentrically outside and insulated from the other, in one cable. Such a cable has the advantage of materially reducing the labour of wiring a ship, while still retaining the advantages of a completely insulated metallic circuit; but it is not wise, in the writer's opinion, to abandon our standard two-wire separate conductor system until the success of the new method has been thoroughly demonstrated by several years' test at sea. The wiring should be divided in separate circuits, lights which are located in the same parts of the ship, and which are ordinarily used at the same time, being grouped on the same circuit. These several circuits are then carried back to the switchboard in the dynamo room where they are so connected that they can be independently controlled. The number of these circuits depends entirely on the size of the vessel and the number of lights required. In large vessels the expense of running each circuit back to the switchboard becomes very heavy, and, to reduce this, feeders are led to certain predetermined centres of distribution, where they are connected by means of suitable junction boxes to the circuit mains, which in turn light a certain section of the ship. In our naval vessels circuits are classed as battle circuits, including the lights needed in action, and lighting circuits, which include the lights for ordinary illumination. At general quarters all lights on the lighting circuits are at once cut off at the dynamo room switchboard.

The present standard U. S. navy wire has no lead covering. It was formerly required as a mechanical protection and waterproof covering of the wire, but it was found that in handling the wire aboard ship, the lead covering was very apt to become broken, thus allowing water to soak in between the covering and the wire, and the ragged, broken edges were frequently driven into the insulation of the wire to such an extent as to ground the metallic conductor to the hull of the vessel. Furthermore, it was practically impossible to discover defects in the insulation of the wire under the lead covering before the wire was put in place, and these defects often caused trouble later in service. The writer advocated the abandonment of the lead covering in 1887 after a year's experience with it on board the cruiser "Atlanta," where many of the circuits had to be entirely replaced during that period. The insulation of the wire should be depended upon to prevent troubles (the best rubber-covered wire only being used) and a good heavy braiding affords all the mechanical protection needed beside the moulding. Samples of all wire should be subjected to rigid electrical and physical tests before use. If a new ship is to be wired, the work should be done while the vessel is building, and the writer believes that the circuits for the engine and firerooms, the coal bunkers and for the exposed decks should be run in continuous iron tubes, having water-tight joints and an inner lining of insulating material. It is almost impossible to prevent trouble on these circuits with the ordinary wooden moulding, and the iron tube method is successfully employed on shore in such places as breweries, dyeing establishments and chemical works, where the conditions are as trying as they are at sea. The loss in the wiring should not exceed 5 per cent., and the expense is not excessive if this loss is limited to 3 per cent.

The electromotive force of all United States naval plant is 80 volts. This standard has been adopted in order to permit the use of searchlights and incandescent lamps on the same dynamos without the interposition of too much dead resistance in the searchlight circuit; and as the searchlights are an important part of the military equipment of a naval vessel, the adoption of a non-commercial voltage for the plant may be justified. But in merchant vessels no such important reason exists, and the voltage should range from 100 to 120 volts, so that commercial incandescent lamps can be used.

All wiring fittings and fixtures should be of bronze, or composition with bronze finish, no iron being used.

Future Development.—Electric Motors.—The use of the electric motor is probably the most important development to be looked for aboard ship. For military purposes they can be used to advantage: (1) For ammunition hoists, (2) for handling the turrets of battle ships and monitors, and also the heavy guns in these turrets, (3) For torpedo discharge apparatus.

For general purposes electric motors can be used to advantage for (1) ventilating blowers, (2) portable drills, (3) portable pumps, (4) operating machinery in engineer's machine shop, (5) deck hoists, which are located at some distance from the boilers, (6) operating valve of steam steering engine, and thus doing away with the long and awkward mechanical connection between steering wheel and rudder. The writer is of the opinion that a motor will eventually replace the steam steering engine itself. It requires about 15 H.P. only, and the application can be made successful. (7) Opening and closing of water-tight doors. This application is simple and would greatly facilitate the prompt closing of doors in an emergency, either from the bridge or from any other desired point. If the water-tight doors of the ill-fated "Victoria" had been thus equipped they could have been closed within the sixty seconds immediately preceding the collision (when the order to close doors was given), and the ship might have been saved.* (8) Driving ice machinery.

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* Abstract of a Paper read before the Society of Naval Architects and Marine Engineers, New York

There are certainly auxiliary steam engines that it is inadvisable to attempt to replace with electric motors ; thus the auxiliaries in the engine and boiler room spaces (including blowers, ash hoists and certain spar deck hoists) require only short lengths of steam piping, and the conditions of service in the boiler and engine rooms are very trying to a motor ; again, the anchor engine requires from 40 H.P. to 50 H.P., and if a motor is used the generator and wiring capacity of the plant must be considerably increased, while the motor is needed occasionally only and cannot be used for other purposes.

Such a general introduction of electric motors as here recommended necessitates an increase in the capacity of the generating plant of from 30 to 60 H.P. (the heavy turret-turning machinery having its own plant) depending upon the number of motors used ; but this increase can be provided for in the existing dynamo rooms of all larger vessels, and the advantages derived warrant the additional expense. A modern vessel is filled with steam and exhaust pipes running to the auxiliary engines. Where they pass through living spaces they are a great discomfort ; they are in constant need of repairs, and they are a menace to life in case of accidental bursting or breaking. Electric wires take up much less room, do not easily get out of order and do not injure anyone if they do get out of order. The electric motor is cleaner, quieter, lighter and more compact than any other form of motor ; they are in daily use on shore for many of the purposes enumerated, and there is no reason why their use should not be equally successful on board ship.

Search-lights.—Search-lights have been in use on war vessels as a military weapon of offence and defence for several years, but their use as an aid to navigation is recent. Vessels now passing through the Suez Canal use their search-lights and so make as rapid progress at night as in the daytime. Vessels plying between New York and Savannah use their search-lights in running up the Savannah River at night, and frequently save 12 hours' time from dock to dock in so doing. The Sound steamers throw the beam of their lights overhead in a fog, and the location of the vessel is indicated by a well-defined luminous spot in the fog. The search-light is frequently used for coaling ship or making repairs at night. These examples sufficiently indicate the uses to which an intelligent captain can put his search-light. The general appearance, construction, and operation of search-lights has been greatly improved of late. There are two general types—those controlled by hand, requiring a man constantly at the projector, and those controlled by electric motors, so that an observer standing at a distance from the projector can, by means of a control stand, throw the beam of light at any desired angle of azimuth or elevation. The hand control is cheaper, and has generally proved more reliable in service ; but recent improvements in the electrically controlled projectors for the navy have so simplified them and increased their simplicity of operation that the arguments in favour of their general use have been greatly strengthened. The projectors should be placed well above the level of rails, guns, boats, &c., and in such a position as to command the greatest uninterrupted sweep around the horizon. The French have tried the experiment of placing the projector close to the water line, either by mounting it at a lower deck port, or hanging it from an overhead support outside the ship. Theoretically, the area of contact of the beam of light on the water is increased by this arrangement, and this is doubtless true in practice when the ship is at anchor in a harbour on a calm night. If the attempt, however, is made to use the projector in this position with the ship under way, it does not seem possible that it can escape injury from the waves, nor that the beam of light will not be frequently shut in by the intervening seas.

The Range or Position Finder.—An instrument which will indicate quickly and with reasonable accuracy the distance of objects within the range of vision at sea is obviously of great advantage, both on account of its military value to a war vessel, and as an aid to navigation in coasting or making land. Several range finders have been devised both here and abroad, but by far the most complete apparatus is that invented by Lieutenant Bradley A. Fiske, United States Navy. This beautiful instrument, after tests extending over a period of five years, has just been officially approved and adopted by the Navy Department, and it has been adopted by several foreign governments as well. The following extracts from an official report of the commanding officer of the "San Francisco" show what it will do in actual service : "In January last, when at Pernambuco, Brazil, I sent to the department a tabulated record of the errors of the range finder as determined in the various parts where the true distances could be gotten from the charts. The average error of all the observations was about six-tenths of 1 per cent. per thousand yards. Since that time I have always made use of the range finder at target practice, and in going into and out of port and in coasting. The range finder is thoroughly adapted to ship use, as is shown by the fact that its whole care and service are in the hands of three apprentice boys. These boys keep it in order, and go to it as their station at general quarters, getting under way and anchoring, and whenever the word is passed, 'man the range finder.' "

Signalling and Firing Circuits.—For night signals the navy has recently adopted an improved form of the Ardois system. Four double lanterns, each lantern being coloured half red and half white, are strung on a jackstay at the mizzenmast, the interval between the lanterns being 12ft. An incandescent lamp is placed in each half of each lantern, and connected by cable to a signal stand mounted on deck as desired. Various combinations of red and white lights are then flashed by a suitable switch at the signal stand, and the lights are burned until the signal is reproduced on all the answering ships. A "multiple filament" incandescent lamp has been recently brought out in England for use with masthead lanterns, the individual filaments being so fine that they lose their incandescence immediately the current is cut off. The search-light provides an excellent means of long-distance signalling. It has been reported that English war vessels have communicated successfully in this way in Chinese waters when more than fifty miles apart.

Means of Communication.—Rapid communication, or exchange of orders, between distant parts of a large vessel is quite a problem. Verbal commands will not carry, and the person to be communicated with is usually out of sight. On the "New York" there is a speaking tube "exchange" below the protective deck and under the conning tower. Some 20 or 30 tubes converge at this point and connection is made between their ends by a short length of flexible tube, so that the commanding officers by calling the "exchange" operator can have his single tube connected with any other tube and *vice versa*. This system is crude, however, and the operator must be sorely perplexed when a number of calls are "blown in" at once. There is no way of distinguishing where the calls come from, unless the operator has a sufficiently musical ear to detect a difference in the notes of the tube whistles.

Steam Turbines.—Considerable attention has been attracted in England to the possible use of steam turbines, directly coupled to dynamos. Their great compactness and simplicity of construction makes them particularly suitable for marine plants, while their comparative high speed permits of the use of a very cheap dynamo ; for in dynamo construction the cost of manufacture varies almost inversely as the speed. Several shore plants using the direct-connected steam turbine have been installed in England, and the reports thus far are very favourable. If they prove reliable in service, some sacrifice of steam efficiency can well be afforded with their introduction aboard ship, on account of their many compensating advantages.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, March 29th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse : "The Structure of the Sugars, and their Artificial Production," by Prof. H. E. Armstrong.

SATURDAY, March 30th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture (V.) :—"Waves and Vibrations," by the Rt. Hon. Lord Rayleigh, F.R.S.

MONDAY, April 1st.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting at the Westminster Palace Hotel. The following Paper will be read : "Portland Cement; some Points in its Testing, Uses, and Abuses," by D. B. Butler.

TUESDAY, April 2nd.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Monthly Ballot. The following Paper will be read : "Torpedo-Boat Destroyers," by J. I. Thornycroft and Sydney W. Barnaby.

WEDNESDAY, April 3rd.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read : "Sand Blast Processes," by John J. Holtzapffel.

FRIDAY, April 5th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting at 28, Victoria-street. The following Paper will be read : "The Practical Measurement of Self-Induction," by C. V. Drysdale.

ROYAL INSTITUTION.

9 p.m. Evening Discourse : "Argon," by the Rt. Hon. Lord Rayleigh, F.R.S.

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* Capt. Bourke testified before the Court of Inquiry that it required three minutes, with a trained crew, and under ordinary drill conditions, to close the doors of the "Victoria."

The Electrician.

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SCIENCE TEACHING v. TECHNICAL "EDUCATION."

The "Student's Simple Apparatus for Determining the Mechanical Equivalent of Heat" has been almost forgotten in the latter part of the controversy begun some three months ago at a meeting of the Physical Society, and afterwards continued in our Correspondence columns. The earlier contributions to this discussion touched upon several matters of considerable importance, and left them unsettled. The stage in a student's course of physics at which he should understand the intelligent application of corrections and the realisation of such quantities as the mechanical equivalent of heat by turning on a ready-made piece of experimental apparatus; the extent to which a student's difficulties in laboratory work should be artificially smoothed; the use of direct-reading instruments, and the paradoxical suggestion that a student should not be allowed to time an experiment until he had made a watch, are only a few of the points which have been raised. The controversy, though apparently dealing with these details, has started a much more profound topic; one which has been gradually developing, but is not even yet ready for thorough discussion. In our comments on Prof. PERRY's communication, we remarked that the controversialists had ranged themselves into two parties, and, since parties must be dubbed with names, we ventured to call them educationalists and technologists. The present discussion has served to show that the division of parties is clearly defined, and the time must come when not only all those who are engaged in teaching science, but those who have to intelligently choose a course of scientific study for their sons, must decide between scientific education and technical instruction.

The old-fashioned school, if we are to believe the technologists, fails to appreciate the value of laboratory work, adheres to antiquated methods, and offers a halfpenny worth of practice to an intolerable deal of theory. On the other hand, the technical college, in the eyes of its critics, is a mere establishment for cramming the smatterings of a trade. The symptoms of jealousy shown by the advocates of either side are a healthy sign: attention thus becomes called both to the principles of teaching and to the subject matter. Better by far have open hostility between the two parties than the lifeless, apathetic routine which has justly brought classical education into such disrepute. Latin and Greek are sneered at by many science teachers, partly for their want of utility, and partly for their waste of time. The former allegation shows a lamentable lack of appreciation of education as distinguished from the acquisition of knowledge; the truth of the latter is due to the schoolmaster, who occupies eight or ten years of a boy's life in teaching that which a Girton girl can learn in as many months. The growth of technical colleges and their new system of instruction is easily accounted for. There was a sudden demand for electrical engineers, or rather for junior assistants, and the demand was quickly filled, not from the ranks of young mechanical engineers, but by schoolboys, who were passed through lecture rooms and laboratories so fast that a thorough grounding in electrical science was as impossible as a practical acquaintance with the principles of engineering. The long-continued flow of students would be a marvel, were it not that the employment of the large majority has turned out to be not engineering at all, but a special department of plumbing and gasfitters' work; so no harm has been done. These colleges have served a most useful purpose—they have met the sudden demand in an admirable manner; but one or two non-municipal have closed their doors, and the time is soon coming when the leading ones must consider the nature of the present requirements, and whether their organisation, mode of teaching, and laboratories may not have to be modified.

Against evening classes for artizans, against polytechnics, technical schools, and against the new kind of instruction commonly called technical education, we have not a word to say; the difficulty there, is to compress as much teaching into as few hours as possible. For the students in such classes the volt must be merely a unit of pressure seven-tenths that of a Clark cell; the ohm a resistance of 10ft. of 10mil. copper wire, and an ampere a convenient unit of current associated with the other units by Ohm's law. We are not discussing this useful sort of knowledge, or the cheapest way of imparting it; its immense value we thoroughly appreciate, and the importance of bringing it down, not only to artisans, but even to the fringe of the incompetent class which, in the least slackness of trade become "the unemployed," we clearly recognise; but we wish to discover whether the higher kind of technological instruction, which claims to compare with the science teaching of men like Glazebrook, Carey Foster, Rucker, Cornu and others, has any other justification than that of the mere shortening of courses, and the catching of the student who has been induced to believe that two years is enough to turn a schoolboy into an electrical engineer. It is very probable that the demand for such "electrical engineers" will soon fall off, if it has not already begun to do so. There will always be clever ones who even in two years learn much that will be useful to them in after life. Prof. Perry wrote of a "crystallised system of laboratory instruction of which the object is the gain of knowledge"; but is this all? Profs. Ayrton and Perry, the champions of technology, are far too good men for this—any crammer could run a crystallised system of laboratory instruction in accordance with a code, and impart all the knowledge set forth in a syllabus or batch of text-books. "It is," as M. Cornu clearly says, "in truth a battle between the scientific and the utilitarian spirit, between exhaustive and abbreviated instruction, between methodical treatises and pocket-books." We have no sweeping objection to the use of apparatus screwed down to a board, with connections already fixed, for the use of students red hot from a lecture in which it has been described, for it may be the only way of hurrying large classes through a laboratory; but we object to call it science teaching. This confusion of the acquisition of knowledge with education is not confined to science; it is undermining whole branches of learning, even, we believe, at Cambridge. The institution of a Mechanical Sciences Tripos, which we lamented some three years ago, is but an example of it. In commenting upon that departure, we observed that nearly the whole of the really scientific subjects of this Tripos fall under the head of mechanics—the first section of physics—and this applies still more forcibly to electrical engineering. If a student has no time to go through a complete course of physics, being by the force of circumstances compelled to specialise from the first, it need not follow, as M. Cornu suggests, that an abbreviated course of instruction must necessarily be incomplete. It would be possible to give him a course carefully selected from those branches of physical science which appear to form the foundation of electrical engineering. The narrowness of such a course is to be deplored, but still more deplorable is the encouragement of specialisation at so early a stage. To choose the profession of an engineer is a serious step, and one too often taken merely because a lad has shown a taste for making model engines. How much more difficult is it to intelligently choose a single and somewhat limited branch of the profession? Whatever the range of the course of study, let it be thoroughly scientific.

One of the lessons to be learned from this controversy is that it is quite possible to overdo laboratory work; of this the penny-in-the-slot experiment affords an example; the other extreme is the jam-pot and sealing-wax system. Somewhere between the two lies the ideal, and on each side of this ideal is a range of practicable systems, the one kind suitable for those who can devote three years or so to physical science, and the other for the artisan who can give but three hours a week during the winter months. It is the scientific education of the former class which is being endangered by the upward growth of technology. Instead of an intelligent and logical study of principles, the student is confronted with ready arranged apparatus which gives him, it is true, cut-and-dried information; but, as Prof. Boys writes, "he has no direct evidence; he depends entirely upon what he is told, or hearsay (whether told by a direct-reading instrument, by a demonstrator, or even professor, it is much the same), and therefore his conclusions are no more valuable than the evidence of a witness who begins by saying that he has been told this and has heard that." A student who does nothing but this sort of work in a laboratory may be compared to a policeman at the National Gallery, who cannot help becoming intimately acquainted with pictures, but does not necessarily know anything about art.

We must, however, again remind our readers that in this spirited controversy there has been a little tendency to exaggeration on both sides, and we do not believe that "the-student-presses-the-button-and-the-professor-does-the-rest" system plays nearly so important a part in the teaching at the leading technical colleges as the strict educationalists seem to imply. The scientific standing of the technologist teachers needs no comment, and more than one educationalist has in the course of this controversy paid tribute to the success of their labours as judged from the men whom they have turned out. We have not a doubt that the teaching of these leading colleges is based upon sound scientific lines, but for all that, we think that the educationalists have made a strong case for the true teaching of science to those who can afford this luxury. A course of scientific study will, no doubt, include subjects of little or no commercial value, and we hope that there may always be found students who are prepared, even though it be at the expense of a little more time, to go through a thorough and logical education. "Who shoots at the midday sun," said Sir Philip Sidney, "though he be sure he shall never hit the mark, yet as sure he is he shall shoot higher than who aims but at a bush."

REVIEWS.

The Measurement of Electrical Resistance. By William Arthur Price, M.A. (Clarendon Press, Oxford.)

This work comprises as many as 200 pages, and is by far the most complete treatise on the subject of resistance that has yet been written. The author is peculiarly well fitted for his task, since he has had during several years the superintendence of the construction of a large number of resistance coils, and also of the various forms of instrument in which these are used for purposes of comparison and measurement. The book contains a great amount of practical information which cannot fail to be most valuable to instrument makers, and interesting to all who have to deal with the measurement of resistances. There are over 70 diagrams illustrating the letterpress; all of these are good, and many of them are exceptionally clear and detailed. There are 12 chapters and six appendices. After first explaining the laws of resistance and the meaning of the ohm, the author proceeds to discuss, in Chapter II., the materials which have been used from time to time in the construction of resistances. A good account is given of the early work of Matthiessen and Hockin on the temperature coefficient of metals, and the laws of resistance fulfilled by alloys of the pure metals. The later work of Dewar and Fleming is also given, and their diagram showing the values of the specific resistance of various substances, determined at the very low temperatures which can now be produced by liquid oxygen and boiling ethylene at low pressure, and measured with the aid of the platinum thermometer of Callendar. The character of the copper and other substances now commonly used for resistances, appears to be purer now than in Matthiessen's time, and the numbers of these early experimenters, although quoted in all text books to this day, are only approximately true. The author has, therefore, very properly referred to more recent work, and alludes not only to the researches of Dewar and Fleming, but also to those of Guillaume. It would, however, have been better if the author had referred more fully to recent work than he has actually done. The measurements of Kennelly, for instance, might have been alluded to. The description of the properties of the various alloys used for resistances is good on the whole. Manganin, however, is very briefly referred to, the only information given being that which was first published about this alloy. The difficulties which makers have had in getting reliable quantities of this material, and the endeavours made to protect it from deterioration by gilding its surface, are not alluded to. Probably the majority of those who have had experience with it regard this substance as untrustworthy; but according to the author of this work "the electrical properties of the material seem to be quite permanent, but long series of observations are required to establish this to the degree of certainty of the platinum silver standards which have been under examination since 1865."

The two chapters on the construction of bobbins and the winding of coils are full of practical information, and are well illustrated. The tables given showing the size of wire to be used for various resistance coils of platinoid and platinum silver, are only instances of the immediate usefulness of the information which the book contains. There is one point in the winding of resistance coils, however, which all makers seem to ignore, and of which no notice is taken in this book. In order to construct non-inductive resistance coils, the wire is wound on the bobbins double, so that the currents in adjacent wires flow in opposite directions. This, of course, does away with the magnetic effect; but the capacity effect, owing to adjacent wires being at different potentials, is greater with this system of winding than if the coils were wound simply, like an electro-magnet. As a matter of fact, if coils of more than 1,000 ohms are wound in this manner, the inductance of them due to this condenser action is generally greater than the self-induction which is avoided by the method of winding. It is, therefore, expedient to modify the winding of high-resistance coils, either by winding them in sections or else by winding them partly on the inductive and partly on the non-inductive plan.

The chapters on commutators, switches, and the various forms of bridges for resistance measurements are admirable, and criticism can only take the form of suggesting one or two instances in which fresh matter could have been introduced with advantage. A large amount of space is well spent on the consideration of the various forms of the metre bridge and its accessories. The Carey-Foster method of using such bridges has been widely employed for scientific purposes, but it is also specially suitable for comparing a resistance coil with a standard, and has, consequently, been considerably used in the commercial manufacture of resistance coils. It is, therefore, a pity that the author of this work has not given a fuller account of the ingenious arrangements devised by various makers for the convenient use of the bridge for this purpose. One form, due to Messrs. Nalder Bros., might with especial advantage have been described. A modification of the metre bridge is also now much used for potentiometer work, and a description of such an instrument should have been included in the present book. The valuable work of Mr. Crompton in this direction is well known, and a good description of his apparatus for measuring voltages and currents of all values in terms of certain resistances, and the electromotive force of a standard cell, would have been a most useful addition to the information given. In the past, standard resistances have been used mainly for resistance measurements, but it appears likely that in the future some of their most important applications will be of an indirect character, in so far as they will be employed for the accurate measurement of the currents and potentials used in electrical engineering work.

The remainder of the book deals with the measurement of low resistances, insulation and cable testing, and the resistances of batteries and electrolytes, and concludes with a number of appendices, in which the mathematical theory of the various bridges and methods previously alluded to is worked out. Taken altogether, the book is an admirable treatise on the subject of resistance.

An Introduction to Physical Measurements. By Dr. F. Kohlrausch. Translated from the German by T. H. Waller and H. R. Procter. Third English Edition. Churchill, London.)

This treatise is by general consent looked upon as the standard work upon the subject of Physical Measurements, and the issue of the third English edition (translated from the seventh German edition) will be welcomed in every physical laboratory in this country and in America. The second English edition was taken from the fourth German one, and the present book thus embodies the numerous changes and additions which have appeared in the three last German editions. Dr. Kohlrausch has, moreover, widened the aim of his work so as to provide not only for the needs of students, but also to some extent the explanations and directions useful to those undertaking research work. In order to make the book yet more complete and reliable, the author obtained the assistance of a number of distinguished German specialists for certain sections of the work, and suitably acknowledges his obligatio to them. The amount of new matter which, under these umstances, has been introduced is considerable; so mu that the present edition contains nearly four times the n r of pages that appeared in the first German edition, issu in 1869. For facility of reference and comparison with former editions, the original numbering of the sections of the book has been retained as far as possible, and where fresh matter is introduced it has been classed with one of the old sections, its only distinguishing mark being a suffix attached to the number of the section. Thus, whereas in the last edition section 71 has no subdivision, in the present volume there are no less than seven parts of this section, occupying 18 pages, instead of three as formerly. One of the most useful features of this work arises from the insertion of numerous references to original researches, and from the addition of a number of valuable tables at the end of the book. In both these respects the present edition has much improved on the previous one. The portion of the work which has been most added to is naturally that which relates to the science of electricity.

We have, in general, nothing but praise to bestow on this book. There are, however, one or two blemishes. The references are almost entirely to German researches. This is quite excusable in a German edition, since the author distinctly states that he does not express any judgment as to priority, and that the bibliography was arranged chiefly with regard to the accessibility and serviceable character of the reference. A judicious selection of references to English work would, however, have increased the value of the book, even from a German point of view; while it is, of course, obvious that, in an English edition, there is every reason for a preponderance of English references. It is strange to find no reference to the work of Lord Rayleigh when the silver voltameter is described, and equally so to find the subject of the absolute measurement of resistance dismissed without allusion to the work of the British Association and the later work of Rayleigh.

The translators might, without much trouble, have removed the foreign appearance of the mathematics given in the book by using symbols more usually employed in England. It is true that there is no common agreement in this country as to symbols, but, although we may use many different letters to represent the strength of a current, we never use the letter J for this purpose, whereas in this book it is so used throughout. In English works, too, the natural logarithm of a quantity k is denoted by $log._{\epsilon}\, k$, but throughout this book it is represented by *log. nat. k*. On pages 366 and 367 the symbol used for the coefficient of self-induction is Π, although the universally used English symbol for this quantity is L. The Greek capital letter, when used in this connection, is bad enough; but when lower down, on page 367, the small letter π is employed for the same purpose, the only excuse which can be offered for such a grave misuse of a symbol universally employed to represent a definite number is that it is the fault of the printer, and an oversight on the part of the reader of the proof sheets.

Electricity, Electrometer, Magnetism, and Electrolysis. By G. Chrystal and W. N. Shaw. (London: A. and C. Black.)

The above work is a reprint of a number of articles taken from the ninth edition of the "Encyclopædia Britannica." Hitherto, anyone wishing to procure a copy of Prof. Chrystal's able article on Electricity has been obliged to purchase Part XXIX. of the "Encyclopædia," containing, besides the subject mentioned, a lot of information about the Elephant, Elijah, Elecampane, and other matters which, though useful in their own way, are not of absorbing interest to the electrician. It is now possible to buy, at two-thirds of the price of part XXIX., a pamphlet which contains not only the article on Electricity, but also the sections on Electrolysis, Electrometallurgy, Electrometer, and Magnetism. The subject matter is merely reprinted, and the reader must not expect to find any account of the important practical developments of these subjects which have taken place since the publication of the ninth edition of the "Encyclopædia." The extent of some of these developments is brought forcibly to the mind of the reader of these pages. The issue of an English work, nowadays, dealing with the subject of magnetism without making the slightest allusion to the researches of Ewing, is a wonderful curiosity. The article on the electrometer, of course, lacks any reference to the recent developments in electrostatic instruments; and other instances could be pointed out which show how great have been the advances since the writing of the articles in question. But although the practical development of the subject has been remarkable, the theory has remained in much the same state as before, and the reader will, at a very low cost, find in this work a clear and exhaustive exposition of the theory of electricity.

Electrical Engineering as a Profession: How to Enter it, and Guide to the Engineering Profession. By A. D. Southam. (London: Southam and Co. 1895.)

The bewildering "guide" does little more than offer a quantity of undigested information to parents, students, and others who may be tempted by its straggling title to turn to its attractively illustrated pages for advice. The most interesting part is contained in five pages giving a collection of the opinions of several leading firms and engineers which have from time to time been published in various technical periodicals, but even these are thoroughly contradictory. We heartily endorse every word of Prof. Kennedy, who is said to hold very firmly to the idea that an electrical engineer must first be made a thorough-going mechanical engineer, and that mere electrical knowledge, however complete, without all the training that a mechanical engineer ought to have, is of little use for the actual work which the engineer has to do. On the other hand, Mr. James Swinburne is quoted as asserting that training given at technical colleges is sufficient in itself for without going through the shops. Mr. Swinburne's remarks, however, relate to work of a "semi-scientific nature," and he admits that he does not care about proficiency in such matters as dynamo or transformer design. The attempted analysis of the engineering profession into sub-divisions is quite illusory, and the author concludes this section by stating that an engineer may be either consulting, contracting, or manufacturing, the *two former* and the two latter often running together!

Part II., which occupies more than three-quarters of the whole volume, contains condensed descriptions of various technical institutions, elaborately illustrated. The space given to the different colleges is ridiculously ill-proportioned to their importance, and thus the descriptions become distinctly misleading.

Part III. gives particulars of fees and conditions of pupillage with electrical and with general engineering firms. In the former class there are several third or fourth-rate concerns who would merely use their pupils as unpaid workmen. This section is utterly out of proportion to the rest of the book, and the only excuse for it is that a good deal of information about the colleges can be easily obtained from prospectuses, while details from firms can, for the most part, only be obtained by letter.

Opinions on the best course of training for an electrical engineer differ very widely. The ideal, we think, is three years at Cambridge or Oxford, taking physics and chemistry, with, perhaps, the elements of another science or two. Then two, or better, three years in a general mechanical engineer's works, and, finally, a year at a technical college. This year may, however, be taken after one year in the works, going back to the works afterwards, for there is a better chance of employment from the works. A few years ago, six or seven years were spent in the works, but then technical colleges were unheard of, and competition was not so keen. For those who cannot spare these years, Mr. Crompton's advice, given in Mr. Southam's book, is good. Leave school at 17, two years in a technical college, a year and a-half or two years in a mechanical engineering workshop, to learn pure mechanical engineering, and electrical works for two years afterwards. For those who have even less time to spend, we would suggest one year in the shops, one at technical college, if possible qualifying as a second-year student, and then two years in the shops again. If a further reduction in time and expense is necessary, knock off the first year in the shops, and, lastly, knock off the college altogether and rely on two years in the shops, and book work. Bearing Prof. Kennedy's advice in mind, a general mechanical shop is to be preferred to anything but the very best electrical works, and not only on the grounds given by Prof. Kennedy, but because it is almost impossible for a lad to intelligently prefer electrical engineering to mechanical engineering when he knows nothing about either. When he is a qualified mechanical engineer he can easily pick up his electrical science, but if he has nothing but electrical knowledge he is incapable of taking a mechanical job if he should have the chance of it. Six months in the best works would be worth more than three or four years with some of the firms mentioned in this book.

The Engineer's Year-Book. By H. R. Kempe. Second Year. (London: Crosby Lockwood and Son. 1895.)

The author does not clearly define in his preface what he means by a year-book; but we gather that it is one that needs periodical revision. By far the most useful part of the book is the tables, which may, perhaps, be modified and re-arranged from time to time. We find, for example, that a very clear table of six-figure logarithms is added this year; these obviously will not need revision. A long article on the Forth Bridge has been wisely omitted this year, and the one on the construction of the Eddystone lighthouse, and handy rules for the demolition of bridges, might well follow it. The electrical section is short; but needs a little revision. In the section on accumulators we are told that "the acidulated water contains 25 per cent. of sulphuric acid," but not a word about the specific gravity; also that "the charging electromotive force should not exceed the electromotive force of the accumulator by more than 5 per cent." What can this mean?

A Treatise on Practical Photometry. By A. Palaz. Authorised Translation from the French, by G. W. Patterson and M. R. Patterson. (New York: D. Van Nostrand Company. London: Sampson Low, Marston and Co., Limited.)

We reviewed the original French edition of this book at great length, since it was, and still remains, the only thorough treatise on the subject, and it is therefore unnecessary to refer to its contents. It has now been translated into the American language by an assistant professor of physics in the University of Michigan. The printing is a great improvement upon that of the French work, and the illustrations have been re-engraved. The translators have added an appendix in which an opportunity was afforded for bringing the book up to date, but it contains very little that is useful or new. Not only is the photometrical work of Abney omitted, but even the researches of their own countrymen have not been noticed by the translators.

La Galvanoplastie. By Émile Bouant. (Paris: J. B. Baillière et Fils.)

This is a clearly-written and clearly-printed little book; but, although there is a diagram of connections in which an ammeter is boldly depicted, there are far too few data as to the current densities to be employed in the various processes, and the selection of a proper current density is the kernel of the whole matter.

INTERIOR CONDUIT WIRING.

The fact that a system of insulation has met with a wide success in America is but little recommendation to English engineers, since it is only comparatively recently that wiring has been done in the United States in what we should consider a safe and workmanlike way, and, besides this, the dry climate of America allows many materials to be used as insulators which would be quite useless here. Besides a natural disinclination to adopt a cheap labour-saving expedient of American origin for first-class work, English engineers are strongly inclined to stick to methods which have proved to be satisfactory in the past, especially when a new method needs re-training of their staff, or when the material can be bought only from one dealer, the sole agent for the patent. Concentric wiring labours under these two disadvantages, and they exist in a minor degree in the materials used for "interior conduit wiring." The advantages of this system, which is now being offered on the English market, are, however, so pronounced that they deserve the attention of all those who are engaged in wiring. One feature of this system is that it entails no special kind of switches or other fittings; but, on the contrary, the blocks for switches, sockets and roses are designed to save a good deal of labour. The "conduits" consist of tubes of paper impregnated with bitumen tempered with a mineral oil. They are intended to supersede wooden casing. The material is distinctly less inflammable than wood, and the central partition between the conductors is deliberately abandoned. For the almost universal use of wood casing, and for the central partition, through which screws are generally put, we have to thank the insurance companies, but it is very satisfactory to learn that all the insurance companies save one have accepted the interior conduit system, and even this last one has permitted its use in certain cases; these cases, as usual with this office, not being allowed to form precedents for further use without special sanction of the inspector. The insulation offered by the tubes themselves is not very high, but it is at least better than wood. Should a short-circuit occur within the tube, combustion of the material is, we understand, practically impossible, although, of course, a tube can be burned by holding it in a fire. For the best kind of work the tubes are cased in iron or brass. Without such casing, it is claimed that they are distinctly cheaper than wood. A very simple joint and round-elbow pieces are provided, and a considerable part of the saving is effected by the total abolition of mitres, and, therefore, of skilled labour. As the wires can be easily withdrawn and replaced after the tubes are fixed, it is urged, and we think very sensibly, that there is no objection to burying the work in plaster. The chief reason for surface work with wood-casing is accessibility in case of need; here, the rounded corners offer accessibility, but from the ends, and not by taking off the capping. Several firms have given it a trial, and we have no doubt that a little experience with it will reveal many other advantages than those to which we have referred.

THE SOUTHWARK BRIDGE EXPLOSION.

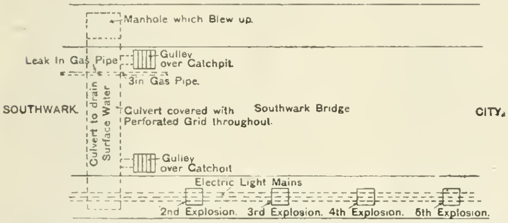
MAJOR CARDEW'S REPORT.

The following is an abstract of Major Cardew's report of the Inquiry held by order of the Board of Trade into the circumstances connected with a series of explosions which occurred on February 1st on Southwark Bridge. An account of the proceedings at this Inquiry appeared in *The Electrician* of February 8th, together with a plan (reproduced on page 679) of the arrangements of pipes, &c., at the spot where the explosion occurred. The report is dated February 7th. After explaining the diagrams accompanying the report the Inspector goes on to say:—

> From the evidence given at the inquiry there appears to be no doubt that the first explosion occurred in the culvert under the pavement and roadway on the west side of the south end of the bridge. Several witnesses were positive that this explosion occurred first by an appreciable interval of time, and one of them, Mr. W. C. Palmer, could hardly have made a mistake on this point, as he was in a pony-cart close to the explosion, and the pony and cart had moved across the road before the second explosion took place. This first explosion was by far the most intense of all which occurred, many paving stones being completely shattered. One woman was reported to be rather seriously injured by the *débris*. It was immediately followed by three explosions in the street boxes of the Electric Lighting Company on the opposite (east) side of the bridge. One woman and two men were injured by these explosions, one man being blown up about 6ft. or 7ft., according to the evidence of a policeman. This man, however, was able to give evidence at the inquiry. The covers and frames of the boxes were broken, and the pavement displaced at each box.
>
> The officials of the Electric Lighting Company were on the spot shortly after the occurrence, and those of the Gas Company as soon as they could be summoned. They found both the gas-meter boxes full of gas, which was also issuing freely from the gully grating over the catchpit on the west side. On opening the ground over the culvert, a large crack was found in the 3in. gas main, out of which the gas was coming in volumes. This crack extended about half way round the pipe, on the upper side. There was also a longitudinal crack in the pipe at the same place, but this appears to have been an old injury, and to have so far rusted up that there was little, if any, leakage through it. The roadway over this gas pipe was frozen very hard, and was practically impermeable to gas, but between the pipe and the grating of the culvert immediately below it the soil was very loose, and some vacant space seems to have existed. Thus the gas found easy access to the culvert.
>
> How it was fired cannot, I fear, be exactly ascertained, but I think I can confidently assert that it was not by means of the electric lighting mains. As before mentioned, there were no electric mains in the immediate vicinity of the first explosion, and the empty pipes prepared to take the mains do not appear to have been in any way injured. These pipes,

is true, communicate at a distance of about 16ft. with a street box which contains electric mains. I examined this box, but found no signs of any firing of gas having taken place within it. The voltmeter records of the Electric Lighting Company show no trace of disturbance on the circuits at the time of these explosions, and as the mains in use were all concentric cables, the outer conductors of which were thoroughly connected to earth at the generating station, I do not think they are likely to have produced a spark. The fact that there was no explosion in the street boxes on the west side of the bridge is a further proof that the escaped gas had not penetrated into them, and in consequence that it could not have been fired by the electric mains. It was stated in evidence that a match which had recently been alight was found in the catchpit communicating with the culvert, and this may possibly have fired the gas. I believe that in the case of firing by ordinary flame it sometimes happens that the gas burns quietly for a considerable time should it be in too great a quantity to form an explosive mixture, and that when the flame reaches a layer of explosive composition a violent explosion may result. It is, I think, quite possible this may have occurred in this instance, and that the person who threw the lighted match into the catchpit may be quite unaware that he thereby caused the explosion. The only other cause I can suggest is a spark struck by a horse's foot or a wheel close to the gulley grating out of which the gas was issuing freely.

The explosion appears to have traversed the culvert and followed the course of the gas, which had percolated into the electric light street box marked *a*[*], on the east side of bridge, whence it found its way by means of the pipes to those marked *b*, *c*, and *d*[†]. The access to street box *a* appears to have been afforded by imperfect sealing round the pipes entering the box, which passed just over the culvert. This was tested by firing some smoke rockets inside this street box, when the smoke appeared in considerable volume at the culvert after about one minute, and seemed to be travelling along the outside of the pipes. Apparently, on the west side, the gas was unable to force its way into the electric light street box, but in this case the street box had only been constructed, and the pipes in connection with it laid, about a fortnight before the explosions occurred, and the pipes crossed at a greater height above the culvert. Having obtained access to street box *a*, the connecting pipes gave an easy passage to *b*, *c*, and *d*. As far as street box *c* the slope of the roadway favoured the passage of the gas, beyond that it was forced down the slope by the pressure from behind, and, no doubt, travelled more slowly. The explosion in *d* appears not to have been quite so violent as in *c*. Had more time been allowed for the penetration of the gas along the system of pipes, there is every reason to believe that more explosions would have occurred.



The existence of numerous empty pipes in the system of mains laid by the City Electric Lighting Company, to which I called attention in my report on the Cannon-street explosion in November last, greatly facilitates the passage of gas should it find access in considerable quantity at any point.

This accident appears to me to suggest far more serious cause for anxiety than that which recently occurred in Cannon-street. It is true that in this case there was no electrical charging of the ground, or any defect in the electric lighting mains, and that the explosions were not due to any electrical action; but the Cannon-street accident was caused by a gross blunder on the part of the Electric Lighting Company, and the Company have since taken steps to make a repetition impossible.

The most striking features about the Southwark Bridge accident are—(1) the distance to which it appears that a series of explosions may travel along the electric mains which form a gigantic network under the whole of the streets of the City; and (2) the proof it affords of the insufficiency of any ordinary system of ventilation of these pipes and street-boxes, if gas can find an easy access to them, and the necessity of exercising great care to make and keep the street-boxes impervious to gas.

The culvert which exploded in this case was provided by means of the catchpits and gulley gratings with large openings for the escape of gas, and yet these did not prevent the explosion, and indeed probably enabled the accumulated gas to be fired. This culvert, however, so far from being impervious to gas, permitted it easy access through the openings of the grating forming the lid of the culvert.

After very careful consideration of the recent accident, I adhere to the recommendations as to prevention of accumulation of gas detailed in my report on the Cannon-street accident.[‡] Had these been carried out, there would have been no explosion in the electric light conduits. I am, however, inclined to give more emphasis to the suggestion that the air capacity of the street boxes should be reduced by filling with incombustible material, and to add that unless and until an efficient system of ventilation by forced draught is provided, all the pipes and conduits should be thoroughly plugged at each street box (as recommended by Major-Gen. Webber, C.B.). With this addition, I can only repeat the requirement No. 7 of my former report—"Accumulation of gas should be prevented by thorough ventilation, by making the sides and bottoms of street boxes impervious to gas, and by filling up the boxes as far as practicable with incombustible material." To this I would now add "by thoroughly plugging pipes and conduits at each street box to prevent passage of gas along the system," and I put the filling up the boxes first, as the most simple and certain method of preventing danger of explosion. In cases where the street boxes are completely filled up, it will obviously not be necessary to adopt the other precautions.

So far the Electric Lighting Company have done very little towards carrying out this requirement. It appears that only 18 street boxes have been provided with ventilating pipes, and these are not, in the cases I have examined, carried up at least 8ft. from the ground as recommended by me, but terminate a few inches from the pavement. The Company have, however, protected the orifices with a cap and a screen of fine wire gauze, which may sufficiently guard against the danger of the gas issuing from these pipes becoming ignited by a match carelessly thrown near them. It must be admitted that in this case the main cause of the explosions was the defect in the gas-pipe, and it again directs attention to the very serious danger to the public arising from the condition of the gas-pipes in many districts, and the way in which they are laid and supported; a danger which is continually increasing owing to the spread of the use of wood paving and other impervious surfaces, and which is temporarily intensified by every severe frost. No remissness on the part of the gas companies can, however, relieve the Electric Lighting Company of the duty of thoroughly complying with regulations (14) and (15) by sufficiently protecting their conduits and street-boxes against an accumulation of gas. How this may be done I have already specified in this report and in my report on the Cannon-street accident, and I recommend that the Board of Trade should require the City of London Electric Lighting Company to at once take the necessary measures to fully comply with the regulations imposed upon them by the Board of Trade for the protection of the public safety.

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[*] Marked "2nd Explosion" in diagram reproduced herewith.

[†] Marked "3rd Explosion," "4th Explosion," "5th Explosion," in diagram reproduced herewith.

[‡] See *The Electrician*, February 8th, p. 428.

THE BRISTOL FATALITY.

MAJOR CARDEW'S REPORT.

Major Cardew, the electrical adviser to the Board of Trade, has reported upon the Bristol fatality, in which a Corporation official, Robert Coleman, lost his life by electric shock. The report is as follows:—

The system of supply adopted by the Corporation of Bristol is a high-pressure alternating current supply to converting stations, from which a low-pressure supply is given to consumers. The converting stations are, as a rule, established in cellars, to which the employés of the Corporation alone have access. Each station contains two transformers, which are inclosed in iron cases connected to earth, and a high-tension terminal board (details of which are shown in a drawing attached to the report). These terminal boards were intended to be used for the purpose of switching transformers in or out of circuit from the generating stations, by means of suitable switches actuated through the "pilot" wires, which are separately insulated in the high-pressure mains. This arrangement has, however, not yet been worked out, and I greatly doubt whether any such method would be found practicable. At present the "terminal boards" are only used to carry high-pressure fuses (pattern shown in a drawing annexed to the report), and it has been found necessary to dust the arrangement occasionally to prevent leakage. The unfortunate man was engaged in this operation, and the rule was that he should do this with one hand only, and should wear an india-rubber glove on that hand, but he neglected his orders by holding the other end of the duster with his left hand, which was unprotected. While rubbing the charged metal with the duster, he looked up, and was apparently about to speak to Mr. W. J. Wilcocks, another employé who was accompanying him, when the knuckles of his left hand touched the charged metal, and he uttered a loud cry, and then seems to have lost consciousness, but remained in a standing attitude leaning slightly against the terminals and, of course, with a powerful current passing through his body, until Mr. Wilcocks got behind him and pulled him off by his coat. Artificial respiration was tried, but without effect. The floor on which the man was standing at the time was of Portland cement and slightly damp, and no doubt the current passed to earth through his feet. The accident is due, in the first place, to great carelessness on the part of the man who was killed; but such carelessness on the part of uneducated men, when constantly dealing with electrically-charged metal, is very natural, and should be provided against by all possible safeguards. In this case I cannot say that proper forethought had been shown. The metal terminals and fuses were so placed as to be easily touched, and the man was required to attend to their condition while they were charged. The only precaution adopted was a verbal order that only one hand protected with an india-rubber glove was to be used. Granting that the duty was one which was absolutely essential, much greater safety would be secured by providing that the man should wear india-rubber gloves on both hands and india-rubber shoes, by making the floor of insulating material, such as asphalt, and by placing a guard of vulcanite round the exposed terminals. I cannot see, however, that the exposure of the high-pressure terminals and fuses in this case is at all essential. It is a very common arrangement to inclose these within the iron casing of the transformer, and when so arranged they can be left for months without examination. In this case the pressure would be switched off at the central station before sending a man to make an examination of the fuses and fittings within the casing. I strongly recommend that this arrangement should be carried out, at any rate until suitable apparatus has been provided. Another matter to which I drew the attention of the electrical engineer, and which I consider calls for remark, is the danger involved in the design and position of the high-pressure fuses on the switchboard at the generating stations, which are such as to make it inconvenient, and even difficult, to take out a fuse without touching metal charged to 2,000 volts. It may be necessary, but it is certainly inconvenient, to have exposed metal charged to high pressure on these switchboards, and the danger is to some extent reduced by the fact that the floor is of wood, and generally thoroughly dry, but the safety of the employés should be carefully considered in the design and position of the apparatus.

The Bristol Electrical Committee of the Corporation have considered the report, and are taking steps to supply the safeguards indicated by the Inspector. The Committee, however, think it should be known that the arrangements of their stations and sub-stations were made under the supervision of their consulting engineers, on whose judgment they naturally relied.

ON THE THERMO-ELECTRIC PROPERTIES OF PLATINOID AND MANGANIN.[*]

BY B. O. PEIRCE.

During the last few years the attention of many physicists has been occupied with the attempt to discover an alloy in every respect suitable for making standards of electrical resistance. Such an alloy, it is evident, must be non-magnetic, ductile, not easily corroded and easily soldered to copper and brass. It must have a high specific resistance independent of the temperature and, when drawn into wire, its resistance must not be subject to secular change.

No one[†] substance is yet known to satisfy all these conditions completely and, since there is still some doubt about the permanency of artificially-seasoned resistance coils made of manganin wire, many makers of standards prefer to use platinoid in spite of its comparatively high temperature coefficient.

I have been trying of late to reduce as much as possible the disturbing effects of thermo-electric currents in a certain standard slide wire bridge and have had occasion to determine the thermo-electric relations of copper to such platinoid[‡] and manganin as are to be obtained in the market. A few years ago such determinations would have had very little practical value, since different specimens of copper had very different positions in the thermo-electric scale; but this last statement is no longer true of copper bought in the American market. I have tested against each other many specimens of copper wire of different sizes, chosen at random from a rather large stock bought at intervals during the last five years, and the highest electromotive force that I have obtained was 0·66 microvolts per centigrade degree, and this was exceptionally large. I believe that a thermal junction made of two specimens of annealed copper wire bought of different reputable makers would probably not yield more than one or two C.G.S. units of electromotive force per centigrade degree, even if one were as large as No. 10 and the other as small as No. 36 on the American [||] gauge. Prof. E. H. Hall tells me that he has tested several specimens of commercial copper wire of different sizes against plates of electrically deposited copper, and that the electromotive force of every one of these combinations was extremely small or insensible. When such results as these are compared with those obtained 15 or 20 years ago,[*] it is evident that great progress has been made in the manufacture of copper wire for electrical uses, and that commercial copper has now a pretty definite thermo-electric position.

The platinoid wire which I used was of two sizes (Nos. 19 and 28 of the American gauge) and was bought about four years ago of Messrs. Elliott Brothers, of London.

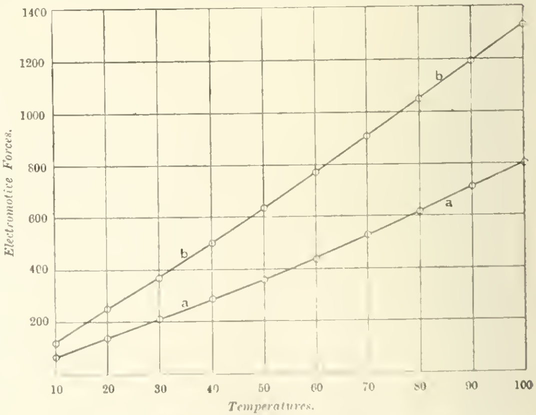
The so-called "manganin" wire was of seven sizes bought at different times through Messrs. Gillis and Gleeson, of Messrs. Bradford, Kyle and Co., of Plymouth, Mass. The largest size (No. 18) was hard drawn; the other sizes were all annealed. Three specimens (Nos. 18, 26, and 30) showed, when examined, qualitatively only a trace of nickel in combination with copper and manganese.

Each of the wire thermal junctions when in use was immersed close to the bulb of a thermometer in a bath containing about a litre and a half of heavy paraffin oil, and furnished with a stirring apparatus. Each oil bath was set into and jacketed by a vessel of about 10 litres capacity, into which ice or warm water or steam could be introduced, or which could be used as an air bath. The electromotive forces of the different combinations were determined by compensation on a potentiometer. When, for the purpose of obtaining a rough check on the other results, quicksilver was opposed to platinoid or to manganin, the lower end of a very large test tube containing about 40 grammes of redistilled mercury was deeply immersed in each oil bath, and the contents of the two tubes were connected by a long glass syphon filled with mercury. The bulb of a thermometer and an end of a piece of wire of the kind to be examined were immersed in the mercury of each test tube, and obvious precautions were taken to prevent undue loss of heat from the contents of the tubes. The following table gives the results of observations made in this way with platinoid wire No. 19, and with hard-drawn maganin wire No. 18. In each case the current passes across the hot junction from the first-named metal to the second, the electromotive forces are measured in microvolts, and the temperatures of the junctions are given in centigrade degrees.

Table I.[*]

Temperatures of the junctions.	Electromotive forces.	
	Mercury *v.* manganin.	Platinoid *v.* mercury.
0° and 10°	66	123
0° and 20°	136	246
0° and 30°	209	372
0° and 40°	283	500
0° and 50°	359	631
0° and 60°	438	766
0° and 70°	524	906
0° and 80°	613	1,048
0° and 90°	704	1,190
0° and 100°	797	1,331

When the hard-drawn manganin wire No. 18, in a thermal junction, was for the first time raised to the temperature of boiling water, and then slowly cooled, the results of a series of observations of electromotive force taken during the cooling were sometimes rather irregular, though they agreed in general fairly well with the regular results (in complete agreement with one another) obtained on a second, third, or subsequent heating. The platinoid wire always gave regular results from the first, and these were repeated with a given specimen as often as the junctions were



CURVE 1.—(*a*) Mercury *v.* Manganin; (*b*) Platinoid *v.* Mercury.

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[*] From the *American Journal of Science*.

[†] Feussner and Lindeck *Zeitschrift fur Instrumentenkunde*, 1889, pp. 233—236; Nichols, *Amer. Jour. Science*, 1890, pp. 471—477; Ahler, Haas and Angerstein, *Electrotechnische Zeitschrift*, 1891, p. 250; Feussner, *Electrotechnische Zeitschrift*, 1892, p. 66; Milthaler, *Wiedemann's Annalen*, XLIV., 1892, pp. 297—305; Lindeck, *Wiedemann's Annalen*, XLVI., 1892, pp. 515—516; Weichert, *Wiedemann's Annalen*, LIII., 1893, pp. 67—75.

[‡] Bottomley and Tanakadate, *Phil Mag.*, XXVIII., 1889, pp. 163—169.

[§] Englisch, *Wiedemann's Annalen*, L., 1893, pp. 88—110.

[||] The diameter in inches of wire No. *n* in the American gauge is approximately $(0{\cdot}32)\,2^{\frac{n}{6}}$.

[*] See Everett's "Physical Constants," p. 151

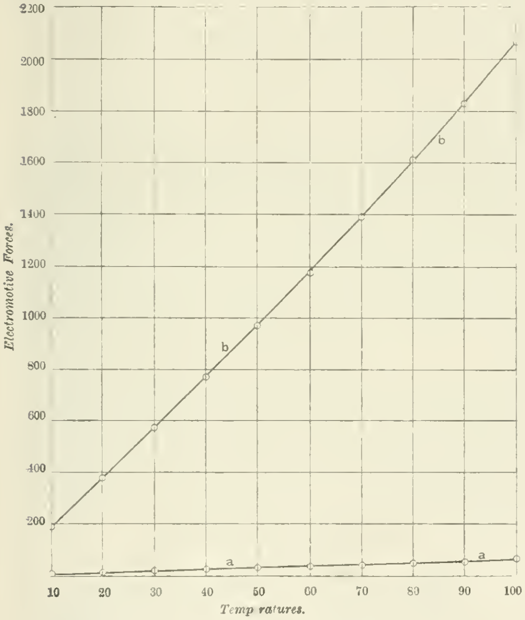
[*] [We have ventured to bring out the meaning of these tables more clearly by plotting the observations in the form of curves.—ED. *E.*]

brought to the same temperatures. The annealed manganin wire showed no irregularities on first being heated. The results of a large number of completely accordant observations with thermo elements made of copper and either platinoid wire No. 19 or manganin wire No 18 are given in the next table.

Table II.

Temperatures of the junctions.	Electromotive forces.	
	Copper *v.* manganin.	Platinoid *v.* copper.
0° and 10°	4·3	189
0° and 20°	9·2	379
0° and 30°	14·1	572
0° and 40°	19·6	769
0° and 50°	25·7	971
0° and 60°	32·6	1,179
0° and 70°	40·2	1,391
0° and 80	48·1	1,609
0° and 90°	56·4	1,834
0° and 100	64·9	2.063

The thermo-electric effects at the junctions with their copper terminals of resistance coils would evidently be far less under given conditions if the coils were made of this specimen of manganin than if they were made of the platinoid. Moreover, this hard-drawn manganin wire could advantageously be used as a slide wire, since accidental heating of a portion of the wire would not alter its resistance appreciably, and since the thermo-electric effects at the junctions of the slider would be insensible. On account of its high specific resistance very fine manganin wire has been much * used as a slide wire in potentiometer work.



Curve 2.—(*a*) Copper *v.* Manganin ; (*b*) Platinoid *v.* Copper.

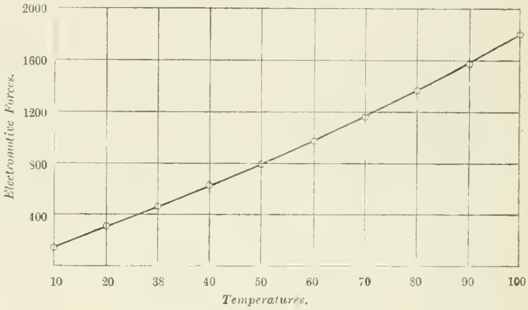
A pair of thermo-electric junctions made of copper wire and a piece of the manganin wire No. 18, which had been kept for about a minute at red heat and then suddenly cooled, gave an electromotive force of 65·9 microvolts when one junction was kept at 23° and the other at 93°. It is instructive to compare this result with the results of experiments mentioned below which were made with manganin wire thoroughly annealed in the manufacture.

The numbers given in Table II. for the electromotive force of platinoid against copper do not agree very well with the results obtained by Messrs. Bottomley and Tanakadaté, who found for the electromotive force of this combination the two expressions $-1,246-5{\cdot}44t$ and $-1,294-4{\cdot}88t$ in C.G.S. units. My experience seems to show that, as these gentlemen suspected, different specimens of platinoid wire have different places in the thermo-electric scale. A number of thermopiles made of platinoid wire No. 28 and copper gave results which agreed with one another perfectly, except for such extremely slight differences as might properly be charged to errors of observation ; but these results were quite different from those obtained with the larger platinoid wire and much closer to those of Messrs. Bottomley and Tanakadaté.

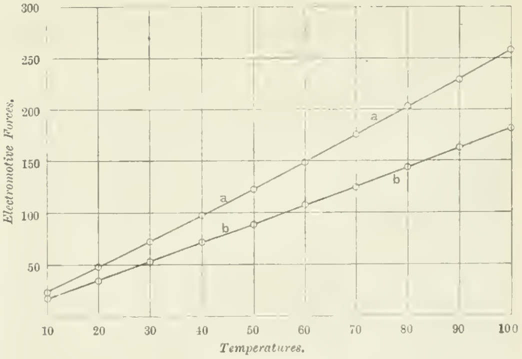
Table III.

Temperatures of the junctions.	The electromotive force of platinoid wire No. 28 *v.* copper.
0° and 10°	152
0° and 20°	306
0° and 30°	465
0° and 40°	628
0° and 50°	799
0° and 60°	973
0° and 70°	1,159
0° and 80°	1,356
0° and 90°	1,569
0° and 100°	1.787

Of annealed manganin wire I had considerable quantities of nine different specimens, and these were of six different sizes, 22, 26, 28, 30, 33, and 36. Of this wire Mr. C. J. Shanahan and I made a very large number of thermo-electric junctions, sometimes opposing one specimen of manganin wire to another, and sometimes to copper. Experiments with these junctions showed that one specimen (No. 22) differed rather widely from the others, which were thermo-electrically pretty close together, and that the thermo electric position of the abnormal wire was in no way changed by heating it repeatedly red hot and cooling it suddenly.



Curve 3.—Platinoid Wire *v.* Copper.



Curve 4.—(*a*) Copper *v.* Manganin Wire, No. 22 ; (*b*) Copper *v.* Ordinary Annealed Manganin.

Table IV. gives the results of numerous experiments upon thermo-electric junctions made of annealed manganin and copper. The numbers in the first column of electromotive forces were obtained with the No. 22 wire just mentioned ; the numbers in the last column are the averages of corresponding numbers in a table where each of the other eight specimens of wire had a column for itself. There were slight persistent differences between these last-mentioned wires, but there was no apparent relation between the size of a wire and its thermo-electric position. It will be noticed that the electromotive force of no one of the manganin-copper combinations experimented on was greater than about one-seventh that of the weakest of the platinoid-copper combinations under similar circumstances.

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* H. M. Goodwin, *Zeitschrift f. Physikalische Chemie*, XIII., 4, 1894.

Table IV.

Temperatures of the junctions.	Electromotive forces of	
	Copper *v.* manganin wire No. 22.	Copper *v.* ordinary annealed manganin.
0° and 10°	24·0	17·3
0° and 20°	48·0	34·7
0° and 30°	72·5	52·3
0° and 40°	97·4	70·1
0° and 50°	123·0	88·0
0° and 60°	149·0	106·0
0° and 70°	175·0	124·4
0° and 80°	202·0	143·0
0° and 90°	229·0	161·4
0° and 100°	257·0	180·0

THE ELECTRIC ANNEALING OF ARMOUR PLATE.*

BY ELIHU THOMSON.

It is now some time since the application of electric welding was made to projectiles for the purpose of building them up, and for producing shells or uniting hardened tips on armour-piercing shells, &c. The present statement, however, will refer to the use of electricity in a novel way to render the armour plate more vulnerable, more especially to the drills and taps of the artisan, and not to projectiles—that is, to make them workable for the drills and taps when the armour plate is being made ready for placing in position, or after it has been placed in position on a modern war ship. The armour plates as now produced are frequently "Harveyised"—that is, provided with a skin of hard steel of greater or less thickness. This coating has been produced by keeping the plate hot in contact with carbon so that the carbon enters the face of the plate, or enriches the face of the plate in carbon, which by a subsequent chilling operation acquires the properties of very hard steel ; when struck by a projectile this hardened surface acts to damage the projectile or break up its puncturing end, and so prevents entrance into the body of the plate, which is of soft material back of the Harveyised surface. The thickness of the Harveyised chilled coating may vary from ½in. to ¾in., more or less.

While it is possible in producing the armour plate to protect certain areas from carbonisation, and thereby retain some portions of the face of the plate soft when the armour plate is finished, still it is very difficult to arrange that these soft places shall be exactly where they are wanted, or that they shall surely be in a condition to admit of drilling and tapping.

Soon after the introduction of the Harveyised plates, it became a great desideratum to be able to locally anneal or soften the chilled surface to a depth sufficient to include all the hard steel at any particular point where it might be necessary to drill the plate in assembling it upon the war ship under construction. Various means, such as the application to the svrface of the most intense flames of the oxy-hydrogen blowpipe, were found ineffective to accomplish the result desired. The matter coming to the attention of the Thomson Electric Welding Company, was referred to its experts and pronounced by them to be capable of accomplishment by the passage of heavy currents locally through the surface of the plate. A number of experiments with sample pieces of plate did not, however, at first yield the desired results, and it was only by the establishment of a process of working or distinct method that the result could be accomplished. This method was patented to Mr. Hermann Lemp, the electrician of the Welding Company, by United States patent No. 531,197.

The process consists essentially in passing a current between two electrodes placed at a certain distance apart on the plate surface, and thereby heating a portion of the plate to an annealing temperature, after which by a very gradual and careful diminution of the current the temperature is slowly lowered so that the too rapid cooling by conduction of heat to the massive plate back of the heated portion shall be prevented from acting as a chill upon the heated metal. This provides that during the cooling there shall be a constant and continual application of the heating current and the production of heat, but at a rate which is made less and less, so that the metal back of the hardened surface, which is constantly abstracting heat, may be kept supplied, with the result that the fall of temperature at the heated or annealed spot may be controlled and kept such that no subsequent chilling takes place.

It will be seen that the operation is one of such nicety that it could hardly be expected that the use of the blow-pipe would suffice, first, from the difficulty of supplying the heat to the plate rapidly enough to make up for that which is conducted away into the body of the plate, and at the same time to continue the increase of temperature at the spot to be annealed, while sufficiently localising the action ; and, secondly, from the difficulty of controlling just the degree of heat and the rate of cooling of the metal, which would be required to prevent rehardening. The real object of annealing the spots on the armour plate is, of course, to enable holes to be drilled through the surfaces and screw threads to be cut into them by tapping, so that the plates themselves can be attached, or have other parts of the ship attached to them.

The apparatus used in the practice of the process consists of a dynamo furnishing alternating currents, suitably driven, these currents being such as are used in operating electric welding apparatus by the Thomson process. The currents from the dynamo feed the primary of a transformer, which is, in many respects, the same in general construction as a welding transformer. Instead, however, of the secondary terminals ending in clamps, they are simply blocks of copper cooled by water circulation, and separated a certain distance. These blocks are applied to the face of the plate under some pressure, and the current passing between the blocks heats up the metal between them, and here, as in certain welding operations, the fact of the use of alternating currents favours the concentration of the heating effect and the flow of current locally. The self-induction effect or reactance is least when the current flows near the surface of the plate between the electrodes, so that any current which branches from the electrodes and enters deeply into the plate not only has a longer path, but has a path in which the self-induction operates to limit the flow.

In actual practice with the apparatus at the Cramp shipyard, it has been found that the results are highly satisfactory, the original apparatus being made to do, with facility, work in position and under circumstances which was not contemplated in its original construction, and for which other special arrangements were being worked out. The value of the process was more clearly demonstrated in the case of the warship "Massachusetts," which is under construction, as it was found that certain of the armour plates for the barbettes were hard, or possessed the hard Harveyised skin where it was absolutely necessary that they should be drilled and tapped. Indeed it was impossible to properly attach the barbettes without making tapped holes in certain portions of these plates. Strenuous efforts had been made to accomplish the result by blow-pipes, and such means did not succeed, while during these trials the building of the upper deck was delayed, and until the proper securing of the barbette plates had been accomplished. On the appearance of the electric annealing apparatus at the yards it was soon turned to the accomplishment of this work for the "Massachusetts," so that there was no further need of delaying the work on the ship from the cause mentioned. There is no doubt that the apparatus and process will soon become one of the necessary features of a modern establishment for the construction of armoured vessels.

CONDUCTIVITY OF SALT SOLUTIONS.

A series of experiments has been carried out by Mr. A. C. MacGregory with a view to determine the electric conductivity of certain salts in their aqueous solutions. Mr. MacGregory contributes an interesting and detsiled account of his researches to the March-April number of the *Physical Review* of America. Two objects are accomplished by means of such researches, namely, the determination of the velocities of the ions, and the gaining of some insight into the condition of the salt when in solution. It is true that the same results may be accomplished by observations of the depression of the freezing points of the aqueous solutions ; but owing to the ease and accuracy of making the electrical observations, the method adopted by Mr. MacGregory seemed to be preferable. The following salts were investigated : calcium sulphate, calcium chloride, calcium nitrate, calcium acetate, strontium chloride, strontium nitrate, strontium sulphate, barium acetate, silver acetate, and potassium oxalate. The water for the very dilute solutions was obtained by triple distillation, the last two distillations being made in a tinned copper boiler having a tin condenser. The boiler was heated by a large Bunsen flame, and the products of combustion were led off into the chimney. The required purity was attained in about an hour and a-half after the water began to boil; then, for about three hours, water was obtained having a conductivity between $0{\cdot}75\times10^{-10}$, and $1{\cdot}5\times10^{-10}$. In a few cases the conductivity was only $0{\cdot}68\times10^{-10}$. It has been noticed by the author, in confirmation of the observations of others, that after the water has stood for a few days the conductivity has decreased from what it was directly after distilling. For example, water distilled on May 5th had a conductivity of $1{\cdot}095\times10^{-10}$, but by May 12th this had fallen to $1{\cdot}019\times10^{-10}$, and by May 18th it was only $0{\cdot}997\times10^{-10}$. The resistance bottles used for the aqueous solutions were the same as those employed by Kohlrausch in his similar investigations. The solutions varied in strength from $m=0{\cdot}0001$ to $m=1{\cdot}00$, where m denotes the gramme equivalent of the salt in a litre of the solution; and it was necessary to use two resistance bottles, one for the solutions from $m=0{\cdot}0001$ to $m=0{\cdot}01$, and the other for the remaining ones. In measuring the most dilute solutions, the author used a Becher glass of 80mm. diameter and 130mm. high, the edge being ground off even, and fitted with a hard rubber cover 10mm. thick and 110mm. across. By means of three small pieces of rubber on the under side, all lateral movement was avoided. Three holes were bored through the cover, two of them situated on either side of the centre and carrying the electrodes, while the third was for the thermometer. With a normal filling of 500cc. the electrodes dipped about 20mm. under the surface of the liquid. The glass was entirely surrounded by felt. Platinum foil electrodes, welded and soldered to copper leading wires, were used. The results of the researches are given in a number of tables and curves which accompany Mr. Mac Gregory's article.

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* From the *Electrical Engineer* of New York.

LONDON COUNTY COUNCIL.

Electric Lighting of London Bridges.

At the weekly meeting of the London County Council held on Tuesday, Mr. Arthur Arnold presiding, Lieut.-Col. Ford asked, on the reception of the Highway Committee's report, whether the Committee had taken into consideration the lighting of Westminster and other Thames bridges by electricity, and if so, when would they be likely to report on the matter. Mr. Alderman Hubbard (Chairman of the Committee) replied that he was not then in a position to say the exact date when the Committee would deal with the matter. Lieut.-Col. Ford said he would not press for the exact date, but could he give the Council any idea when the matter was likely to be proceeded with. Mr. Hubbard said he could not even give that information. The question was before the late Council, and he had no doubt it would be re-introduced as soon as possible.

The Telephone Agreement.

The Highways Committee of the London County Council recommended at the weekly meeting on Tuesday—"That the Highways Committee be authorised to take all necessary steps for properly placing the Council's views before the Select Committee of the House of Commons on the telephone service; and that, subject to an estimate being submitted to the Council by the Finance Committee as required by the statute, the Council do authorise the expenditure of a sum not exceeding £100 in connection with the matter."——Some considerable discussion ensued first as to whether the Council could legally spend the £100 as proposed, and secondly, it was urged that as the new Council had not considered the question, it was impossible for Mr. Dickinson to appear before the Committee in any authority. On a division, however, Sir John Blundell Maple's amendment for referring the recommendation back was negatived by 74 votes to 42, and the recommendation was carried.

BOOKS RECEIVED.

"Scientific and Technical Papers of Werner von Siemens." Translated from the Second German Edition, Vol. II. Price 14s. (London: John Murray. 1895.)

"The Telegraphist's Guide." By James Bell. Price 1s. 6d. (London: "Electricity." 1895.)

"Meteorology, Weather, and Methods of Forecasting." By Thomas Russell. Price 16s. (London: Macmillan and Co. 1895.)

"Leçons Élémentaires de Télégraphie Electrique." By L. Michaut and M. Gillet. Second Edition. (Paris: Gauthier-Villars et Fils 1895.)

Journal of the Institution of Electrical Engineers. No. 115, Vol. XXIV. Price 3s. (London: E. and F. N. Spon.)

PARLIAMENTARY INTELLIGENCE.

THE SELECT COMMITTEE ON THE TELEPHONE SERVICE.

At the first sitting for the hearing of evidence by the Committee of the House of Commons appointed to inquire into the telephone service, Mr. Arnold Morley, the Postmaster-General, presided, and the other members present were Lord Stanley, Sir Charles Cameron, Sir Julian Goldsmid, Sir James Fergusson, Sir Frank Lockwood (the Solicitor-General), Capt. Bagot, Mr. Baird, Mr. Benn, Mr. Tully, Mr. Grant Lawson, and Mr. Snape.

Mr. J. C. LAMB, C.M.G., Assistant-Secretary of the Post Office in charge of the Telegraphs Department, was the first witness examined. Asked by the Chairman to give the history of the introduction of the telephone into this country, he said that it was first introduced here in a very crude form in the year 1876. Previous to that date, the Post Office had an exchange system at Newcastle-on-Tyne worked with A B C telegraph instruments. In 1276 the system of putting one subscriber in communication with another by means of a switch was first introduced in Newcastle, and that was afterwards extended to other towns. In 1877 the first practical telephones were brought over, but they were not very efficient instruments, and it did not then appear that they were likely to be very much used. Nevertheless, the Post Office made arrangements with the agents of the inventors, and secured the use of this apparatus for its private wires. In 1878 Prof. Hughes invented the microphone, which, used in conjunction with the telephone, converted it into a thoroughly practicable instrument. In the same year a company was established for the purpose of acquiring and working Bell's patent telephone, and in the following year this company sought an alliance with the Post Office, under which the Post Office were to obtain the telephones at cost price, and were in return to facilitate the operations of the Company. At that time there was no suggestion of an exchange system. In the same year the Edison Telephone Company was established in London, and in the autumn announcements began to appear in the public Press that it was proposed to establish telephone exchanges. It was thereupon pointed out that this would interfere with the rights of the Postmaster-General under the Act of 1864, and an information was filed against the Edison Company and the Bell Company, which two Companies amalgamated in the year 1880 under the title of the United Telephone Company. As the result of legal proceedings which occupied the whole year, judgment was given in favour of the Post Office. In anticipation of this judgment, the Post Office had made arrangements to establish telephone exchanges of its own, and steps were taken for obtaining a sufficient number of telephones to enable the Department to carry on the work. At the same time they entered into negotiations with the United Telephone Company for the grant to that Company of licences for the purpose of carrying on telephone exchange business.

Sir JULIAN GOLDSMID: Was not that a part of the arrangement with the Telephone Company in order that they might not appeal against the judgment of the High Court?

The WITNESS: When the Company accepted the license, they at the same time accepted the judgment. They were allowed to proceed with their operations, and they decided not to appeal against the judgment which had been entered in favour of the Postmaster-General.

The CHAIRMAN: The policy of the Post Office in granting licences was not influenced by any fear that the Court of Appeal would have decided against them?

The WITNESS: I am decidedly under that impression. On the day on which judgment was given in their favour the Post Office issued an advertisement through the principal newspapers of the country describing the A B C telegraph exchange system which had been in operation in Newcastle and other towns, announcing that the telephone would be substituted, and offering to establish telephone exchanges wherever they were required. In April, 1881, the United Telephone Company was granted a licence to carry on telephone exchange business in London within a radius of five miles from a central point to be selected by themselves, and a royalty was to be paid to the Post Office. The policy of the United Telephone Company was to confine its own exchange operations to London, and to allow subsidiary companies to take up apparatus to be used in other parts of the country, leaving those subsidiary companies to negotiate with the Post Office for licences. Afterwards, licences in similar terms, but with not so wide a radius, were granted to companies in the provinces. All these licences were to run for 31 years from the date of the original licence to the United Company, and would expire on December 31, 1911. In 1881 the Postmaster-General allowed the exchanges of the United Company to be connected with the Post Office, in order to enable the Company's subscribers to send telegrams for transmission over the public wires through the exchanges. The Company were to provide wires, and the Post Office were to charge for the cost of working them at the Post Office end. The Company, however, availed themselves of this privilege only to a limited extent. Meanwhile, the Post Office itself established telephone exchanges in several additional towns, amongst others Cardiff and Newport.

The CHAIRMAN: Up to that time had there been any trunk wires sanctioned between the large towns?

The WITNESS: No; but negotiations had taken place between the companies and the Department for the construction of trunk wires to connect one town with another. The Post Office offered to supply the trunk wires on condition that the persons using them should pay the Department for working them. This offer was not accepted by the companies, but in a few cases wires between one town and another were provided by the Department for the use of the Companies at a fixed annual rent. For instance, a wire was provided from London to Brighton, and the United Telephone Company paid the Post Office for the use of the wire a fixed annual rent, and used it in their own way. The use of that wire was under agreement for a limited time, and the Company had no power of making trunk wires from one town to another.

Sir JULIAN GOLDSMID: Do the exchanges in Newport and Cardiff exist now in the hands of the Post Office ?—They do.

The CHAIRMAN: Altogether, how many towns have been supplied by the Post Office with telephones ?

The WITNESS: Thirty separate towns and a few outlying parishes connected with those towns. Many of the towns are small places such as Morpeth, for instance. Meanwhile, the Postmaster-General was gradually granting licences to subsidiary companies. In 1882 a new Company, called the London Globe Telephone Company, appeared upon the scene and applied for a licence to carry on an exchange business in London. This application raised a great many questions with regard to the competition between one company and another. The United Telephone Company urged reasons why there should be no competition; but eventually a licence was granted to the London Globe Company, and in the same year the Postmaster-General granted licences for the establishment of exchanges by companies even in towns where the Post Office had up to that date retained the business in its own hands; for instance, at Newcastle-on-Tyne, where the Post Office had been carrying on exchange business for many years, first with the A B C and then with telephones. In 1884 the London Globe Telephone Company was absorbed by the United Telephone Company. In the same year attacks were made in the House of Commons and in the Press upon the policy of the Department. On May 22, 1884, Mr. Dwyer Gray, in a speech in the House of Commons, accused the Department of practising a policy of strangulation. Mr. Fawcett, who took the whole of the responsibility upon himself, confessed that some of the conditions imposed by the Post Office had checked the development of private telephones. On June 24th he suggested that the Telephone Companies should meet and put their demands in writing, and on July 28th, after consultation with the Companies, he sought the authority of the Treasury to abolish all restrictions as to area, and to throw the whole country open to the operations of the licensees. Mr. Fawcett's policy appeared to be to encourage competition, but in his speech in the House he said: "If there is to be a monopoly of telephone communication, or any other communication, it should be in the hands of the Government, which can be controlled, and which is directly amenable to public opinion." Under this new arrangement a royalty was to be paid to the Post Office: the operations of the companies were to be limited to aural communications, and there was to be no transmission of written telegrams. The Treasury sanction to this arrangement was announced in the House of Commons by Mr. Fawcett on August 7, 1884, and as a result the licences now held by the companies were granted in substitution for the old licences.

The CHAIRMAN: Can you say how many licences have been granted and are in existence upon those terms ?

The WITNESS: Altogether, 23 licences have been granted; but the National Telephone Company, for instance, have been authorised by separate legal instruments to carry on exchanges in 25 towns, counting them as coming under one licence. As an illustration of the way in which the new policy worked, a Mr. Tasker, who held one of the old licences to operate in the two towns of Sheffield and Rotherham, was, in pursuance of Mr. Fawcett's policy in 1884, given a licence for the whole of the United Kingdom upon the terms which I have described.

The CHAIRMAN: What were the reasons which led the late Government to develop a new policy, and to consider the question of entering into fresh arrangements ?

The WITNESS: Public dissatisfaction with the service which the telephone companies were rendering, and the alarm which was felt at the uncontrolled monopoly which had been granted to them. The Government were also influenced by the repeated demands of the companies for further powers to enable them to meet the public requirements. Then, again, the Government were concerned at the effect which the competition of the telephone companies was having upon the telegraph revenue.

The CHAIRMAN: Have you any figures which you can give to the Committee in this connection ?

The WITNESS: Yes. In the six years from 1886 to 1891, the business of the companies increased from £261,000 to £465,000, while the net revenue of the telegraph service was going down. In the year ending March 31, 1889, there was a balance of revenue over expenditure in the telegraph business of only about £88,000; in 1890 it had decreased to £85,000, in 1891 it had fallen to £68,000, and in 1892 there was a deficit of £9,000. Then in 1894 the revenue of the companies had risen to £709,000, which was an increase of 171 per cent. over 1886, while the increase in the telegraphic business of the country was only 50 per cent. over 1886. The deficiency in the telegraphs in the year ending March 31, 1894, was £178,000, and it was estimated that the deficiency on March 31st next would be £240,000.

Sir JULIAN GOLDSMID: Surely you do not mean to induce the Committee to believe that this is to be put down to the telephones ?

The WITNESS: My own conviction is that it is very largely due to the telephones, although it is partly due to the increase in the pay of the telegraphists.

Sir JULIAN GOLDSMID: Is not there another reason, namely, the very large extension of offices ?

The WITNESS: No; the extension of offices is made under a rule of the Treasury, that in no case is there to be an extension unless it can be shown that the expenses will be covered by the receipts, or unless a guarantee can be obtained from the neighbourhood securing the Post Office against loss.

Sir JULIAN GOLDSMID: That rule has not always been observed, has it ?

The WITNESS: I think the only cases in which it has not been observed are in a few places in the highlands and islands of Scotland.

Sir JULIAN GOLDSMID: And in Ireland.

The WITNESS: There may, perhaps, have been one or two cases in which it has been held that an extension was absolutely necessary for the administrative purposes of the Government in Ireland, and the public have got the benefit of those extensions. If they looked for efficiency and economy they must have one system in one area. If the users of the telephone were divided into two groups, the persons in one group could not communicate with those in the other unless they paid to both exchange systems.

The CHAIRMAN: You say experience shows that where there are two competing systems one is eventually absorbed by the other. You are not referring to the National, but to the old system, under which there were competing licences ?

WITNESS: That is so. I could refer to several cases of the kind. The inconvenience of having two competing companies in Stockholm was so great that the municipality of Stockholm brought all their influence to bear on those two companies to combine. That is an illustration.

The CHAIRMAN: Then what has happened in foreign countries bears out the experience the Department has gained from the past history of telephones in this country ?

WITNESS: Yes, and I believe there is absolutely no difference of opinion among experts that the existence of rival systems within one area must result in inconvenience to the public, and expense, and want of efficiency. Witness went on to describe the reduction in the revenue from telegraphic business caused by the introduction of telephones. In a case of neighbouring towns, like Glasgow and Greenock, for instance, the telegraphic business was annihilated. He certainly considered that the telephone companies were partly the cause of the loss at present shown on the working of the telegraphs.

By Sir J. GOLDSMID: It was true that the cost of all extensions of the telegraph system was charged to revenue.

Sir J. GOLDSMID: You charge all your extensions to revenue, and then say that the business does not pay ?

WITNESS: It has always been the practice to charge the extensions to revenue; but that does not affect the question of the effect of the telephones on the telegraph revenue.

In answer to further questions, Witness said there had been a large increase in the expenditure for wages, &c., which would partly account for the loss on the telegraphs. No doubt the revenue was also affected by periods of commercial depression.

Mr. BENN: Mr. Fawcett's policy was free trade in telephones, was it not ?

WITNESS: Yes.

Mr. BENN: The present policy of the Post Office is a distinct reversal of that position ?

WITNESS: I would rather guard myself against describing matters of policy. I would rather limit myself to an opinion on the broad question whether competition is for the benefit of the public.

Mr. BENN: Can you point to any period when Parliament authorised a reversal of Mr. Fawcett's policy ?

WITNESS: I don't think the matter was ever directly presented to Parliament, but there was a Treasury Minute against the granting of licences to persons who might apply for them who were not financially sound.

Examination continued: He was certain that telephone business could not be done in London at the same charges as in Stockholm. No doubt the State acquisition of trunk wires was an important step in the direction of the State acquisition of telephones. The New Telephone Company was no doubt considerably advantaged by the present arrangement.

The CHAIRMAN: I must point out that the question of the Agreement is definitely closed, and is not referred to this Committee. I must rule all questions out of order that go to reopening the matter. The policy of the Agreement and the validity of the Agreement are excluded from our consideration.

In answer to the Chairman, WITNESS said the telephone service affected most materially the most remunerative part of the telegraph business—the direct and short-distance messages, as distinguished from the long-distance and across-country messages.

The CHAIRMAN: Has Parliamentary sanction been given to the policy of favouring competition in regard to telephones ?

WITNESS: I suppose it might be urged that Parliament had acquiesced in the policy advocated in Mr. Fawcett's speech, but there was otherwise no direct Parliamentary sanction.

The CHAIRMAN: And any change that has taken place in the views of the Department has been the result of experience in our own country and in foreign countries ?

WITNESS: That is so.

The CHAIRMAN: Is not the reasonableness of the charge rather dependent on the service that is given ? Is it not the case than in large areas, with a large number of subscribers, the increased opportunities of telephonic communication not only causes great expense, but justifies an increased charge ?

WITNESS: Yes.

Sir ROBERT HUNTER, solicitor to the Post Office, having answered a few questions on legal points,

The Committee adjourned till to-day (Friday).

Electrical Boot Cleaners.—In Vienna there are a number of automatic boot cleaners, which, on "dropping a penny in the slot" and pressing a handle, clean the boots, including the soles, of the passers-by in the shortest possible time.

CORRESPONDENCE.

RECTIFIERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In a letter *re* Electric Lighting at Cardiff, from a Mr. Sydney F. Walker, published in your last issue, I was much surprised to read that the adoption of a "rectifier" for public lighting was denounced as a blunder.

The use of rectifiers for arc lighting is not yet very extended, but I have been fortunate enough to have had four of them running for the last ten months, and I am convinced that rectifiers are a most important factor in the economical running of a central station supplying current for arc lamps.

Each of the four rectifiers used here will run 40 12-ampere arc lamps, and considering that each lamp only requires about 1 H.P. delivered to the alternator, and that the attendance required for the four rectifiers costs about 11s. weekly, I think there can be no question as to their economy. This is, I consider, sufficient to justify the adoption of rectifiers without considering their small first cost, the gain of using one generator only for all lighting, and the steadiness of the feeding of the lamps.

My Committee are so satisfied with the behaviour of these rectifiers that they are about to recommend the Corporation to erect three or four more each of 50 lamps capacity to light another 100 or 150 arc lamps.

As this is the first central station that has given the rectifiers a trial, and as we are so thoroughly convinced of their fitness for the work, it seems hardly right to let the statement I have questioned pass without comment.—Yours, &c., E. PRICE.

Electric Light Central Station, Portsmouth,
March 25, 1895.

COMPENSATING COILS FOR THE ARMATURE CURRENT REACTIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read Mr. C. L. R. E. Menges' letter under the above heading in your last issue. The patent he refers to was before me at the time of filing my Specification 16,572, 1891, but a careful examination of the patents will show that they are essentially different.—Yours, &c., W. B. SAYERS.

Glenwood, Bearsden, March 26, 1895.

LEGAL INTELLIGENCE.

Wise v. The Metropolitan Electric Supply Company (Limited).

This case again came before Mr. Justice Stirling on Friday last upon a motion for a writ of sequestration against the Company for breach of an injunction restraining them from carrying on their business in such a way as to cause a nuisance to the plaintiffs by vibration. The plaintiffs are lodging-house keepers in the neighbourhood of Manchester-street, and their case against the Company is that the vibration caused by the electric lighting machinery at the Company's Manchester-square station is such as to constitute a serious nuisance and injury to them. The injunction was granted by his Lordship in April last, but its operation has from time to time been suspended in order to give the defendants the opportunity of abating the nuisance by means of alterations in their machinery and otherwise. The last occasion on which the case came before the Court was in November, 1894, when the Company gave an undertaking not to use more than one reciprocating engine in addition to certain steam turbines which had been substituted for the original engines. The plaintiffs now alleged, and brought evidence to prove, that the nuisance still continued, and they pressed for the issue of a writ of sequestration.

Mr. WAGGETT, for the Company, contended that this was not a case for the exercise of so extreme a remedy as the issue of a writ of sequestration. There was evidence that the nuisance was much abated, and that the vibration was now very slight, if it existed at all. If the plaintiffs were asking for an injunction on the present evidence, it would not be granted, and still less would the Court make an order of sequestration. The Company had ordered two additional and improved turbines, which would be delivered in June, when the Company would be able to dispense with the reciprocating engine altogether.

Mr. JUSTICE STIRLING said that the vibration was clearly much diminished, but it appeared to be still perceptible at times. He thought that when it did occur it was caused by the use of the reciprocating engine. There was no evidence before him that it was impossible for the Company to carry on their work without the use of that engine, and instead of ordering a writ of sequestration to issue he should put the Company on terms not to use the reciprocating engine, and they must pay the costs of the motion.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NOW READY.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Although about 100 pages are added to the book, no addition is made to the price, which is 7s. 6d., post free 8s. 3d., abroad 9s.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices:—*

LABORATORY NOTES AND FORMS.—With the above title, we are publishing a set of Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free. The complete set is now ready.

THE LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, published with our issue of January 4th, can be obtained mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s.—each post free. The Map showing positions of Supply Stations is mounted on the back of the Table. The Coloured Map of Metropolitan Electric Lighting Areas issued with the Jan. 18th number and the Electricity Supply Statistics issued with the Feb. 1st number, are also mounted on some copies, and the price of these, complete, post free, is 5s.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

TENDERS INVITED.—The President of the Rangoon municipality will receive, not later than November 4th next, tenders for the lighting of Rangoon by electricity. Tenders have to be sent in to the Municipal Committee of the Rangoon municipality, Rangoon, India.

——— The Directors of the Lancashire and Yorkshire Railway invite tenders for the supply of the Company's ordinary requirements, the supplies and lists of which will be found in our advertisement columns. The period of supply is 12 months ending April 30, 1896. Tenders must be sent in to Mr. C. W. Bayley, secretary, Hunt's Bank, Manchester, not later than 10 a.m. on Monday, April 8th. Further particulars and forms of tender may be obtained at the Steward's Department, Osborne-street, Manchester.

——— The Gas and Electric Lighting Committee of the Corporation of Leicester invite tenders for the supply of about 6,000 yards of high and low-tension cable. Specifications, &c., can be obtained of Mr. A. Colson, engineer and manager, at the Gas and Electric Lighting Offices, Millstone-lane, Leicester, and tenders must be sent in to Alderman Lennard, chairman of the Committee, not later than 11 a.m. on April 6th. Some further particulars are given in our advertisement columns.

——— Tenders are invited by the German Public Works authorities at Königsberg for the supply and erection of six pumping engines, to be operated by steam or electricity. Tenders have to be in by April 17th.

——— The General Direction of the French Posts and Telegraphs in Paris is inviting tenders until April 5th for the supply of eight lots of Baudot telegraphic apparatus.

——— The St. Pancras Vestry require tenders for the construction of a sub-station in connection with their electricity installation. Tenders have to be sent in by 12 o'clock on Thursday next.

TENDERS ACCEPTED.—The Stafford Town Council have accepted the tender of the Electric Construction Company for a switchboard for their electric lighting station, and also the tender of Messrs. C. and W. Walker for a 12,000-gallon overhead tank.

SALE BY AUCTION.—Mr. T. G. Wharton, of 7 and 8, Ironmonger-lane, London, E.C., will sell by auction at 56, Hoxton-street, Shoreditch, London, E., this day (Friday), at two o'clock, the stock of an electrical engineer, including tools, machinery, lathes, lamps, &c.

INSTALLATION BUSINESS FOR SALE.—The Hastings and St. Leonards-on-Sea Electric Light Company have decided to dispose of their installation business, and invite tenders for purchase. A useful stock of fittings is included. Tenders must be sent to the Secretary of the Company, 20, South-terrace, Hastings, not later than Monday, April 1st.

PERSONAL.—Mr. T. A. Nunwick, formerly branch manager and representative in the North for Messrs. Poole and White (Limited), has joined the firm of Messrs. Dorman and Smith, Ordsal Station Electrical Works, Salford, as their representative for the Northern and Midland counties.

APPOINTMENTS VACANT.—The Vestry of St. Mary, Islington, London, N., require a canvasser for electric lighting business. Particulars are given in our advertisement columns, and applications must be sent in to Mr. Albert Gay, electrical engineer, 50, Eden-grove, Holloway, N., not later than 12 o'clock of April 3rd.

——— The Tiverton Town Council require a manager for their gas works, with a knowledge of gas-engines and electric light machinery. Applications have to be sent in by Saturday, April 6th.

DISSOLUTION OF PARTNERSHIP.—The partnership hitherto existing between Messrs. Sotheby and Ridout, electrical engineers, Regent-street, London, W., is dissolved. Debts will be paid by Mr. L. Ridout.

AGENCY.—Mr. Carrington Smythe, of 12, Idol-lane, E C., has been appointed sole agent for London and district for Messrs. Mavor and Coulson, of Glasgow.

BANKRUPTCIES.—A first meeting of the creditors of G. F. Roger, took place on Monday last before Mr. Wildy, the Official Receiver. The debtor, a telegraph engineer and general merchant, of Great Winchester-street, London, E.C., furnished accounts showing liabilities £27,982, and assets £264. The debtor, who has also acted as director of public companies, attributes his failure to liability on accommodation bills for which he received no consideration, to loss in trading and investments, and depreciation in value of securities held by creditors. A trustee and committee of inspection were appointed to wind up the estate.

——— The first meeting of the creditors of Samuel Elliott, whose bankruptcy was announced in our last issue, is held this day (Friday) at 12 o'clock, and the public examination will be held on April 25th, at 11:30, at Bankruptcy-buildings, Carey-street, London, W.C.

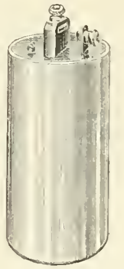
——— At the Edinburgh Sheriff Court House on Tuesday, Messrs. Browning and Gardner, electrical engineers, of 122, George-street, Edinburgh, appeared for examination in bankruptcy. In reply to questions on behalf of the trustee (Mr. John Hamilton Buchanan, C.A.), Mr. Browning said that he had no papers or books except the vouchers for petty cash expenditure. On December 18th last he gave a bill for £60 to Messrs. Anderson and Chisholm, but he was not sure whether that was the day he was gazetted out of the firm. He did not know he was gazetted out out of the firm. The bill was granted for a business account. He could not say whether he received a letter from his partner a week before, terminating the contract of co-partnery, and he did not know whether it was before or after that that he granted the bill in the firm's name. Sometimes he corresponded in his own name and sometimes in the firm's. The firm in October, 1894, showed a surplus of £150, and the trouble was caused because they had not money in hand. The case will be resumed this day (Friday).

CHELSEA ELECTRICITY SUPPLY COMPANY (LIMITED).—Notice is given that on and after July 1st next the above Company will supply current at the following prices:—For lighting purposes, 6d. per unit, with a sliding scale to 5d.; for motors, cooking, and heating, by separate meter, 1d. per unit.

NEW ZEALAND ELECTRICAL SYNDICATE (LIMITED).—The holders of First Mortgage Debentures in this Syndicate applied last week to Mr. Justice North for the appointment of a receiver and manager, with power to borrow £2,000 for paying off pressing claims, &c., and for the purpose of keeping the business going. The Company did not oppose the application, and his Lordship appointed the principal plaintiff, Mr. Barcley, ad interim receiver. Mr. Justice Kekewich was afterwards applied to on behalf of other creditors, and granted leave to serve short notice of motion to compel registration of a transfer of shares, and for an injunction restraining the previous applicants to Mr. Justice North from acting as Directors of the Company. The plaintiffs in the action before Mr. Justice North include Mr. Barclay and Lord Claud Hamilton, and the amount of the debentures issued is £30,000. The assets were stated at about £300.

ELECTRIC PUMPING MACHINERY.—In 1893 the Lothian Coal Company, Dalkeith, N.B., placed an order with Messrs. Scott and Mountain for the supply and erection of two sets of electric pumping machinery, and the plant has given such satisfaction that Messrs. Scott and Mountain have received an order for a further set. Another order recently received by the same firm comprises additional electric pumping plant for the Cambois Collieries, Northumberland.

BALL BEARINGS FOR SHAFTS AND SPINDLES.—We have received an illustrated pamphlet of Badger's multiple adjustable ball bearings for shafting and spindles for all classes of machines. The growing importance of high economy in machinery for mill work has turned the attention of power users to the friction of bearings, and there is no doubt that there are many instances where this friction may be reduced by the use of ball bearings.



DRY BATTERIES.—Messrs. Krupka and Jacoby, of 15, Queen-street, Cheapside, London, E.C., have recently been appointed sole agents for Dr. A. Lessing, of Nurnberg, Germany. Dr. Lessing is contractor for the German Post Office and State railways for batteries, plates, carbons, &c. The illustration shows the latest type of the Lessing dry battery, which is put on the market in this country to sell at 2s. 6d. The battery is made in only one size, height 7½in. over all and 3in. diameter. Amongst the advantages claimed for the battery by the makers are a long life, good insulation, and low internal resistance. Messrs. Krupka and Jacoby keep a stock of Dr. Lessing's manufactures in London.

SMOKING CONCERT.—Those interested are reminded that the Electro-Harmonic Society's smoking concert takes place this (Friday) evening, at St. James's Hall Restaurant, at 8 o'clock.

ACTON.—With regard to the offer of Messrs. New and Mayne to purchase the District Council's Electric Lighting Order for £500, on certain conditions, at the last meeting of the Council, Mr. Rome urged that it was important this offer should be accepted, or their Provisional Order would lapse, and then it would be possible for any private company to obtain an Order, and so place the Local Authority in a worse position than they now were. Mr. Miller said he was opposed to the Council taking up the electric lighting for themselves, and he thought the present offer a good one. The scheme would not create a monopoly, but simply a partnership in which Messrs. New and Mayne would take all the risk and the Council a fair share of the profits. The motion was then put that the offer should be accepted, and this was carried by nine to four.

ADELAIDE (AUSTRALIA).—It has been decided by a number of the leading citizens to form a company to work a scheme for supplying electric current for the lighting of the streets and public and private buildings and for power purposes.

ARLESEY (BEDS.).—At a Parish Council meeting held last week a proposal was discussed to establish gas works at an estimated cost of £2,100. An endeavour was made to interest the councillors in a proposal to introduce the electric light, but ultimately gas won by eight votes to four.

BANGOR.—A report on the electric lighting question is to be presented at the next meeting of the Town Council by the Water and Gas Committee, who have fully discussed the subject at a recent meeting.

BATH.—Respecting the inquiry recently held on the application of the Bath Electric Lighting Company for a Provisional Order, in place of its expiring licence, Major Cardew reports that he cannot advise that the consent of the Local Authority should be dispensed with, but suggests that the Authority should give consent to the application of the Company on condition that a clause in the licence under which the Company is now working, giving the Authority power to purchase, is included in the Order, and that provision is made that, if this option is exercised by the Authority, the powers and applications of the Order should be simultaneously transferred. The final decision in the matter is therefore deferred until the City Council has considered the suggestion.

BOHEMIAN CONCERT.—The members of the City Electric Athletic Club gave a Bohemian concert in the Banqueting Room of the St. James's Hall on Tuesday evening last. The chair was occupied by Sir David L. Salomons, who was supported by Mr. Cecil Bull. An excellent programme was provided, and a crowded audience was capitally entertained.

BRAY.—In a Bill now before the House of Commons the Improvement Commissioners propose to take power to supply electric light. The Commissioners propose to purchase the interests of Messrs. J. E. H. Gordon and Co. (in liquidation), for £3,060. Borrowing powers are applied for for £6,000 for electric lighting purposes. It will be remembered that the electric light was installed at Bray about three years ago, the Commissioners having invited tenders and Messrs. J. E. H. Gordon and Co. obtained the contract. That firm became insolvent, and the agreement for purchase, now about to be ratified, has been already approved by the Court of Chancery. At present, although the principal streets are electrically lighted, very few shops or private houses have adopted the light. Hitherto, householders have been afraid to incur the expense of having the proper fittings, &c., installed, for fear the

Company should fail, and the supply of current cease. The town has got a very good bargain in acquiring for so modest a sum an electrical installation which must have cost £20,000 some three years ago.

Bristol.—The Electrical Committee of the Corporation have recently sent out letters inviting criticism on proposed extensions of the electric lighting area, but have deferred further consideration of the matter until April 3rd, by which date it is anticipated the replies will be received.

Building Trades' Exhibition.—An interesting exhibition of materials and appliances used in the building trades is now being held at the Agricultural Hall, London, N., and will remain open until Thursday next. The exhibitors include a number of engine and machinery makers. The Building Exhibitions held annually at this Hall are amongst the most successful of the year.

Cardiff.—A proposal was before the last meeting of the Free Library Committee as to the advisability of introducing the electric light. Mr. Massey's estimate of the cost is £500. The matter was subsequently referred to the Lighting Sub-Committee.

Chester.—A writer in the *Chester Chronicle* states that Dr. J. Hopkinson has intimated to the Electric Lighting Committee of the Town Council that he is unable to continue his services as professional adviser on the Council's proposed electric lighting scheme. The same journal states that it is rumoured that the Duke of Westminster has given Mr. Enfield Taylor instructions to arrange for the putting down of machinery for the supply of electric current to his Grace's tenants in the Rows.

Church Lighting.—The electric light is to be introduced into the church of St. Margaret, Princes-road, Liverpool. There are many valuable frescoes in the building which have cost several thousand pounds.

Commission of Sewers (London).—Mr. D. J. Ross, the engineer to the London City Commission of Sewers, has presented a report on the work of his department during the past year. The report states that during the year six days of fog were experienced, and both the electric light and gas were used during that period. There are now 483 arc lamps in use in the City of London, the total length of main thoroughfares so lighted being 13 miles. The number of gas lamps supplanted is 1,338.

Edinburgh.—The date for turning on the electric light has been altered from the 10th to the 11th April, previous to which an inspection of the whole installation is to be made by Prof. A. B. W. Kennedy.——On Wednesday the Lord Provost's Committee of the Town Council resolved unanimously to recommend the Council to apply to the Postmaster-General for a licence to establish a system of telephonic communication within the city.

Electricity on the Stage.—Herr Carl Lautenschlager, the great Bavarian stage machinist, is, it is stated, in this country, in connection with the preparation of a new ballet at the Empire Theatre of Varieties, London. Herr Lautenschlager is well known in theatrical circles as electrician to the Court Theatre of Bavaria, and his efforts to introduce the use of electricity in connection with the machinery of the stage have been crowned with considerable success.

Electric Organs.—An interesting account of the Hope-Jones Electric Organ appears in *Colonies and India* of March 23rd.

Fareham.—The clerk to the District Council has been instructed to defend, in the High Court, the action of the Council in its dealings with the Fareham Electric Light Company, which, as stated in our last issue, has issued a writ.

Foundry Cleansing.—An order appears in Tuesday's *Gazette* adding a new proviso to Section 33 of the Factory and Workshops Act, to the effect that if any foundry is not in a cleanly state an inspector may, by written notice, require the occupier to limewash or wash the same, and failing compliance within two months, the special exception now in force under the same Act shall cease to apply. The new order comes into effect on the 30th inst.

Huddersfield.—Amongst the recommendations of the Electric Lighting Committee discussed at the last meeting of the County Council, was one that tenders should be obtained for additional plant for an extension of the electric lighting scheme next winter. The Committee have received from the India Rubber Company explanations as to some defective cable supplied, and an offer to replace the same by satisfactory cable, which offer was accepted. The Committee's recommendations were approved.

Institution of Engineers and Shipbuilders.—On Wednesday evening the monthly meeting of the Institution of Engineers and Shipbuilders was held in the rooms, 207, Bath-street, Mr. George Russell presiding. A discussion took place on "Electrical Transmission of Power in Shipyards and on board Merchant Steamers," on which subject a Paper was read at the last monthly meeting.

Islington (London, N.).—In moving the adoption of the Electric Lighting Committee's report at the meeting of the Vestry last week, Mr. Lambert, the chairman, referred to the rapidity with which the electric lighting works were proceeding. The Committee hoped that by next August the current would be ready for supply, and recommended the appointment of a canvasser, a suggestion which was adopted.

Liverpool.—The Liverpool Chamber of Commerce has received a letter from the Postmaster-General on the subject of the delivery of telegraph messages from the Continent to their destination by telephone. The letter points out that the postal authorities have no power to undertake this work. Mr. Hemelryk, a member, said that now direct cables with the Continent had been established, delays were tenfold more numerous than hitherto. Liverpool was used as the centre from which a very large proportion of Lancashire and Yorkshire messages were sent, and the delays were very serious, as they materially hindered commercial transactions with the Continent. A telegram can be received from America and a reply sent in a quarter of an hour, whereas it frequently takes six or seven hours to communicate with and receive a reply from the Continent. He recommended that if no law existed enabling the Department to send cable messages through the telephone, it was advisable that a short Act should be passed enabling the Postmaster-General to offer this convenience to the public. The Chamber resolved that the Postmaster-General be requested to grant the cable companies authority to avail themselves of the telephone in order to transmit cable messages received from Liverpool firms between 6 p.m. and midnight at a fixed charge per message (6d.), to be refunded to the Postmaster-General.

Manchester.—A Local Government Board inquiry into the application of the Manchester Corporation to borrow £260,000, including a sum of £100,000 for electric lighting purposes, was held last week before Col. A. G. Durnford, R.E. The Town Clerk pointed out that the Gas Committee of the Corporation were dissatisfied at the short term of 25 years allowed for repayment of the last loan, although they did not now ask for a longer period. Alderman Gibson, Chairman of the Committee, referred to the fact that in 1892-93 sanction was given for the Committee to borrow £150,000 for their electric lighting scheme. Their first idea had been to put down a plant equal to a supply of 20,000 16-c.p. lamps, which they anticipated would be sufficient for the first two or three years' demands. They had, however, exercised foresight in the acquisition of lands and the erection of buildings, so that they were able to double the original plant capacity of their works. They ultimately spent £163,886, or nearly £14,000 in excess of their borrowing powers. Their calculations as to the quantity of current they would be called upon to supply had proved altogether erroneous. They were at once overwhelmed with applications for the light. In September, 1893, they had 82 customers; in December of the same year, 289; in March, 1894, 416; in June, 450; in September, 509; in December, 624; while in February, 1895, they had 706 customers taking current equivalent to 32,528 16-c.p. lamps. By the 12th inst. 41 further applications had been received, bringing their total up to 747 customers consuming current equal to 34,528 16-c.p. lamps. After their first year's working, and after the payment of interest on mortgage, sinking fund, &c., they had only a loss of £210. In the next year's working, up to March, 1895, they would show a profit, after deducting interest and sinking fund, of between £7,000 and £8,000. Alderman Higginbottom, who described the Corporation's scheme and the Committee's proposals from an engineering point of view, stated that in view of the profit made it had been decided to reduce the price of current from 8d. to 6d. per unit.

Newcastle.—The Electric Lighting Committee of the Corporation have received from Prof. A. B. W. Kennedy his report on the proposed scheme for the lighting of Newcastle by electricity, which is expected to involve the taking over of the two private companies now supplying electric current. The report has been remitted to the permanent officials in order that a synopsis may be prepared and the financial points duly epitomised. The report is a very lengthy one, and the Committee expressed a high opinion of the labours of Prof. Kennedy in its preparation.

Newspaper Office Lighting.—The *Gazette* offices, Weston-super-Mare, have been fitted for the electric light by the Newton Electrical Engineering Works, of Taunton, under the superintendence of Mr. H. N. Hickley. The lighting includes machine room, offices, stock rooms, composing rooms, reporters' rooms, &c.

Obituary.—Mr. James Maxwell, electrical engineer, and who was well known in the north in connection with patent locks for railway carriages, died at his residence, Wellpark-terrace, West Newport, Dundee, last week, in his 76th year.

Portsmouth.—The new electric lighting scheme of the Portsmouth authorities is voted by the local Press to be of a very satisfactory and comprehensive character. Every important thoroughfare in the borough will, if the scheme is adopted (of which there is practically no doubt), be lighted by electricity before the close of the current year. With regard to the financial aspect of the scheme, as the Electric Lighting Committee have already powers to borrow £11,000, a further £2,000 is all that it will be necessary to obtain to complete it.

Shoreditch (London, E.).—It has been decided to borrow from the London County Council £12,000 at 3¼ per cent. for the purposes of the electric lighting scheme, repayments being arranged over a term of 54 years.

Stafford.—At the last meeting of the Town Council the Electric Lighting Committee presented regulations and conditions as to wiring and fitting up consumers' premises for the electric light, and leave was asked to authorise the engineer to purchase the necessary fittings, so that the wiring work could be proceeded with. The Committee also recommended the reduction of the period of maximum demand from 2 hours to 1½ hours. The recommendations were adopted.

Stockwell and Clapham Electric Railway.—The Unopposed Bill Committee of the House of Commons to-day passed the Bill promoted by the City and South London Railway Company for the purpose of obtaining an extension of time until July, 1901, within which to construct the authorised extension of their electric railway from Stockwell to Clapham Common. The Bill also sanctions the creation of £10,000 additional Debenture stock and £30,000 additional Preference stock.

Stores Lighting.—A very satisfactory account of the installation of the electric light by the managers of the Ravensthorpe Self-Help Industrial Co-operative Society was given by the Chairman at a meeting of the members last week. A discussion took place as to the cost of gas *versus* electricity, and the Chairman pointed out that they had, of course, been put to some considerable initial expense in putting down the plant for the installation, but they had, by the adoption of the electric light, got rid of a great amount of heat, and there would be a considerable saving from the item of goods soiled alone. When using gas they obtained only 5,000 c.p. illumination, but electricity now gave them 25,000 c.p. The gas bill had come to close upon £100 per annum, but the cost of electric light had not reached 35s. per week, even in the darkest week in winter. He considered that the difference between the cost of lighting by electricity as against gas would be something towards the interest on the money they had sunk in the plant.

Torquay.—At the meeting of the local gas company reference was made to the subject of the electric light, more particularly with regard to the lighting of Southport, and the shareholders were asked to take comfort in the fact that the introduction of the electric light would mean a much increased expenditure on public lighting. The Directors had, however, decided to reduce the price of gas from 3s. 3d. to 3s. per thousand.

York.—The Sewerage Committee of the Corporation recommend that the extensive sewage works now being erected should be lighted by electricity. The works are situated at Fulford and Naben, and it is proposed to use the power available at each place for generating current. The Committee recommend that the tender of Messrs. Scott and Mountain (Limited) be accepted for the sum of £157. 10s., and if the plant is found satisfactory, that a duplicate set be obtained at a small cost.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

March 15, 1895.

5,451. A. Wright. Brighton. Improvements in self-recording electric meters.

5,515. R. E. P. Crompton. London. Improvements in electric measuring instruments.

5,521. O. March. London. Improvements in electric couplings.

March 16, 1895.

5,568. W. P. Thompson. Liverpool. Improvements in alternating-current arc lamps. (W. Mathiesen, Germany.)*

5,596. S. Jevons. London. Improved construction and arrangement of commutators for dynamos.

5,601. S. O. Cowper-Coles and I. W. N. Hickley. London. Improvements in signalling and electric search light apparatus.

March 18, 1895.

5,665. V. Willis. London. Improvements in electro-pneumatic and pneumatic movements for organs.

March 19, 1895.

5,671. C. Langstone, B. Young, and A. Van Den Bogaerde. Birmingham. Improved storage battery.

5,693. F. P. Bergh and C. W. Tarbox. Manchester. Improvements in and relating to electrical railways and tramways.*

5,699. G. R. MacIntire. Manchester. Improvements in electric arc lamps.*

5,700. G. R. MacIntire. Manchester. Improvements in electric arc lamps.*

5,701. G. R. MacIntire. Manchester. Improvements in electric arc lamps.*

5,722. H. Hirst and J. T. Baron. London. Improvements in electricity meters.

5,742. L. S. Wright. London. Apparatus for automatically limiting the speed of electric cars.*

5,747. B. F. Perkins. London. Improvements in dynamometers.*

5,798. J. Burry. London. Spring-winding apparatus for printing telegraph and other instruments.*

March 20, 1895.

5,867. H. J. Price and L. de M. G. Ferreira. London. Improvements in electrical signalling apparatus for use upon railways.

5,868. H. Cardozo. London. An improved secondary battery.

5,875. F. L. Muirhead. London. Improvements in and relating to conduits for electrical conductors.

5,878. C. H. Wordingham. London. Improvements in or connected with the distribution of electricity.

March 21, 1895.

5,892. J. H. Robottom and F. C. Geary. Burton-on-Trent. A device for the better regulation of electric currents.

5,903. G. H. Firth. Manchester. Improvements in the application of electricity to the working of ships' turrets, and apparatus therefor.

5,913. R. E. Gill and W. Hockly. London. Improvements in means for regulating the electric light in railway-coach compartments.

5,927. R. J. Crowley. Queenstown. A means of transmitting electrical impulses from pencil marks on paper, or like material, and of reducing the electrical resistance of paper.

5,936. Siemens Bros. and Co. (Limited). London. A current collector for electrically-propelled railway or tramway vehicles. (Siemens and Halske, Germany.)

5,939. A. Fraser and The Eastern Telegraph Company (Limited) London. Improvements relating to automatic telegraphs.

5,956. R. Pearson. London. Improvements in thermometric circuit-closers or alarms.

5,964. A. Holler. London. Improvements in the construction of galvanic battery elements or cells.

5,965. E. A. Allen. London. Improvements in or connected with electrolytic cells.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

5,001. Essinger and Harden. Electric fuses and switches.
7,711. Bishop. Element board for electro-therapeutic diagnosis.
8,238. Clerke. Electro-medical apparatus.
8,240. Ball and Winter. Ceiling rose for electric lamps.
8,480. Rushton. Galvanic batteries.
16,887. Oliver. Ships' telegraphic apparatus.
18,525. Jeckell. Laying electric conductors.
21,323. Thompson (Coffin). Welding electrically.
21,893. O'Neil. Facsimile telegraphs.
23,944. Diatto. Electric rail and tram vehicles,

COMPANIES' MEETINGS AND REPORTS.

W. T. Henley's Telegraph Works Company (Limited).

The 16th ordinary general meeting of this Company was held at the offices, 27, Martin's-lane, Cannon-street, on the 22nd inst., under the presidency of Mr. Sydney Gedge.

The SECRETARY (Mr. A. E. Salmon) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, I have been suffering, so as not to be out of the fashion, from the prevailing epidemic, and have left my room for the first time to-day, in order to have the pleasure of presiding at this meeting. I have had more than once to preside at meetings of this Company when I would, perhaps, have rather been away; but I should have been sorry not to be present to-day, because we meet in circumstances which enable us to congratulate each other and every one connected with the Company very heartily. You have, no doubt, all of you had a copy of the report and accounts sent to you. They are very simple and very satisfactory, and there is not much room for me to make any comment. They show that we are doing a good, steady, and increasing business. I may say that not only has our business increased over that of last year, but the ratio of profit has increased; and in view of statements which have been made at general meetings of some other companies engaged in similar business, where the complaint has been that the business has been less and the ratio of profits smaller, I think we may congratulate ourselves that we have a very different tale to tell. It is not that our prices are higher, for we have been singularly successful when we have had to compete with other parties. The reason we are able to sell at low prices and yet get a good profit is because our works are so ably and economically managed under the able supervision of Mr. Hatton, the engineer, and still more of Mr. Sutton, who is now sitting by my side. If there had not been good buying, and good and careful management and attention paid to our work, our position would have been very different, but there is good buying in our case, together with careful management, and every attention is also paid to the details of our work. The whole thing, in fact, is thoroughly well done, and the result is the satisfactory one I have mentioned. With respect to our past complications, which arose in connection with the International Cable Company, when we were struggling for existence—all those things are at an end. You will observe among our assets in the balance-sheet "Shares held in the International Cable Company £48,200, less reserve against these shares £48,200;" and nothing is brought forward as of any value at all as an asset. We write off the whole of that, because, as you will find in the profit and loss account below, there is an entry "Reserve account—further amount charged to fully provide for International Cable Company's shares, £2,180. 9s. 2d." That has been written off against the profits of the year, and I am happy to say that, although it is not any large sum, yet, still, a substantial sum is still coming from that source. We were not able to bring it into the balance-sheet, because the amount was not settled at December 31st last, nor is it even now actually settled; but a substantial sum is coming from that source, which will be to the good this year. Again, if you look further at the report, you will find a statement that the whole of the debenture stock has now been issued. In the accounts to the end of the year only £44,500 of that stock is put as a liability, because, at that time, £5,500 was outstanding. That £5,500 has now, however, been subscribed for. In the accounts for the year, in the profit and loss account, we put the whole of the expenses of issuing the Four and a-Half per Cent. Debenture Stock and the redemption of the old mortgage and the "A" and "B" Debentures, all that being charged to the year. Of that amount, however, something like half might with great propriety have been charged to capital, and something more might have been spread over two or three years, because the holders of the "A" and "B" debentures know that their interest was paid under discount in order to induce them to retire then instead of waiting until their due date. That has all been charged to the profit of the year. Further, all maintenance has been charged to the profit of the year, as well as £1,000 for depreciation of machinery; and in the footnote to the accounts you will see that the adequacy of the amount so written off is certified by the Company's engineer. A very short time ago I went carefully over the works with Mr. Sutton and General Hutchinson—and General Hutchinson knows more than I do of matters of that kind, as he is an old engineer officer; but for myself, as far as my limited knowledge goes, I found that the works were in excellent condition; and when I contrast it with the state of things in former years, I see that a vast improvement has taken place. It is quite delightful now to go over the works and see their admirable condition, and the order and efficiency prevailing, and the way in which all our space is being availed of. The next matter I have to mention is with respect to the share capital. Year after year we have shown in the balance-sheet that there were only 6,837 Ordinary shares of £10 each, or, £68,370 of capital, leaving a balance of £1,630 unsubscribed. The whole of that share capital has now, however, been placed at par without expense to the Company, and has been subscribed and paid-up in full. You also see next our 100 shares of £10 each, making £1,000 in all, which have been held for some time, arising out of some old contract with the Electric Lighting Company, and taken over by this Company. Those shares have also been purchased at par without expense to the Company. In this way £2,630 of additional capital that was required has now found its way, or is finding its way, into the coffers of the Company. All this is very much for our advantage, because we are still suffering from the want of capital. Our new works and our fine machinery have cost more than was expected, and from the way in which our business is branching out in different directions, we shall require additional machinery. If, therefore, our business continues to go on as it is at present, I think we may come before you within a few months to ask you to give us power to increase our capital—not because we like too much capital, but because we shall see our way to that capital earning and paying a good dividend. When that time comes, I hope we shall be able to put before you some plan for the benefit of our men at the works. The average number of men employed at our works is now over 500. We have never hitherto seen our way, until you were receiving a good dividend, to go to any expenditure for the benefit of our men in the same direction in which expenditure is incurred in many large works—expenditure for their benefit, not merely from any philanthropic motive, but because we know that such expenditure, when judiciously laid out, does obtain a return to the employer as well as to the employed in various ways. I am not going to bind you or the Directors now to any proposal, but I throw out the mere idea of giving them a comfortable dining-room, where they can cook and eat their dinner; expenditure of that kind is found to pay. I am sure that the interests of the workmen are as dear as your own interests to you, and I feel convinced that if we can propose to you some expenditure for the benefit of the workmen and of yourselves, you will be pleased to authorise the outlay. The great motive for incurring expense is to get a return, and I believe we shall bring this matter before you before very long, and we have no doubt whatever that when we do it will meet with very favourable and fair and businesslike consideration. The last point I have marked to mention to you is this: under our liabilities in the balance-sheet you see an entry "Reserve under cable-repairing contract, £2,450. 5s. 8d." That figure is on the other side of the account, although it does not appear, in the item of "Debentures and shares held in other companies, £4,894. 1s. 6d." What it means is this: When we laid the cable between Florida and the Bahamas, we undertook a repairing contract for 20 years. £700 was to be paid annually by the Colony of Bahamas, and to be invested in the joint names of your Chairman and the Crown Agents of the Colony, and that money has accumulated. At the end of last year it amounted to £2,450. 5s. 8d. That is there put as the measure of your liability; but I am happy to tell you that three years have passed since that cable was laid, and the liability to repair it was included in the repairing fund, but not one shilling has had to be paid on its repair, and therefore, under that contract, there is an accruing profit, which some day, I hope, will be very considerable. Ultimately, the profit in the 20 years is to be divided between you and the Colony. I may also say, with regard to the Bermuda cable, that not one shilling has been laid out for its repair. With reference to all the other cables in the West Indies which you have laid and which have been laid on behalf of French companies within the last few years, I am informed credibly by those who know that the only cables laid in those waters which have not required repair are those which have been laid by Henley's Company. Not a shilling has had to be spent in repairs on any of your cables, whereas several other cables have been continually in need of repair. All that, I think, points to the goodness of your work. When you refer to the balance sheet and see these excellent profits that have been earned and divided—and I shall have the pleasure of proposing presently a dividend at the rate of six per cent. on the Ordinary shares, leaving a good amount to carry forward—I think you will be gratified at the position. We have thought it right to carry forward a large amount under the circumstances. When you reflect that this money has all been earned merely from the general business of the Company and not through any large submarine order—by mere bread-and-butter business, such as electric lighting and telephone work and golf balls—and when I add to that the fact that the increased business this year since the 1st of January has averaged more than 10 per cent. week by week over the business of last year, although that showed a considerable increase over the business of the previous year; I think you may congratulate yourselves on being shareholders in a Company which, whatever difficulties it had to undergo in its infancy, has now arrived at a healthy and vigorous maturity, and is in a position which induces us to hope that it will go on doing well and earning money as long as we shall live to see it, at any rate. I have now great pleasure in proposing the following resolution:—

"*That the report and balance sheet now presented to the meeting be, and is hereby received and adopted.*"

Mr. R. J. JENKINS, C.E., seconded the motion.

The CHAIRMAN, in answer to Mr. Kitt, said that it was not customary to read the minutes of their previous meetings, which were always confirmed by the Directors at their next Board meeting. The Directors' remuneration was £1,000 a year; but it was not usual at a meeting of that kind to mention the remuneration of the officers. That was a matter which was in the hands of the Directors. He then put the motion, which was carried unanimously. He afterwards proposed the declaration of the dividends recommended—at the rate of 7 per cent., less income-tax, on the Preference shares, and at the rate of 6 per cent. per annum, free of income tax, on the Ordinary shares.

The Hon. RANDOLPH STEWART seconded the resolution, which was unanimously carried.

On the motion of the CHAIRMAN, seconded by Major-Gen. GEORGE HUTCHINSON, C.B., C.S.I., Mr. Jenkins was re-elected a Director, as was also the Hon. Randolph Stewart on the motion of the CHAIRMAN, seconded by Mr. FREDERICK NEWTON.

The CHAIRMAN then stated that Mr. Sutton was willing to enter into an agreement with them, by which he would continue to be managing director of the Company for 10 years. The Board thought it would be a very great advantage to the Company to secure Mr. Sutton's services for that period. The details of the terms of arrangement were on the point of being settled, but it was not necessary to trouble them with the actual details. By clause 69 of the Articles of Association, the Board might appoint one of their number to be managing director for such term as they might think fit, provided the period should in no case exceed five years, without the consent of the Company in general meeting. He wanted them to authorise the Board, if they thought fit, to make the term 10 years. Mr. Sutton had been with them for several years, and he had worked the Company up, with the assistance and under the supervision of the Directors, from a very small concern to be the very fine business it now was. He was perfectly familiar with the whole concern, and he possessed the full confidence of the Board, while the latter had Mr. Sutton's full confidence also. He then moved a resolution authorising the Board to engage Mr. Sutton's services as managing director for a term not exceeding 10 years.

In answer to Mr. Kitt,

The CHAIRMAN said he did not know that one could have a better guarantee of a man's fidelity than intimate acquaintance with him extending over some years, and he had known Mr. Sutton intimately for 15 years.

The Hon. RANDOLPH STEWART seconded the motion, observing that he had had the privilege of knowing Mr. Sutton for many years. He believed that everything that that gentleman had made during that period had been invested by him in the Company.

The CHAIRMAN put the resolution, and it was carried unanimously.

The auditors having been re-elected,

A cordial vote of thanks was passed to the managing director, the engineer, and the officers generally.

The MANAGING DIRECTOR, in reply, stated that one great cause of the success of the Company was the large amount of interest taken in his work by every man individually. He had been very glad to hear the intimation of the Chairman as to making some provision for benefiting the workmen at Woolwich. It would be a good thing, certainly, if it could be done without too great expenditure, and he could testify to the admirable way in which the whole staff worked, many of the officers labouring recently for two days and nights, without any extra remuneration, to get off certain work.

A hearty vote of thanks was afterwards passed to the Chairman and Directors.

The Chairman briefly acknowledged the compliment, and the meeting then separated.

Eastbourne Electric Light Company (Limited).

The annual meeting of this Company was held on Monday last at Eastbourne, Alderman Boulton presiding.

The CHAIRMAN, in moving the adoption of the report (which appeared in our last issue), said that he had never shared the doubts which some people entertained as to the ultimate success of the Company. In 1893 they paid their first dividend of 3 per cent., last year they paid 5, this year they had made it 7½, and next year they hoped it would be 10 per cent. He complimented their engineer (Mr. H. W. Wilkinson) upon the manner in which he had fitted the light in his (the Chairman's) house. The Directors proposed to reduce the cost of current from June 30 next from 9d. to 8½d. per unit.

The motion for the adoption of the report was seconded by the MAYOR, who said he felt confidence in the prophecy that they would pay 9½ or 10 per cent. next year.

The motion was carried, the 7½ per cent. dividend declared, the retiring directors and auditors re-elected, £200 voted as directors' remuneration, and a vote of thanks passed to the directors, manager, and secretary for their skilful and successful management of the Company's business.

Edison Gower-Bell Telephone Company of Europe (Limited).

The twelfth ordinary general meeting of this Company was held yesterday at the offices, 53, New Broad-street, Sir Alexander Armstrong, K.C.B., F.R.S., presiding.

The SECRETARY (Mr. Richard Rodgers) having read the notice calling the meeting,

The CHAIRMAN stated that since they last met the Belgian suit, which had been in existence for several years, had terminated in the Company's favour. The suit was in connection with the Company's patent rights in Belgium, and the action in the Court of Appeal at Liège, referred to in the last two reports, had resulted in a reversal of the previous verdict against the Company, and in the Zurich Telephone Company, working at Namur, being found in damages and costs. This was a very satisfactory conclusion to a long-pending litigation, and the question of the amount of damages to be assessed was now being argued before the Court. Having got a verdict in their favour, they hoped that at an early date a substantial amount of damages would be granted to the Company. In view of this success, and in anticipation of a satisfactory financial recognition of their claims, the actions entered against other and more important infringers were being vigorously proceeded with. They had every reason to expect the same satisfactory results from these actions which had attended their suit with the Zurich Company—a contest which had extended over a period of eight years. He trusted that when they next met they would have a still more satisfactory account to render of the working of the Company. He concluded by moving the adoption of the report and accounts.

Mr. C. L. W. FITZGERALD seconded the motion, which was unanimously carried.

Sir Alexander Armstrong was afterwards re-elected to his seat on the Board, on the motion of Mr. FITZGERALD, seconded by Mr. ARTHUR HENRY BAKER; and the auditors, Messrs. Deloitte, Dever, Griffiths and Co. were also reappointed on the motion of Mr. GREWING, seconded by Mr. CURTOYS.

The proceedings then terminated.

The following is the report of the Directors of this Company in regard to litigation in which the Company is engaged:—

In connection with the Company's patent rights in Belgium, the action in the Court of Appeal at Liège, referred to in the last two reports, has resulted in a reversal of the previous verdict against the Company, and in the Zurich Telephone Company, working at Namur, being found in damages and costs. The question of the amount of damages to be assessed is now being argued before the Court. In view of this success, and in anticipation of a satisfactory financial recognition of our claims, the actions entered against other and more important infringers are being vigorously proceeded with.

Anglo-Portuguese Telephone Company (Limited).

The eighth ordinary general meeting of this Company was held yesterday at the offices, 53, New Broad-street, under the presidency of Sir Alexander Armstrong, K.C.B., F.R.S.

The SECRETARY (Mr. Richard Rodgers) having read the notice calling the meeting,

The CHAIRMAN said he thought the state of the Company was very satisfactory. The amount to the credit of profit and loss account, after making all deductions, and including the balance brought from last year, was £10,629. Of this amount it was proposed to place £6.500 to reserve account, bringing the reserve up to £20,000, leaving £4.129 to be carried forward. This was very satisfactory with regard to the present position of the Company, and it was the opinion of the Directors that a dividend should be paid at the earliest moment the finances of the Company would permit. The expenditure on capital account for the year had been £3,226. The number of paying subscribers on December 31st last was 1,178 in Lisbon, of a gross annual value of £8,959, while in Oporto the number was 1,199, the gross annual value being £6,679. Since the close of the year there had been an increase of £352 in the gross annual value of their subscribers; that was up to February 28th. The income of the Company was thus brought up to £16,000 a year, and he thought it very satisfactory, in view of the depressed financial condition of Portugal, that the telephone had been in every way successful there. The number of subscribers increased last year by 106, and it was remarkable that from the first introduction of the telephone into Portugal its use had continued to increase gradually year by year until they were now in receipt of the handsome income he had mentioned. The continuance of the high rate of exchange between the two countries was a very great misfortune, and it had again entailed a serious loss upon the Company, amounting last year to £2,241, which was really equivalent to 4½ per cent. on the Company's share capital. This loss and the expenditure on capital account had tended most seriously to cripple their resources. Still, he had to express the satisfaction of the Board that the state of the Company was so sound, and they looked forward at an early date to being able to pay a satisfactory dividend. Their relations with the Lisbon Board continued to be of the most satisfactory character, and added very much to the good working and efficiency of the Company. He concluded by proposing

"That the Directors' report and accounts of the Company for the year to December 31, 1894, as now presented, be received and adopted."

Mr. C. L. W. FITZGERALD seconded the resolution, which was unanimously carried.

On the motion of the CHAIRMAN, seconded by Mr. HENRY GREWING, Mr. Fitzgerald was re-elected to his seat on the Board; and Senhor Barbosa Collen was also re-elected a member of the Lisbon board, on the motion of the CHAIRMAN, seconded by Mr. FITZGERALD.

Mr. ARTHUR HENRY BAKER afterwards proposed, and Mr. CURTOYS seconded, the re-election of the auditors, Messrs. Deloitte, Dever, Griffiths and Co.

The proceedings then terminated.

The Directors' report is as follows:—

The amount to the credit of profit and loss account, after making all deductions, and including the balance brought from last year, is £10,629 6s. 4d. Of this amount it is proposed to place £6,500 to reserve account, leaving £4,129. 6s. 4d. to be carried forward; but it is the opinion of the Directors that a dividend should be paid at the earliest moment the finances of the Company will permit. Acting upon the instructions of the auditors, the assets and liabilities in Portugal have been made up at the exchange ruling on December 31st last. The expenditure on capital account for the year amounted to £3,226. 5s. 2d. The number of paying subscribers at December 31st last was—

In Lisbon 1,178, of a gross annual value of	£8,959	
In Oporto 1,199, „ „ „ „	6,679	
		£15,638

showing a total increase in subscribers of 106, and in value of £907, over the preceding year.

The continuance of the high rate of exchange between the two countries has again entailed a very serious loss, amounting last year to £2,241 13s. 6d., which is equivalent to 4½ per cent. on the Company's share capital. This loss and the expenditure on capital account have tended most seriously to cripple the available financial resources of the Company.

Direct Spanish Telegraph Company (Limited).

The report of the Directors of this Company for the half-year ended December 31st last, which will be presented at the half-yearly general meeting of shareholders, to be held this day (Friday), at No. 280, Winchester House, London, E.C., at 12 o'clock, states that the accounts for the half-year show, after providing for debenture interest and redemption of debentures, a balance to the credit of revenue of £4,076 13s. 5d. The traffic receipts show a decrease of £1,244. 7s. as compared with the corresponding period of 1893. This falling off in the receipts is due to the continued depression of trade between England and Spain and France and Spain. The working expenses are £40. 13. 3d. in excess of those for the corresponding period of 1893.

The Company's cables, and the land-lines in connection with them, have, with one exception, continued in good working order throughout the half-year. The Falmouth-Bilbao cable became interrupted on November 14th last, having been broken by the British steamer "Caloric" in Bilbao Bay. It was effectually repaired by the Eastern Telegraph Company's steamship "John Pender" on December 2nd. The cost of these repairs has therefore been included in the amounts due outstanding.

After adding the usual sum of £2,500 to the reserve fund, the balance of revenue amounts to £1,576. 13s. 5d. To this the Directors propose to add £1,166. 8s. 7d. from interest on investments, and recommend the payment of the dividend at the rate of 10 per cent. per annum on the Preference shares, and a dividend, free of income-tax, at the rate of 4 per cent. per annum on the Ordinary shares. The reserve fund will then amount to £22,888. 1s. 6d.

Sir John Pender, G.C.M.G., M.P., and Mr. J. Denison Pender offer themselves for re-election as Directors, as do the auditors, Messrs. Deloitte Dever, Griffiths and Co.

Sheffield Electric Light and Power Company (Limited).

The report of the Directors of this Company states that during the past year the Company have continued the extension of the underground mains into the residential districts of Broomhill and Ranmoor, and have also completed the construction of the new electric light station, and the erection of a new chimney, consequent on the development of the business brought about by the increased demand for current. The accounts show the balance of profit as follows:—

	£	s.	d.	£	s.	d.
Balance brought from last year				585	5	6½
Balance of suspense account transferred				146	19	5½
Net profit for the year				1,943	3	10½
				£2,675	8	10½
From which must be deducted:—						
Interest on debentures	691	4	8			
Proportion of formation expenses written off	202	7	2½			
Transfer to depreciation fund	1,250	0	0			
				2,143	11	10½
Leaving a balance of				£531	17	0

which the Directors propose to carry forward to the current year. In view of the substitution of underground mains for those overhead, it has been considered prudent to set aside the substantial sum of £1,250 to provide for this and any other depreciation. It is gratifying to record that the gross revenue from the supply of current has increased during the past year from £3,355. 11s. in 1893 to £4,849. 9s. 4d. in 1894, whilst the working costs during the same period have been satisfactorily decreased. Messrs. George Senior and William Tasker seek re-election as Directors, as do the auditors, Messrs. T. G. Shuttleworth and Son.

NEW COMPANIES, STATUTORY RETURNS, &c.

J. G. BARTLETT AND COMPANY (LIMITED).—This Company was registered on March 22nd with a capital of £2,000, in £1 shares, to acquire the business carried on by Joseph G. Bartlett at Redcliff Wharf, Redcliff Backs, Bristol, and to carry on the business of mechanical, electrical, hydraulic and marine engineers, machinists, &c.

GENERAL TRACTION COMPANY (LIMITED).—This Company was registered on March 20th with a capital of £7, in £1 shares (with power to increase), to enter into or acquire by purchase or otherwise, and carry out contracts or concessions or other grants in any part of the world, for making, purchasing, and working railways, tramways, telegraph lines, telephone lines, electric and other lighting, electric, hydraulic, or other works, and for the equipment of any such undertakings or works with electric or other plant, stock, or apparatus, and generally to carry on the business of contractors. The subscribers include four clerks, one gentleman, and two secretaries, and W. Graff Baker originally signed the Memorandum of Association, but his name has since been struck out.

McPHAIL AND SIMPSON'S DRY STEAM PATENTS COMPANY (LIMITED).—This Company has been registered with a capital of £416,000, in shares of £10 each, to acquire certain patented inventions connected with the generation, application, control and utilisation of dry or superheated steam, and to carry on the business of engineers, boiler makers, founders, &c.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return of this Company, made up to March 13th, and filed recently, shows that a capital of £800,000, divided into 40,000 Ordinary and 40,000 Preference shares of £10 each, has been subscribed for and allotted. The full amount per share has been called and paid.

NATIONAL ELECTRIC ENGINEERING COMPANY (LIMITED).—An agreement, dated December 21st (just filed), made with Arthur C. Cockburn and Douglas C. Bate, electrical engineers (vendors), provides for the allotment as fully paid of shares Nos. 255 to 1,254 inclusive to Arthur C. Cockburn, and shares Nos. 1,255 to 2,254 inclusive to Douglas C. Bate, as part consideration for the purchase of the business of electrical engineers carried on by them at 2, Holborn-place, 261, High Holborn, London, W.C.; at 1, Gresham-street, London, E.C., and 73, Bridge-street, Manchester.

NATIONAL ELECTRIC SUPPLY COMPANY (LIMITED).—This Company's return, made up to February 27th, has been filed. The nominal capital is £100,000 divided into 100 Founders' and 19,900 Ordinary shares of £5 each. All the Founders' and 10,520 Ordinary shares have been taken up, and the full amount called.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to February 28th, has been filed. Out of a nominal capital of £50,000, in 10,000 £5 shares, 7,811 have been taken up, of which 115 have been issued as fully paid. A call of £4 per share on the remaining 7,696 shares, and £33,815 has been received, including £3,031 paid in advance.

NEW-MAYNE ELECTRIC RUDDER-MOTOR SYNDICATE (LIMITED).—An agreement, dated February 28th, with Anthony G. New and Arthur J. Mayne, electrical engineers, and John L. Higgs, gentleman (referred to as "the creditors"), states that whereas the Syndicate is indebted to the creditors in the sum of £8,000, and is not now in a position to satisfy such indebtedness, it is therefore agreed that the Syndicate shall allot as fully paid 800 shares of £10 each, Nos. 1,201 to 2,000 inclusive, to the creditors in full satisfaction and discharge.

PACIFIC TELEGRAPH COMPANY (LIMITED).—The annual return of this Company, made up to December 31st, was filed on March 8th. The nominal capital is £2,000,000 in £10 shares; 18 shares have been taken up, and the full amount per share called. £150 has been received, leaving £50 in arrears.

PERU TELEPHONE COMPANY (LIMITED).—The annual return of this Company, made up to January 14th, is filed. The nominal capital is £100,000 in £5 shares, of which seven have been subscribed for. Nothing has as yet been called on these shares.

PONTYPRIDD ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return of this Company, made up to March 16th, is filed. The nominal capital is £10,000, in £5 shares. Of these 1,143 have been subscribed for and allotted. The full amount has been called on 669 shares, and calls amounting to £4 per share have been made on the remaining 474, resulting in the total payment of £5,241.

ROGER'S ARC LAMP COMPANY (LIMITED).—An agreement, dated February 8th, with James W. Rogers, engineer; Harry W. Christmas, solicitor; John M. Catton, gentleman; Joseph H. Ashby, civil engineer; and George W. Yorston, provides for the allotment, as fully-paid, of the following shares of £5 each: J. W. Rogers, 1,750; H. W. Christmas, 400 shares; J. M. Catton, 220 shares; J. H. Ashby, 600 shares; and G. W. Yorston, 30 shares.

ROSE AND BIRD (LIMITED).—An agreement dated December 14th (just filed) with Thomas A. Rose, electrical engineer, and John A. Bird, merchants' and manufacturers' agent (vendors), states that whereas the vendors are the proprietors of, and Thomas A. Rose the inventor of, improvements relating to the process of manufacturing incandescent electric lamps, and have agreed to sell their rights to the Company, the purchase consideration for such sale being 1,000 fully-paid Founders' shares of £1 each, Nos. 2,001 to 3,000 inclusive, to be equally divided between them. In addition, the Company agrees to pay Thomas A. Rose a royalty of ¼d. for every lamp manufactured and sold by the Company. Thomas A. Rose becomes General Manager and Superintendent of the Manufacturing Works for life, without payment, and John A. Bird becomes General Business Manager for life, and to provide office accommodation without remuneration.

RUGBY SCHOOL ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return of this Company, made up to March 9th, is filed. Out of a nominal capital of £5,500, in £50 shares, 70 shares have been taken up, and calls amounting to £40 per share have been made, resulting in the payment of £2,800. The shareholders are all past or present masters of the Rugby School, including the head master.

R. WAYGOOD AND COMPANY (LIMITED).—The statutory return of this Company to December 24th has been filed. The nominal capital is £60,000 divided into 3,000 Ordinary and 3,000 Preference shares of £10 each. Ten Ordinary shares have been taken up, the full amount called, and £100 paid.

CITY NOTES.

CALLS DUE.—To-morrow (Saturday) a call of 40 per cent. on the Five per Cent. Debenture Stock of the City of London Electric Lighting Company falls due. On the same day calls of £2 per share on £19,900, and £6 per share on £10,000 Ordinary £10 shares of the County of London and Brush Provincial Electric Lighting Company fall due.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended March 24th were £893, as against £792 in the corresponding week of 1894, being an increase of £101. The total receipts for the half-year amount to £11,716, as against £11,192 for the corresponding period of 1894, an increase of £524.

EVERED AND COMPANY (LIMITED).—The Directors of this Company recommend a dividend at the rate of 7½ per cent. per annum for the past half-year. The amount carried forward to next account is £3,450.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 24th inst. amounted to £943. The amount for the corresponding week last year was £797.

McPHAIL AND SIMPSON'S DRY STEAM PATENTS COMPANY (LIMITED).—A prospectus has been issued of this Company, which is formed with a capital of £416,000, in £10 shares, £150,000 being Six per Cent. Cumulative Preference shares, £216,000 Ordinary shares, and £50,000 Deferred shares. The Company acquires the business of McPhail and Simpson, of Wakefield, who claim to have perfected a method of producing dry and superheated steam at a controllable temperature. The patentees claim that by the adoption of their apparatus a perfect dry steam of greatly-increased power can be obtained with a much smaller consumption of fuel, and that the apparatus can be applied to every ordinary form of boiler. Perfect circulation and uniform temperature are maintained throughout the boiler, and priming is absolutely impossible. The prospectus contains a long list of firms whose boilers have been fitted with this apparatus, including the Charing Cross and Strand Electricity Supply Company, who have repeated their first order. The lists close to-morrow (Saturday).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ending March 22, 1895, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,411.

WILLANS AND ROBINSON (LIMITED).—The register of transfers of this Company will be closed from March 27th to April 10th inclusive. The third ordinary general meeting of the Company will shortly be held.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Mar. 20.		Price Wednesday, Mar. 27.		Rate per Crnt. Yielded.	Dividend Due.	Business Done During Week Ending Mar. 27.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£1,012,880	Stock	14 0	Anglo-American	41½	42½	41½	42½	4 14 2	Jan., Apr., July, Oct.	42½	41¾
£2,993,560	Stock	28 0	Do. Preferred	78½	79½	78½	79½	5 0 2	,, ,,	79½	78½
£2,993,560	Stock	5/0	Do. Deferred	6¼	6¾	6½	6¾	..	..	6½	6⅜
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 17 10	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	12¼	12¾	12	12½	5 4 0	Mar., June, Oct., Dec.	12$\frac{7}{16}$	12$\frac{5}{16}$
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	109	113	109	113	4 9 6	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	148	152	148	152	4 12 1	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	13¾	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	,, ,,	20¾	20½
12,931	5	1/8	Direct Spanish (fully paid)	4	4½	4	4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9½	10	9½	10	5 0 0	,, ,,	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8½	9	8½	9	5 0 0	Jan., Apr., July, Oct.	8$\frac{13}{16}$	
400,000	10	2/6	Eastern	16¼	16½	16¼	16½	3 18 9	,, ,,	16½	16¼
70,000	10	6%	Do. 6 per Cent. Preference	17¼	17¾	17¼	17¾	3 7 7	,, ,,	17$\frac{9}{16}$	17⅜
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	124	127	124	127	3 3 0	May and November	125½	124½
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	108	105	108	4 13 3	February & August	..	..
250,000	10	2/6	Eastern Extension	17⅛	17⅝	17⅛	17⅝	4 0 8	Jan., Apr., July, Oct.	17¾	17⅛
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	123	126	123	126	3 3 6	February & August	124½	..
£62,700	100	6%	* Do. 6 p. c. (Austln. Gov. Sub.) Debs. 1900	103	107	103	107	4 14 1	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	103	107	4 14 1	,, ,,	104	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106	109	106	109	3 13 9	February & August	107	—
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 8	May and November	..	—
180,227	10	1/6	Globe Telegraph and Trust	9¾	10⅛	9¾	10⅛	4 8 1	Jan., Apr., July, Oct.	10$\frac{1}{16}$	9$\frac{15}{16}$
180,042	10	6%	Do. 6 per Cent. Preference	16⅝	16⅞	16⅝	16⅞	3 11 3	,, ,,	[illegible]	16¾
150,000	10	5 0	Great Northern	21½	22½	21½	22½	3 16 7	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 13 6	March & September	..	..
17,000	25	12/6	Indo-European	52	54	52	54	4 12 7	May and November	..	—
37,548	10	5/0	London Platino-Brazilian	6	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	105	109	105	109	5 10 7	March & September	..	—
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	105	108	3 14 9	..	..	—
11,839	8	4/0	Reuter's	4	5	4	5	..	April and October	..	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	119	124	119	124	4 16 9	,, ,,	..	..
15,609	10	5/0	West African Telegraph	4	5	4	5	..	January and July	..	—
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	101	104	4 16 5	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	—
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	98	103	7 15 4	June and December	..	..
88,321	10	6d.	West India and Panama	⅞	1⅛	⅞	1⅛	..	.	1⅛	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	5 6 8	May and November	11⅛	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	9¾	—
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 11 1	June and December	..	..
64,242	15	3/0	Western and Brazilian	10	10½	10	10½	5 4 6	May and November	10½	10¼
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	—	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	4	4½	4	4½	..	..	4½	4⅜
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 15 5	February & August	103¼	102¾
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 15 6	,, ,,	..	—
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115	120	115	120	5 19 8	May and November	..	—
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	101	103	101	103	5 17 1	March & September	..	—
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	—	..	..	..
224,850	10/0	2⅞d.	Consolidated Telephone Const. & Maintenance	$\frac{1}{16}$	$\frac{3}{16}$	$\frac{1}{16}$	$\frac{3}{16}$	..	May and November	..	—
171,504	£1	..	Oriental Telephone and Electric (fully paid)	$\frac{9}{16}$	$\frac{11}{16}$	$\frac{9}{16}$	$\frac{11}{16}$	..	Yearly	—	..
484,597	5	2/6	National	5½	6½	5½	6½	4 10 11	June and December	5$\frac{7}{16}$	5$\frac{5}{16}$
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	16	15½	16½	3 12 9	,, ,,	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	15½	14½	15½	3 17 5	,, ,,	15½	..
119,234	5	2/6	Do. 6% Non-Cumulative 3rd Pref.	5⅝	5⅞	5⅝	5⅞	4 5 1	—	5$\frac{13}{16}$	5$\frac{11}{16}$
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	104	106	3 6 0	January and July	105½	104
58,000	5	1/0	United River Plate	1	2	1	2	..	,, ,,	..	—
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	85	90	85	90	5 9 11	,, ,,	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	13	14	13	14	1 15 8	—	..	..
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15	15½	14¾	15½	3 18 8	..	15½	15
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	135½	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	6	5½	5	5½	3 17 9	—	..	..
£57,400	£100	5%	Do. 6 per Cent. Debentures, 1900	..		..		..	—	..	—
8,322	£5	..	House-to-House Electric	..		..		—	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		—	—	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		—	January and July	—	—
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7⅜	7⅝	7½	7⅝	—	—	..	—
111,000	5	..	London Electric Supply	..		..		..	—	..	—
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	10½	10¾	10½	10¾	2 6 6	..	10¾	10⅝
£150,000	Stock	4½%	* Do. 4½% Debs.	118	120	118	120	3 15 8	June and December	..	—
6,452	£10	2 0	Notting Hill Electric	7½	7¾	7½	7¾	..	..	..	..
19,980	£5	4 6	St. James and Pall Mall	7½	8	7½	8	..	—	7⅝	7½
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8½	9	3 17 9	—	..	..
59,900	5	6%	Westminster Electric Supply (fully paid)	7⅜	7⅞	7½	8	3 2 0	—	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	8	1/6	Brush Electrical Engineering	2¼	2⅜	2¼	2⅜	6 6 7	—	2⅜	2¼
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2¾	2¼	2½	4 16 0	—	2$\frac{5}{16}$	2¼
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	113	116	113	116	3 17 9	March & September	113½	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2¾	3¼	2¾	3¼	—	January and July	..	..
12,139	5	..	Edison and Swan United	1⅝	1⅞	1⅝	1⅞	—	..	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		..	..	—	..
120,000	2	..	Electric Construction	¼	½	¼	½	—	..	..	..
12,845	2	2/0¾	Do. 7 per Cent. Cumulative Pref.	1¼	1¾	1¼	1¾	..	..	..	—
91,195	2	10/0	Elmore's Patent Copper Depositing	1¼	1½	1¼	1½	—	..	1$\frac{5}{16}$	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	..	..	..
60,000	10	10/0	India Rubber, Gutta Percha, &c., Works	22	23	22	23	4 6 11	February & August	22⅝	..
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	103	106	101	103	4 7 5	March & September	..	—
15,995	£10	..	International Okonite Ordinary	..		..		..	—	..	—
16,000	£10	..	Do. 8 per Cent. Preference	..		—		..	December and June	..	—
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	⅛	—	⅛	..	..	..	..
37,370	12	36/0	Telegraph Construction and Maintenance	39	41	39	41	8 15 7	March and July	40¾	40
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 11 1	January and July	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)							..	..
41,008	£5	..	Do. Preference (fully paid)	.		..		..	..	..	..
£63,870	10	10/0	W. T. Henley's Telegraph Works Ordinary	10	11	10	11	4 10 11	..	10¾	..
£30,000	10	..	Do. Preference	..		..		..	..	..	—
			RAILWAYS AND TRAMWAYS.								
£030,000	Stock	1½%	City and South London Railway	45	47	45	47	2 13 2	May and November	—	..
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	14⅝	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	130	133	130	133	3 0 2	May and November	132¾	132
87,500	£10	2%	Liverpool Overhead Railway	8½	8⅝	8½	8⅝	2 6 4	..	..	..
8,205	10	5%	Do. 5% Preference	13½	14	14	14½	3 11 6	..	..	..
125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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NOTES.

In spite of many an amusing *non sequitur*, the Scotch evidence in favour of the municipalisation of the telephone service given last Friday before the Select Committee was very much to the point. Competitive telephony as a permanent phenomenon is, of course, out of the question. Experience and common-sense show that whenever two companies start rival exchanges in the same town, the absorption of the one by the other is inevitable. We, however, have yet to see what would be the result of an able and powerful municipality starting an exchange. Not only would a municipality have at its back ample financial resources, but it would have, what in the matter of rival exchanges is almost as important, the *esprit de corps* of the citizens, which in the case of two rival companies is practically a non-existent factor. One such successful attempt would, probably, suffice; it would apply that sustained stimulus to the National Telephone Company which is so necessary to continued progress. Nothing short of the impossibility of quickening in any other way the pace of this powerful telephone concern could justify yet another manifestation of municipalisation. We may note in passing that the National Company is reaping the fruits of its pertinacious opposition to electric traction. One of the many reasons given by the Edinburgh Town Council for viewing with favour the municipalisation of the telephones is the manner in which the Corporation was hampered by the National Company when it was proposed to convert the Edinburgh tramways into electric lines.

In their laudable anxiety to promote local trade, the Electric Lighting Committee of the Hull Town Council seemed at one moment bent upon inflicting their fellow-citizens with home-made plant for the proposed extensions of their central station. At the meeting of the Committee, held on Thursday last week, the Borough Electrical Engineer reported that machinery of an estimated value of £2,851 would probably be required for the year 1895-96, and he very sensibly recommended that the Committee should in each case place the orders with the firms who had carried out the work before to everyone's satisfaction. Several members, however, argued that in common fairness Hull firms should have an opportunity of trying their hand at electric lighting plant construction, and the now common objection that the works of one of the original contracting firms were not "fair shops" was used to clinch the matter. After much irrelevant discussion, a deadlock terminated the proceedings, five members of the Committee voting on one side and five on the other. Notwithstanding all this pother over so trumpery an order, the only question at issue by the time the vote was taken was whether or no the boilers should be home made, it having been previously admitted that perhaps Hull was not equal to turning out an exact equivalent of a Willans engine, or for the matter of that, of a first-class central station dynamo. It is impossible not to sympathise with this very natural desire to convert local electric lighting stations into a source of profit to local engineering firms; at the same time, there can be no manner of doubt that from the single point of view of prime cost, and economy when running, the plant of large firms who have had a long experience of central station requirements, must prove the better bargain.

Dr. Fleming has likened the process of delineating current and volt curves on the conductors of a system of alternating current supply to the process of indicating an engine. A few weeks ago we were able to describe an apparatus which he had devised for the former purpose, and to give some of the "cards" taken with it from alternators under various conditions of load. The value of such a process, capable of being quickly and easily and withal accurately carried out, is very great, and will become increasingly so. Practical engineers—and especially motor men—are interested in the kind of "card" which may be tapped from any given part of any given network of mains. But, carrying the analogy of "indicating" a little farther, it will be seen that not only is it useful to be able to take the "card" at any place, but it will also sometimes be necessary to take simultaneous cards from two or more circuits; just as the steam engineer is often obliged to indicate the two or three cylinders of a steam engine simultaneously, and for the same kind of reason. In an interesting article, which we publish this week, Prof. Hicks shows how this may be done, and describes an instrument which for some considerable time he has himself employed for the purpose. With this, both the primary and the secondary circuits of a transformer, or the branches of a divided alternating-current circuit, may be indicated for volt and current curves. Unfortunately, neither Prof. Hicks' nor Dr. Fleming's instrument will enable curves to be taken with a facility approaching that of the steam-engine indicator. Nor is this a matter for surprise, when we remember that the frequency of a steam-engine cycle averages about 100 per minute, while that of a commercial alternating current is usually about 5,000 or 6,000. While referring to the actual mechanism of the process, it is interesting to note that Prof. Hicks prefers the use of a condenser and ordinary galvanometer to that of an electrostatic voltmeter or electrometer.

As will be seen by the Paper of M. Poincaré, which we publish in another column, our neighbours across the Channel are still busy on research work with a view to the improvement of secondary batteries, but so far the experiments which have been carried out with various materials only tend to confirm Planté's opinion, that for practical purposes lead is the most suitable metal to employ. It will be remembered that MM. Cailletet and Collardeau found that, with spongy platinum electrodes, a gas battery could be constructed which, under a pressure of 580 atmospheres, yielded a discharge of 56 ampere-hours per kilogramme, as against the 10 to 20 ampere-hours which M. Mascart pointed out as the practical capacity per kilogramme of total weight of lead batteries; and now M. Poincaré finds that the practical capacity of the cell with mercury electrodes in a solution of potassium iodide only reaches the lower limit of that of the lead cell. So far, the results obtained do not offer much hope of a practical cell, but still they are interesting from a theoretical point of view. It is, perhaps, natural that more attention should be directed to the subject of the storage of electrical energy in France, which was the home of the first successful attempt at the solution of the problem; but one would like to see more work done in this connection in this country. The mechanical construction of batteries has been much improved in England, but most of the improvements in the chemical processes connected with their manufacture come to us from abroad. Some years ago Prof. Ayrton pointed out that in the lead cell, "in consequence of its being slightly warmer than the air during charging and discharging, there is a loss of energy from radiation and convection equal to about 17 per cent. of the energy put into the cell," and he suggested that it was possibly due to some non-reversible oxidation; but since then not much has been done with a view to discovering the cause, although it would appear that investigation in this direction might lead to some substantial improvement.

The comments of our American contemporary, the *Electrical World*, upon a Paper on "Large Arc Dynamos," which was read recently at the Cleveland Convention of the National Electric Light Association by Mr. C. N. Black, should prove as interesting to engineers on this side of the Atlantic as on the other side. There is a considerable amount of series arc lighting with continuous currents done in this country, though neither so great in actual amount nor bearing so large a proportion to other systems as in America. With us the comparative merits of closed and open coil armatures for arc light machines, although of technical interest, is not so vital a matter as in the United States. For neither do we depend to so great an extent upon the simple series system, nor, when we use that system, do we string quite so many lamps in a single circuit. We have our series systems, it is true; but these are largely *multiple*-series with continuous or alternating currents, or, as at Portsmouth, Cardiff, and Edinburgh, on the rectified alternate-currents plan. Very commonly we abandon the constant-current circuit altogether, and light our streets with arc lamps strung in pairs or groups across three-wire mains, as at Brighton; or, we place single lamps on isolated transformers, as at Hastings. They do not do these things in America, at any rate, not to any very considerable extent. We do not intend here to enter upon a discussion of the comparative values of closed and open coil winding. Two significant points in Mr. Black's Paper call for some remark, however. The one is the statement that practically all the latest large American arc-light machines are constructed with closed coil armatures; and the other is, that whereas a 125-light open-coil machine required only 24 segments, a 100-light closed-coil machine had to be provided with no less than 160 segments. We can only remark that if, in face of the great structural difficulties which the adoption of the latter type of winding seems to involve, American engineers yet prefer to build this type for high-pressure circuits, there must be advantages in it which outweigh the obvious troubles at the commutator, which no amount of structural accommodation seems to have been able completely to eliminate. To our minds the remedy lies in the abandonment of these excessively loaded series circuits; and not till then is it likely that Mr. Black will see the "massive field-magnets, having an enormous amount of copper, and small armatures, both of which militate against high efficiency," relegated to the scrap heap or the museum.

Theological and scientific discussions possess one very undesirable feature in common, to wit, a pronounced tendency towards acrimony. Dr. Borchers some time ago communicated to the scientific world what he considered to be the discovery of a battery the electromotive force of which was generated by the bringing of carbon monoxide gas into contact with atmospheric air. As was natural, the Borchers battery received considerable attention at the hands of chemists and electricians, and gave rise to much discussion. To the lay mind it must be a complete mystery why, in discussing such a subject, any unnecessary heat should be generated. Mr. C. J. Reed, however, who has recently contributed to the *Electrical World* an article entitled "Electricity Direct from Fuel," apparently thinks the more heat the better. His article contributes no new facts, nor does it present old facts in a better light, and it is difficult to see what possible good can be served by introducing into an interesting scientific controversy irritating remarks such as the following: "It is natural that he (Dr. Borchers) should wish to let himself down easily. He, therefore, abandons his acid battery, and with considerable exertion shows that my criticisms do not apply to the alkaline battery, which he did not describe, and on which he has not yet given the public any figures. Evidently he still tries to believe that he has produced electricity by the direct combination of carbon monoxide and atmospheric oxygen. This belief seems reasonable for one who, like Dr. Borchers, has not given proper attention to the chemical reactions involved, and has drawn all his conclusions from the fact that with a certain arrangement of apparatus and chemicals he obtains an electromotive force of 0·56 volts." Mr. C. J. Reed has "a short way with dissenters" all his own.

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New Cable.—The cable laid for the French Government from Majunga (Madagascar) to Mozambique began working on the 1st inst.

Inductive Telegraphy.—The cable between Oban and the Isle of Mull being out of order, messages have been transmitted inductively.

The Laval Steam Turbine.—A central station is about to be established at Carthagena. A feature of the plant will be that two 100-H P. Laval steam turbines are to be put down as the motive power.

Cable Interruptions:	Date of Interruption.
Latakia—Cyprus	Nov. 27, 1894.
Cadiz—Teneriffe	Feb. 23, 1895.
St. Louis—Noronha	Mar. 12, 1895.

University College, Bristol.—It is announced that the usual courses on civil, mining, and electrical engineering will be held during the term, which commences on April 23rd. The course on electrical engineering comprises lighting, dynamo electric machinery, and transmission of power. A special series of lectures will be given on electrotechnics during the course.

Motor Work for American Supply Stations.—The *Electrical Engineer* of New York, while pointing out that American "stations have ceased to sell light; what they now deal in is current," mentions that at one station "the current furnished for power is practically 40 per cent. of the load, while in another city 250 elevators, aggregating 3,000 H.P., draw current daily from the mains laid down for lighting."

Electric Traction in France.—The municipal authorities of Lyons have voted in favour of the application of the Lyons Omnibus and Tramways Company for permission to convert the Lyons-St. Fonsvénissieux tramway into an electric line. Plans have been prepared, and are at present receiving the consideration of the local authorities, for the construction of four lines of electric tramway in the town of Rennes.

Electric Traction in Oporto.—A contract has recently been secured, in competition with several German firms, by the French Thomson-Houston Company for the construction of an electric tramway, about two miles long, on the overhead-conductor system in the city of Oporto. The plant will comprise a 150-H.P. engine and a 100-kilowatt dynamo, together with three cars, each provided with two 25-H.P. motors.

Institution of Civil Engineers.—From a revised list it appears that there are now on the books of the Institution of Civil Engineers 6,737 members of all classes, there being 17 honorary members (including five Princes of the blood), 1,862 members, 3,687 associate members, 355 associates, and 816 students. At the last meeting, Messrs. Albert Gay, Frederick Spencer, and Jacob Stöttner, were passed in as members; and Messrs. W. G. Clarke, W. Corin, Henry M. Darrah, H. S. Howard, H. Johnson, W. S. Sharwood, H. E. Soper, and Captain Frederick Dennett Falshaw, as associates.

The Magnetic Qualities of Gun-Steel.—In a recent number of the *Journal* of the United States Artillery, Lieut. George O. Squier describes some tests made by the aid of the ballistic method on the magnetic qualities of a muzzle ring from a 3·2in. cannon. The tests indicate that the steel of the new American guns, besides possessing remarkable physical qualities, also has excellent magnetic qualities, and, but for the cost, could be used for the construction of electrical machinery with very efficient results. The B-H curve shows it to be magnetically comparable with the best wrought-iron. When compared with the curves for the average steel castings from various manufacturers in the United States, the magnetic values are about 8 per cent. in favour of gun-steel.

Obituary.—The death is announced of Prof. P. H. Van der Weyde, who died at New York on March 18, at the advanced age of 82 years. Prof. Van der Weyde was born in Nymegen, Holland, in 1813. In 1849 he came to New York; he studied and graduated from the New York University Medical College in 1856, and practised medicine until 1859. In that year he was appointed professor of physics, chemistry, and higher mathematics at the Cooper Institute. He was also professor of chemistry in the New York Medical College. In 1864 the chair of industrial science was created for him at Girard College, Philadelphia. Of late years Prof. Van der Weyde has done little active work except the preparation of occasional contributions to the technical press.

The Electrical Statistics of Boston.—The electrical condition of Boston is set forth by the Wire Commissioner in his first report, which covers the electrical plants of seven large companies, some small ones, and a few individuals. The total number of electric lights in use is 226,251; 219,653 of these are incandescent, and 6,598 are arc lamps. In the seven large companies the number of motors in use is 4,036. The total electrical horse-power employed daily for electric lighting and power purposes is 27,889, requiring for its generation 38,799 mechanical horse-power. The maximum capacity of eight power stations is 42,010 mechanical horse-power, capable of furnishing 30,660 electrical horse-power. There are in the city 380 miles of underground duct, and about 1,000 miles of overhead wire.

Transformer Patents in Italy.—The law courts at Grosseto have pronounced their decision on the action of Messrs. Ganz *v.* Messrs. Siemens and Halske, which action related to alternate-current patents. The decision confirms the validity of two patents granted by the Italian Government to Messrs. Zipernowsky Déri, Blathy, in May and August, 1885, under the title of "Improvements in the means of distributing electricity," and "Improvements in inductive apparatus for transforming electric currents." The former of these patents relates to parallel distribution by means of transformers, and the latter to the construction and use of closed circuit transformers. This decision, arrived at by the law courts at Grosseto, gives the Ganz Company practically a monopoly of alternate-current work in Italy. It is said to be the intention of the Ganz Company to proceed even against polyphase installations. The legal experts, we may add, were Profs. Ferraris, Grassi, and Roiti.

A Proposed Electric Railway between Buffalo and Niagara Falls.—The contract has recently been signed for the construction of an electric railway between Buffalo and Niagara Falls. According to plans, the road is to be built of 94-lb. steel girder rails, with side trolley poles. It is to be double-tracked, except for a distance of 2½ miles, where the Highway Commissioners of the town of Wheatfield refused to grant more than a single-track line franchise. It will give Buffalo and Niagara Falls cheap fares, the rate to be but 50 cents for the round trip at all times. Quick time is to be made, and in order to do this the road is to be made so that heavy cars can be used. The power for operating the road will be furnished by the Niagara Falls Power Company, and, according to the contract, the cars will be running by July 1st of this year. In Niagara Falls the road will be run on the tracks of the local Street Railway Company from Echota, and this line, which is now a single track, will be double-tracked this spring, and rebuilt entirely. All the capital for the building of this road has been secured, and the moment the weather permits, work on its construction will begin.

Electric Traction in Germany.—The Stettin Tramways Company has decided to replace horses by electric traction. The length of the lines to be so altered is about 10 miles. In connection with the proposed electric tramways in Stuttgart, a committee recently journeyed to Hagen, in Westphalia, to inspect the accumulator line recently completed in that town. It has been decided, however, that the system is not suitable for adoption in Stuttgart. The horse tramway in Leipzig has just been acquired by the Gesellschaft für Electrische Unternehmungen, of Berlin, with the view of converting it into an electric line. A special company will be formed to operate the new electric tramways when completed. A company has recently been formed in Darmstadt, with a capital of £325,000, to be known as the South Germany Railway Company. The new company acquires no less than 11 local railways and tramways in the district, including all the electric tramways in Essen. Tenders are at present being invited by the municipal authorities of Kiel for the construction of an electric tramway in the town. The contract includes the erection and equipment of the central power station.

Exhibition Contracts in Germany.—To the recommendation of the Council of the Verband Deutscher Elektrotechniker, to which we recently alluded, that in exhibitions for distribution of current for light and power, at least the prime cost should be made good to those who undertake such jobs, some 31 firms have, says the *Elektrotechnische Zeitschrift*, replied, three of whom have declared that the matter has no interest for them, as they do not undertake exhibition lighting. The following are some of the 28 firms who have signified their approval:—"Helios" Company of Ehrenfeld, the Hagen Accumulator Company, Gebrueder Naglo (Berlin), G. Kuhn (Stuttgart), L. and C. Steinmüller, Pöschmann and Co. (Dresden), O. L. Kummer and Co. (Dresden), Hartmann and Braun, the Allgemeine Elektricitäts-Gesellschaft of Berlin, the Union Elektricitäts-Gesellschaft of Berlin, Schuckert and Co., Friedr. Krupp (Essen), the Maschinenfabrik Esslingen, and Messrs. Siemens and Halske.

Storage Batteries in America.—In the discussion on Mr. N. W. Perry's Paper on "Storage of Energy Essential to the Economy of Working Stations," at the Cleveland Convention of the National Electric Light Association, Prof. Stine referred to the positive prejudice manifested in America toward the storage battery, which he considered to be due to the hit-or-miss manner in which they have been constructed and exploited, and the lack of proper knowledge in their operation. Prof. Stine stated that while European experience had shown that it was possible to reach a watt efficiency of from 75 to 80 per cent., which, while good, yet seemed capable of improvement, he was of the opinion that the most we could expect from invention was to make the product more uniform and reliable, as the least variation in the quality of the materials employed often led to disastrous failure. As militating against high efficiency, Prof. Stine mentioned the nature of the complex chemical reactions in the cell, which absorbed energy and could not well be reduced in amount. There also occurred during every charge and discharge a certain amount of chemical action which could not be reversed, resulting in the eventual consumption of the plates.

Cathode Rays.—At a recent meeting of the Société Française de Physique, M. de Kowalski read a Paper on the conditions necessary for the production of cathode rays. Starting from an experiment due to Goldstein, in which in a vacuum tube having a constriction at its middle it is found that the cathode rays are formed not only at the negative electrode, but also at the constriction, the author has made several experiments, using tubes of different shapes. He finds that wherever the electric discharge is sufficiently dense, as near the electrodes, or in a capillary tube joining the two parts of a vacuum tube, cathode rays are produced. These rays are propagated in straight lines, are deviated by a magnet, and produce a bright patch where they strike the glass. The author has also succeeded in obtaining cathode rays in a tube without electrodes. This tube had somewhat the shape of an elongated hour-glass, and was placed alongside a discharger, through which "Tesla currents" were passed. Under these circumstances cathode rays are produced at either end of the capillary tube forming the central part of the vacuum tube. M. de Kowalski concludes from his experiments: (1) that the production of cathode rays is not connected with the disintegration of metallic electrodes in a rarefied gas; (2) that these rays are produced wherever the density of the discharge is sufficiently great; (3) that the direction of the rays is the same as that of the lines of flow of the current at the point where they are produced, and that they are propagated in the opposite direction to that in which positive electricity is supposed to flow.

The Capacity of Resistance Coils.—A note on the electrostatic capacity of resistance coils, wound in the ordinary way to avoid self-induction, is published in a recent number of the *Comptes Rendus*. The author, M. J. Cauro, has experimentally determined the electrostatic capacity of coils wound in several different ways, using for this purpose a Wheatstone's bridge arrangement with a commutator similar to that used by Profs. Ayrton and Perry in their secohmmeter. By comparing coils of practically the same shape and resistance, the author finds that the errors due to capacity may, in the case of coils containing a large number of turns, be considerable when the ordinary double method of winding is adopted, but these errors are considerably reduced if the method of winding proposed by M. Chaperon is employed. The best results of all are obtained by winding the two wires in alternate layers, always starting from the same end of the bobbin, the wire being brought back parallel to the axis of the coil. For instance, with coils having a resistance of about 14,000 ohms and about 9,500 turns, the three methods of winding give apparent self-induction (due to capacity) of −1·79, −0·27, and −0·16 respectively. In order to make sure that the values obtained were really due to capacity, the author placed bundles of fine iron wire inside the different coils. The results obtained in this case were the same as those obtained without any iron core. By altering the connection of the two wires in the coil wound in the ordinary manner, so that the current traversed the two circuits in the same direction, the self-induction was found to be 0·13. Thus, by winding the wire double, the error due to electrostatic capacity was about twelve times as great as the error to eliminate which this method of winding was adopted.

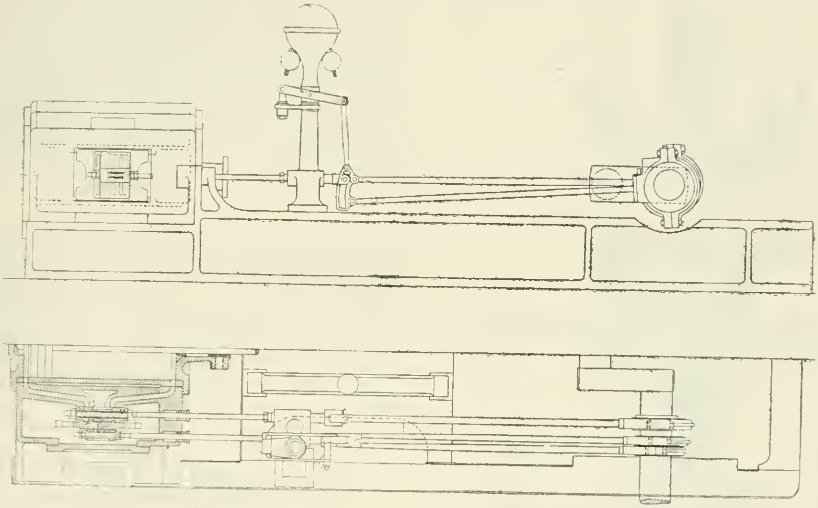
Field Telegraphy.—It was due to General Keith Fraser's pertinacity, says *The Times* correspondent, referring to the recent cavalry manœuvres, that any telegraph work entered into the manœuvres. The Engineers were averse to coming, and for the very natural reason that, possessing no authorised organisation for working with cavalry, they did not wish to run the risk of a breakdown in the publicity of the Downs. However, they eventually pluckily determined to make a try, and they yielded to the General's request; and the light thrown on the subject of our military telegraph arrangements by General Keith Fraser's remarks must undoubtedly help them in extricating themselves from the slough of disorganisation or of defective organisation in which our military telegraphists appear to find themselves at the present time. The slowness with which the British army adapts itself to the ever-changing requirements of war has long since become proverbial, and the truth of the accusations finds its illustration in the department of military telegraphy. The governing military mind cannot help recognising the alterations in the conditions of war due to improved means of transferring soldiers' bodies from one point to another. Owing to improvements in road-making and the increase in the number of roads, armies need no longer go into winter quarters, but must be ready to move about irrespective of the seasons. That the concentration of troops is accelerated by the existence of railways, is another truth this mind accepts and turns to account; but it has not yet grasped the fact that the rapid transmission of corporeal beings in due time from one place to another depends on the rapid transmission of thought and speech from those who order to those who are to obey. The governing military mind is much put out if in civil life it cannot wire its order for some article it wants, however trivial; but it does not seem to regard this power of "wiring" as, what it really is, a necessity of vital importance in military life. A German writer has recently likened a general and the telegraph wire to a dress with it train; but whereas the latter may with comfort and advantage to the wearer be discarded, the general without a wire at hand is deaf and dumb save to the troops in his own vicinity. If our cavalry are to do their work in the same fashion as the cavalry did in the Napoleonic wars, then there is no meaning in General Keith Fraser's remarks; but if they are to do that work as it ought to be done now, the General has acted judiciously in showing how little cared for and how undeveloped are the military telegraphic arrangements in our Army at the present time.

MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 636.)

Paxman Automatic Expansion Valve Gear.—To the first of these two classes belong the slide valves in which the expansion valve is contained in a separate chest from the main steam chest, in which the main valve works. An example of this class is furnished by the very admirably designed valve and gear known as the Paxman automatic expansion valve gear. This apparatus is shown in vertical section in Fig 55, and in horizontal section in Fig. 56. The bald principle of this class of valve may be illustrated by saying that its action is equivalent to closing the steam chest at the moment expansion is required to commence. If this were done, with an ordinary valve and chest—say, by suddenly closing the throttle valve—a quantity of steam would still be enclosed in the chest and would expand along with the cylinder steam. The result would be that very little regulation would be obtained. In the actual valves, the reservoir space between the expansion valve and the cylinder is made very small indeed; it is, in fact, in many instances reduced to the capacity of mere steam ports or passages in the partition between the two valves. Such passages may be seen in the horizontal section of the Paxman valve.



Figs. 55 and 56.—Paxman's Automatic Expansion Valve Gear.

The variation in the cut-off is caused in the following manner. First, there is the ordinary or main valve eccentric, with its unvarying throw and angle of advance; and the main valve itself, with its unvarying travel and laps. These are on the side nearest to the cylinder, and the main valve travels over the ordinary valve seat. In place of an ordinary relief frame there will be seen, in Fig. 56, a fixed ported plate immediately on the outside of the main valve, and forming the partition between the two valves; and outside this, again, the expansion valve, into which steam passes from the steam chest by through-ports. This expansion valve is reciprocated by a valve rod, and the travel and lead of the valve are varied according to the desired cut-off. It will be seen that the other end of the expansion valve rod terminates at a segmental link, the upper and lower extremities of which are fixed to the ends of two eccentric rods. A governor at this point in the engine lifts or lowers the segmental link, according to the speed of the engine, and thereby determines the position of the expansion rod end with respect to the slot in the link. When the speed rises the governor raises the link and causes the point of attachment of the expansion valve rod to come nearer to the bottom of the slot. When the speed falls the opposite occurs. Now, the two eccentrics which actuate the two eccentric rods on the segmental link are set at very different angles of advance. One of them, called the *positive* eccentric, has an angle of advance such that it would cause a late cut-off, if it directly actuated the expansion valve; the other has an angle of advance which would cause a very early cut-off, and is called the *negative* eccentric. When, therefore, the load of the engine falls and the engine tends to race, the governor shifts the link until the expansion valve rod end is at such a point that the desired change in the cut-off has taken place. For example, if the engine has no external load the link will be quite lifted, and the expansion valve will be actuated directly by the negative eccentric; while, if the highest load for which the engine is built comes on, the link drops to its lowest position, and the expansion valve is directly actuated by the positive eccentric. Besides having different angles of advance, the two expansion eccentrics possess also different amounts of throw, causing diverse travel in the expansion valve. This valve gear is manufactured by Messrs. Davey, Paxman and Co., of Colchester.

Meyer Expansion Valves.—To the second of the two classes of automatic expansion slide valves belongs the system of valve arrangement designed by Meyer, and generally known by his name. The Meyer valves are constructed both for automatic regulation and for hand regulation; in the former case the travel of the expansion slide being made to vary, while in the latter case the travel is fixed and the steam lap is varied. There are two slide valves in this apparatus; the main valve, which is through-ported, regulating the points of admission, release and compression, and being actuated by a fixed eccentric; and the expansion valve, which slides upon the back of the main valve, and regulates the cut-off by covering the through-ports of the main valve at a moment which in the automatic valve is determined by the governor. The regulation is effected by means of a shifting or vibrating link, the position on which of the expansion rod end is adjusted by the governor. In the hand valve, the moment of covering the steam ports in the main valve is controlled by means of a hand wheel, the turning of which in one direction causes the expansion slide to increase in lap, and in the other direction

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to decrease in lap. This is effected by constructing the expansion valve in two separate parts or slides, one of which works on a right-handed screw and the other on a left-handed screw on the same rod. The hand wheel causes the valve rod to rotate, and thereby alters the relative distance of these two slides.

Hartnell Automatic Expansion Gear.—An ingenious and effective form of valve gear for actuating the expansion slide in a valve of either of the two above-named classes has been invented by Mr. Hartnell, and is manufactured by Messrs. Marshall, Sons and Co. (Limited). This gear is shown in elevation in Fig. 57, and it will be seen that it is actuated by a single eccentric having a fixed setting. The gear consists essentially of a vibrating link, pivoted at its upper extremity, and attached at its middle to the expansion eccentric rod, and an expansion valve rod the position of the link end of which last is shifted up or down the link by a governor, according as the speed becomes too high or too low. Thereby, the travel of the expansion slide is controlled by the governor, and the cut-off correspondingly kept in agreement with the load.

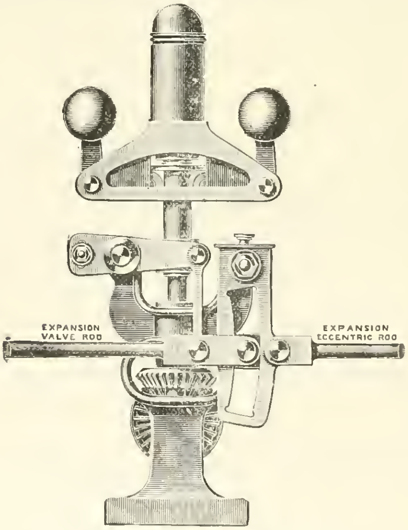

Fig. 57.—Hartnell Automatic Expansion Gear.

The governor consists of two massive iron balls, mounted, as shown in the figure, upon two bell-crank levers. The centres of these levers are pivoted to the revolving piece, in the upper, cylindrical part of which a coil spring is placed. This piece is revolved by a central spindle, actuated by bevel wheels seen at the base. The ends of the bell cranks not attached to the balls press upwards against the coil spring and tend to compress it; and it will be seen that when the balls fly outwards this compression is increased. At the same time, the inner ends of the bell cranks press upwards on a sleeve, which is free to slide on the main spindle of the governor, and a collar at a point lower down this sleeve acts on a lever which directly communicates with the expansion valve rod. When the speed increases the balls fly outwards and lift the sleeve against the force of the coil spring, and the effect is to raise the expansion valve rod end in the link. When the speed drops, the force of the spring drives the sleeve down, and the reverse effect takes place.

Pickering Governor.—As an example of the class of governors which are adapted to regulating the engine through the throttle valve, we may cite the Pickering governor, an elevation of which, with a section through the throttle valve, is shown in Fig. 58. There are three governor balls, each fixed at the middle of a flat spring band. The lower end of each band is fixed to a collar, the under side of which is geared to the driving pulley of the governor by means of bevel wheels. The upper end of each band is attached to the central spindle, which is free to move up and down within limits, and the lower extremity of this spindle is attached to the throttle valve. The effect of any outward movement of the governor balls is to depress the central spindle by the bulging of the band springs, and the tangential momentum of the balls is opposed by the elastic resistance of the springs thus bulged. It will be seen that the depression of the spindle tends to close the throttle valve. The valve is made double-beat, consisting of two portions—an upper and a lower—the steam pressures on which are balanced against one another.

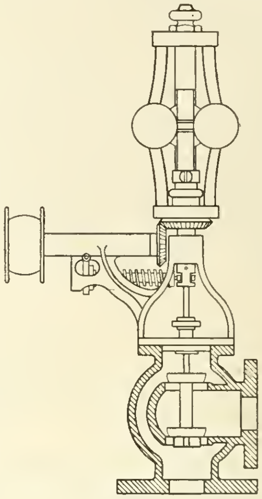

Fig. 58.—Pickering Governor.

(To be continued.)

AN APPARATUS FOR THE ANALYSIS OF ALTERNATING CURRENTS.

BY W. M. HICKS, F.R.S.

The interesting Paper of Dr. Fleming in the *Electrician* of February 15th and 22nd, on "The Delineation of Alternating Current Curves," induces me to send you a description of an apparatus on similar lines which I had constructed in the spring of last year. The motor is a synchroniser, designed on the lines of the Mordey alternator, as illustrated in the figure. This design was chosen partly because it lent itself easily to the means at my disposal for construction, and partly because the considerable momentum of the field magnets would help to steady its motion. The field magnets were at first made of permanent magnets, carrying a coil on the axis of thick wire for the purpose of magnetising them when it might be found necessary. As the instrument did not work, these were replaced by soft iron bars and a coil of smaller wire, with two brushes. The power absorbed by the friction of the different parts was, however, apparently larger than the machine could supply. As I have only been able to experiment with it at rare intervals since last summer, it is only recently that I have succeeded in getting it to run satisfactorily. This has been attained by the simple expedient of fixing the instrument vertically and running it with its lower pointed pivot on a hardened steel socket.

The revolving field magnet is 12·5 centimetres long, and the centres of the poles on a circle of 10 centimetres diameter. The field magnets take about 1½ watts. With an armature current of ·4 ampere, the motor runs with great smoothness. The resistance of the armature is high, viz., 60 ohms.

The details of the instrument are evident from the figure. A few words further only are necessary on the analysing arrangements. It is designed to analyse simultaneously both primary and secondary amperes and volts in a transformer. The currents are, of course, measured by the volts at the ends of a non-inductive resistance.

In Fig. 1 we may call the large disc which revolves with the field magnets the commutator, and the other one the brush holder. This latter is movable on an axis of its own, and is adjusted to any given position by means of a screw worm actuated by a small handle. Its position is determined by a pointer and scale at the back, whose reading determines the phase. The commutator carries a system of brass connections. Its working can be best explained by supposing its rim opened out to be in one plane with the face, as shown in Fig. 2. The face has a circular brass ring cut into four pieces, *e*, *f*, e^1, f^1 (Fig. 2), the opposite ones, *e*, e^1, and *f*, f^1, being metallically connected. A spring connected to one alternating main, presses on the conductor (*e*, Fig. 2). Two light brushes, *a b*, press on the outer connection, and are so arranged that as the commutator turns, *a* passes over the lug on *e* between *g* and *h*, whilst *b* passes over the insulation. The brush *a* is connected to one armature of a condenser, the other armature being connected to the second main (or other end of non-inductive resistance), and also in series with a mirror galvanometer to the other brush, *b*. As the commutator turns, the two brushes experience the following changes :—

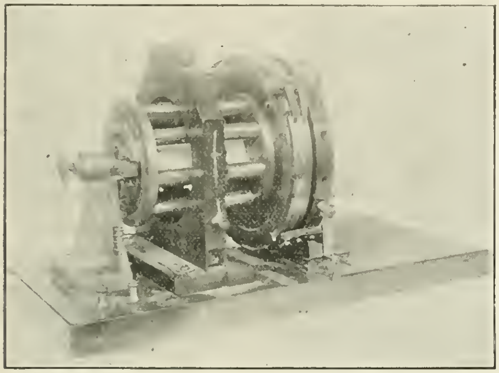

Fig. 1.

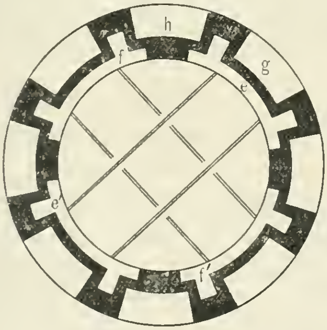

Fig. 2.

1st. They are both on *g*; thus the two armatures of the condenser are closed.

2nd. An instant later they are both insulated.

3rd. *a* slips on the lug of *e*, and the mains charge the condenser.

4th. *a* then slips off, and is insulated for an instant. The condenser is left charged to the P.D. of the mains at the instant when *a* slipped off the lug.

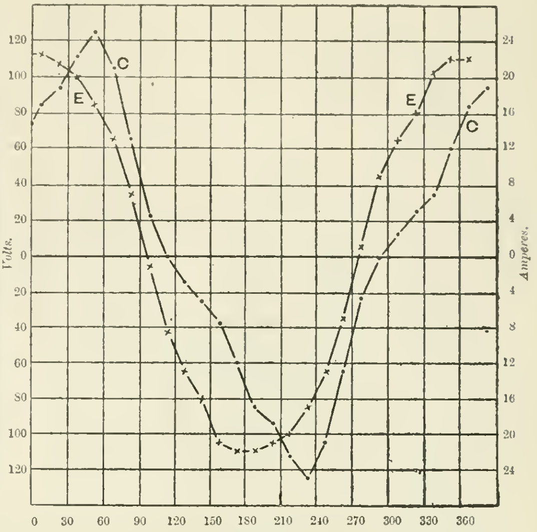

Fig. A.

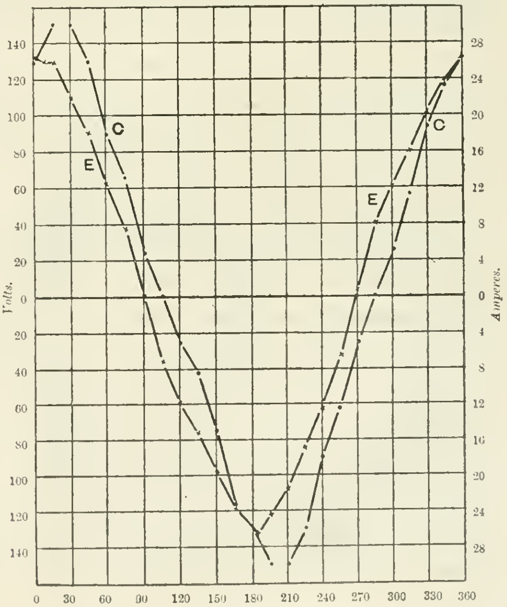

Fig. B.

5th. Then both *a* and *b* slip on to *h*. The condenser at once discharges itself through the galvanometer, and the same cycle of proceedings is gone over.

If the rate of alternation is *n* per second, and *q* coulombs is the charge in the condenser, the galvanometer is deflected as if with a steady current of nq amperes. The galvanometer constant is found by applying a known continuous voltage. By rotating the brushholder by means of the handle the phase at which a leaves the lug of e is adjusted at will. On the commutator, opposite parts e and e' are connected, and another system of brushes, opposite $a\,b$, serve to measure the simultaneous volts produced by the current in the non-inductive resistance, *i.e.*, measure the current. The other pair of connections with f, f' serve to do the same for the secondary current.

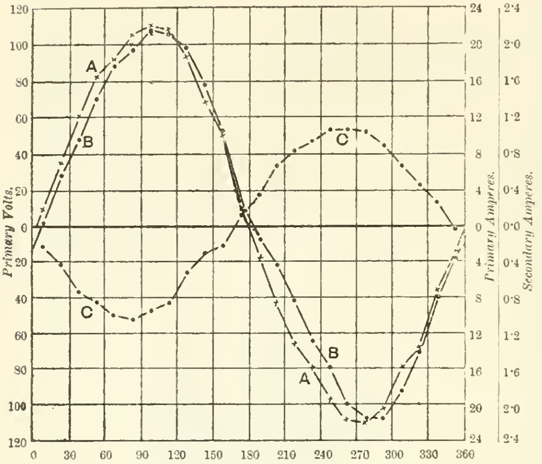

Fig. C.—A—Denotes Curve of Primary Volts. B—Denotes Curve of Primary Amperes. C—Denotes Curve of Secondary Amperes.

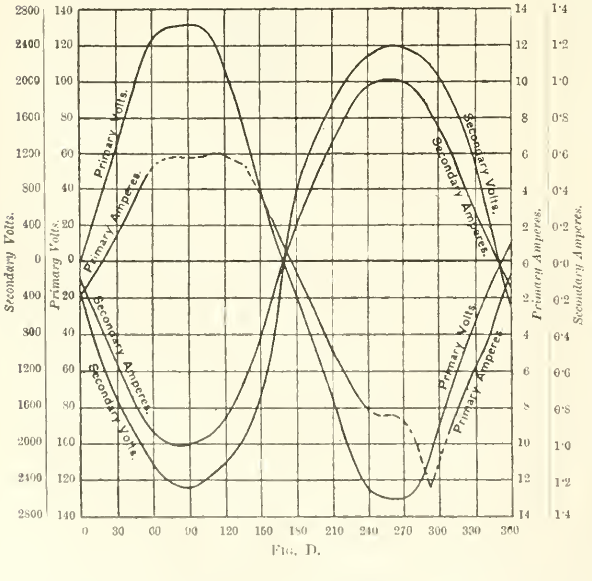

Fig. D.

It is, of course, possible to use electrostatic voltmeters in place of the galvanometers; but the latter seem preferable, for when adjusted to read for the maximum values, their intermediate readings are proportional to the actual values, and can, therefore, be used throughout the whole range. It is intended to use with the galvanometers adjustable condensers, whose capacities can be varied so as to give convenient galvanometer deflections.

The instrument is started and got into step in the following manner: A wire fastened to a plug, which fits into one of the holes on the brushholder seen in Fig. 1, presses on the rim of the commutator with its point about 180° phase reading ahead of the brush b; one terminal of the exciting main is connected to one armature terminal, the other to a turn-over key, and thence to the brush b. The plug spring is connected to the other armature terminal. The brush holder is then adjusted to the proper position, and the commutator turned until both b and the plug spring rest on one of the brass conductors. The armature at once starts as a motor the continuous current flowing while it helps to turn it, and being cut off as soon as it tends to stop it. As soon as the speed runs up slightly above its proper value, the key is thrown over, cutting off the continuous volts and throwing on the alternating. The speed falls off until it is nearly in step (as shown in the usual way with glow lamps in series). It generally immediately falls out, but if the key be thrown back for a moment and then again reversed, the armature is found at the right speed, and it gradually settles down into complete synchronism.

With the running of the machine on end there is no doubt but that the permanent magnets will be effective. I hope shortly to replace them and make the experiment.

At the suggestion of the editor, I append examples of curves taken by the machine. Figs. A and B are curves taken on the same inductive resistance, A early in the afternoon, B later, when the central station had changed over to their new Ferranti flywheel alternator for the evening load. E denotes the curve of E.M.F. and C of current.

Figs. C and D give curves from a cylinder type of a Swinburne transformer. They are given as determined; the summits of the primary current in D are quite wrong owing to a defect in the galvanometer not noticed until too late.

For comparison of shapes of the curves, each curve might be observed singly; but if it is desired to determine lag or phase difference, all the curves should be determined at one operation, otherwise the slightest alteration in the friction, or in the field or armature current of the instrument, will alter the phase relation of the armature (and, therefore, of the brush connecttions) to the driving current. As an example, A and B were determined with a rather strong field and current, C and D with very weak ones. The zero phase in each case corresponds to the same position on the instrument, but it is seen that the currents were tapped by the brushes at nearly 90deg. difference in phase.

THE VARYING COST OF ELECTRICITY SUPPLY.

BY ARTHUR WRIGHT.

After Mr. Ward Leonard's (see *The Electrician*, March 15th, p. 602) very clear exposition of the intimate relation of the load factor to the cost of supplying electricity, it may interest your readers to learn how this cost actually varies in practice according to the number of hours per day the consumers use their demand on the generating plant, and some of the results obtained at Brighton after two years' use of a sliding scale based on this relation.

That the main object of the adoption of the system at Brighton, viz., the improvement of the load factor, has been attained, is most readily seen from the curve (Fig. 1), where the upper line represents the various monthly load factors after the system has been in use for some considerable time, and the lower curve the load factor for the corresponding months before the system was introduced.

By monthly load factor I mean the ratio of the electricity actually registered by the consumers' meters to that which could have been sold had the greatest rate of consumption from the mains been maintained for 24 hours per day during the whole month.

In a rapidly-growing undertaking it is evidently difficult to ascertain the actual annual load factor, but the following figures will show in a striking manner how much better use is now made by the customers of the capital laid out in plant and mains than before the adoption of the system :—

—	Uniform charge, 1892.	Sliding scale, 1894.	Improvement since adoption of system.
*Annual sale of electricity per maximum kilowatt taken from the mains	711 units	888 units	Nearly 25 per cent.
Revenue derived per maximum kilowatt.	£20 14 0	£22 14 0	About 10 per cent., although average price obtained had fallen more than 12 per cent.

The true value of the fact that the sale of electricity has nearly quadrupled since the adoption of the system, while the maximum load observed at the generating station has only increased threefold, will be appreciated by the commercial central station engineer when he remembers that, in stations of about the capacity of that at Brighton, that part of the annual expenditure which, in a given station, is independent of the sale of electricity, is generally 80 per cent. of the total expenditure.

Another object of the sliding scale has been attained, viz., to get the electric light introduced into basements, kitchens, and other places, which, under the uniform system of charging, would be the last to be so lighted. This is shown by the fact that the average number of units consumed per lamp installed has increased from 19·5 to 22·45, or 15 per cent. This, I need hardly point out, is the reverse of the general experience elsewhere.

It will now be interesting to compare Mr. Leonard's table of the estimated proper charges for electricity on the sliding scale system to the figures which I have reason to expect will represent the cost of supplying it from the Brighton station in the present year, and with the present tariff, based on the use of one hour per day of the consumers' demands being charged at 7d., and the remainder at 3d. By consumers' demands I mean their greatest call made on the generating plant and mains, as measured by a maximum recording indicator.

Consumers' load factor.	Average hours use per day.	The probable cost of supplying electricity from the Brighton station in 1895.	The average charge at Brighton in 1895 per unit.	Mr. Ward Leonard's suggested tariff.
		d.	d.	d.
5	1·2	6	6·32	13
10	2·4	3·5	4·66	10
15	3·6	2·66	4·12	8
20	4·8	2·25	3·83	6½
30	7·2	1·83	3·56	5
50	12	1·5	3·33	3⅓
100	24	1·25	3·16	2

In order to arrive at the varying cost of supplying consumers who use their maximum demand on the plant for varying periods per day, it is necessary to find out how much the standing charges will amount to in the year; this, in a station having supplied electricity for more than two years, can be fairly accurately ascertained, as also can the approximate cost of supplying the electricity after everything has been put or placed in readiness to do so. The next item necessary to know is the sum of all the customers' demands in kilowatts the station with the existing plant and mains will safely supply, while retaining a proper margin in reserve. The standing charges per day, divided by the total kilowatts severally demanded by all the consumers, will give the actual daily charge per kilowatt demanded that must be made to just cover the standing charges. This, in addition to the running cost per unit, gives the only possible basis for ascertaining the actual costs of producing electricity in accordance with the true Hopkinson principle.

In the year 1895 these figures for the Brighton station are estimated to work out at the rate of 6d. per day per kilowatt demanded, and 1d. for running costs.

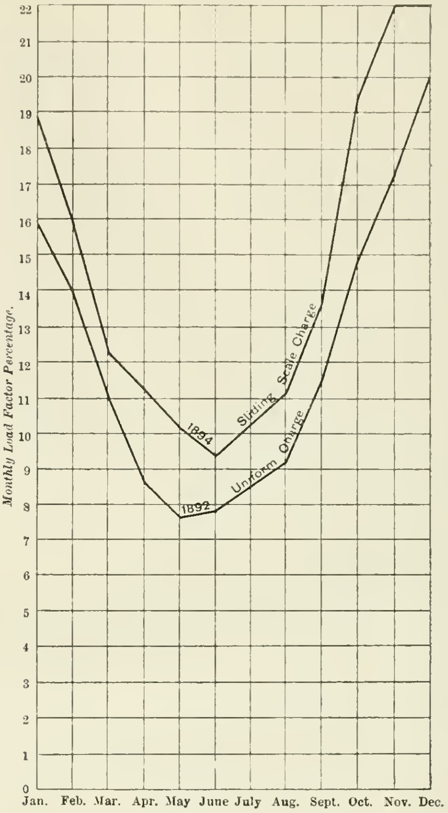

FIG. 1.—Improvement of Monthly Load Factor.

While granting that the above is the true theoretical basis on which the charge for electricity should be made, I recognised in 1884 the fact that the more popular way of carrying out its principles would be to charge a high rate per unit consumed until each consumer's proper proportion of the standing charges had been met, and after that to make a considerable reduction,

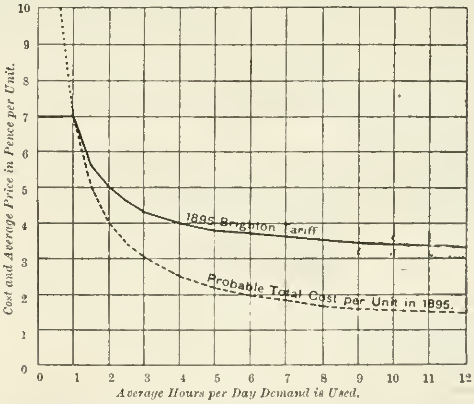

FIG. 2.

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* The meaning of this expression may perhaps be clearer if I explain that the figures given are arrived at by dividing the kilowatt hours sold by the greatest demand in kilowatts experienced at any moment. The improvement of the 1894 figure over that of the 1892 figure is an evidence that the average demand and the maximum demand have been brought more nearly to coincidence.

and I still think the highest admissible rate per unit should be maintained as long as is necessary to cover the standing charges, plus the costs for running for that time. Until these costs are covered, obviously no profit can be made or reduction equitably allowed.

The estimated figures for Brighton in 1895 show that these costs will be about met by the consumers using their demand on the average one hour per day, and paying during that first hour 7d. per unit. After this time it can be fairly assumed that the cost of supplying each unit will not exceed 1d. As the highest allowable rate at Brighton is 7d. per unit, it follows that no profit can be made on consumers who only use their demand one hour per day, and that the actual loss incurred in having to supply those consumers who do not average one hour per day, has to be unfairly met by charging the profitable consumers a greater rate of profit, and for this reason it has been decided that in 1895 all electricity consumed after the first hour is to be charged at the comparatively high rate of 3d. per unit. The fact that there can be a loss in supplying some short-hour consumers at 7d. per unit from a large station will be clear when it is recognised that if it were not for some 13 per cent. of the present consumers, and who only use the light at all about three months in the year, or less than one hour per day on the average, our present plant, station and feeders could go on supplying the increasing business for one or two more years, whereas, owing to their existence, it is necessary to put down fresh plant this summer for the ensuing winter's load, which could be entirely dispensed with for nine months in each of the next two years.

The curves in Fig. 2, illustrating the estimated cost and the present tariff, demonstrates how rapidly the cost of supplying electricity at Brighton in 1895 will diminish with the lengthened use of the plant, and how the 1895 charge actually varies with the lengthened use of the consumers' demand.

As there are only two real divisions in the items constituting the cost of supplying electricity, viz., standing and running cost, it may be well to remind the readers that it is therefore only necessary to have two rates of charges for the supply in order to obtain a perfectly equitable form of sliding scale of rebates, and that this involves hardly any more clerical work than does a uniform price system.

I am inclined to think that the fact that Brighton probably is this year the record station, both for lowest cost of production and greatest sale per inhabitant, is in no little way attributable to the "sweet simplicity" of the sliding scale used, and the adoption of Prof. Kennedy's suggested demand indicator.

Too much importance, in my opinion, cannot be attached to the superiority of a system giving rebates based on a consumer's actual use of the generating plant and mains, over one based on the more or less prolonged use of all the lamps installed. The former, if properly understood, actually encourages the general use of the electric light in a house, whereas the latter must necessarily have the reverse effect, and, moreover, is not based on any sound principle, as the preponderating standing charges are not altered in any way by the proportion of the total number of lamps in a house that remain unlighted.

The following figures, obtained by means of the demand indicators, may be of service to central station engineers, and as they are derived from the records of nearly 1,000 customers, may be taken as fairly representative of any average town :—

—	Less than one hour per day.	More than one and less than two hours.	More than two and less than three hours.	More than three hours.
Percentage of consumers who use their demand on the average.	13·6 %	38·6 %	32·1 %	15·8 %

From this and the previous table of the 1895 Brighton tariff it will be seen that nearly 50 per cent. of the consumers will pay about 5d. per unit, or actually less for electricity in 1895 than for the equivalent amount of Brighton gas, taking 1,000ft. of this as being equal to 7 units of electricity.

ON A CLASS OF SECONDARY BATTERIES.[*]

BY LUCIEN POINCARÉ.

In almost all the accumulators actually in use,[†] the oxidation and reduction of an oxide of lead is made use of. In spite of all the ingenious improvements of which it has been the object, this apparatus still presents in principle certain defects. The layers of active material must be supported by a framework of lead, which constitutes a dead weight. The oxides are not very good conductors of electricity. Peltier effects are to be feared at the contact of the oxides and the metal, and from these two causes an appreciable proportion of the energy is dissipated in the form of heat. The active material, always fragile, gradually disintegrates. If one does not wish to rapidly put the battery out of work, it is necessary to work it only at a well-defined rate. It is necessary to be careful not to push the discharge to the very end, and to carefully avoid short circuits, and it is these restrictions which almost prohibit what would otherwise be a very interesting use of accumulators as transformers.

It may well be asked if these defects cannot be diminished if we employ as electrodes metals in a liquid state, in which the chemical attack can take place more thoroughly, and in which disintegration is not to be feared, and naturally mercury is the first metal thought of in this train of thought. An acid electrolyte cannot be used in this case, for the hydrogen would be liberated completely wastefully; but if we substitute a salt for an acid, there will be formed at the cathode an amalgam which will constitute, with the mercury of the anode, a secondary battery. Among the many salts which I have tried, the most interesting results were furnished by the alkaline salts of the haloids. With these salts one obtains perfectly reversible batteries with high electromotive force, generally about 2 volts, but the chlorine or the bromine which combines with the positive mercury forms a layer of high resistance, and the efficiency is not good. The result obtained with iodide of sodium is quite different. Provided the iodide solution is sufficiently concentrated, that the density of the current is not too great, and that the positive electrode has a larger surface than the negative, no deposit is formed on the anode, which remains perfectly clean; the liquid containing the iodide of mercury in solution in the iodide of the alkali remains limpid, whilst the sodium combines almost entirely at the cathode, if care is taken that the temperature does not rise too high. In this way we can make a secondary battery, the two electrodes of which remain, after the charge, entirely metallic. It follows that we can make the loss of energy as small as we please, it being only necessary to adopt an arrangement such that the resistance is very low, by taking, for instance, two concentric electrodes, the free surfaces of which are nearly in the same horizontal plane, and immersed in the electrolyte, and separated by a thin glass partition terminating at nearly the same level. The only loss which takes place in the apparatus is the disappearance of a fraction of the sodium deposited by the current, but this loss may be made very small when the current is not very large. The quantity efficiency of the accumulator may exceed 90 per cent., and the energy efficiency is nearly the same. The rate of discharge is quite a matter of indifference; the battery may be short-circuited, and completely discharged without injury. The electromotive force, measured by means of a Gouy standard, is, when the cell is fully charged, 1·85 volts; it falls slowly as the cell is discharged. The capacity per kilogramme is of the same order as the practical capacity of ordinary accumulators (10 ampere hours). I have also investigated the variations of electromotive force of this battery with the temperature, and I have discovered that at a certain period the value of the electromotive force is sensibly independent of the temperature. Interpreted by the thermodynamic theory, this fact proves that all the chemical energy given to the cell is given out again under the form of electrical energy.

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[*] From the *Comptes Rendus*, Vol. CXX., No. 11, p. 611.

[†] Among the attempts made to substitute another type for the lead accumulator, I should mention the remarkable researches of MM. Cailletet and Collardeau on the compressed gas battery. See *Comptes Rendus*, Vol. CXIX., p. 830. See also *The Electrician*, November 23, 1894, p. 105.

Batteries of this kind certainly could not be used commercially in their present form. The high price of the materials which compose them, the difficulties inherent to the use of liquid electrodes, the necessity, if one wishes to retain the charge for a long time, of keeping the amalgam from contact with the liquid (this result can be arrived at by a device similar to that employed in the batteries with rolled up electrodes) are so many obstacles to their employment. But these batteries present the same features of theoretical interest, and may, on account of the ease with which they can be made, be of some use in particular cases, and offer a fresh example of the possibility of replacing the principle of the lead accumulator by another.[*]

LARGE ARC DYNAMOS.[†]

In a Paper with the above title read at the Cleveland meeting of the National Electric Light Association, Mr. C. N. Black spoke of the significant fact that while arc lighting was among the first practical applications of electricity, it has been the most backward branch as regards improvements in its generating machinery. This cannot be ascribed to the fact that there was nothing left to be desired in the efficiency of the arc dynamo, since it has always been notoriously weak in this respect, and has by no means kept pace with the incandescent dynamo. Within the past 18 months, however, there has been an awakening to this fact, and the general tendency now seems to be towards large units and lower speeds, but while the increase of size has increased the efficiency to some extent, yet we still see massive field magnets, having an enormous amount of copper, and small armatures, both of which militate against high efficiency. Another noteworthy fact is that with the one exception all new machines thus far described are of what is known as the closed coil type, which is the more remarkable when it is considered that fully 75 per cent. of the arc lights of this country are at present run from open coil dynamos.

In accounting for the reasons for the preference heretofore given to the open coil type, Mr. Black states it is a principle that the large amount of self-induction in each bobbin of these machines is an advantage, being, in fact, almost essential in order to obtain the best results. On the other hand, the less self-induction in each bobbin of the closed coil type the better the action of the commutator, which is true of all closed coil machines whether for arc or incandescent lighting. Referring to the spark at the commutator on open coil machines, wonder is often expressed that this spark does not cut the segments; as a matter of fact, it does so to a certain extent, but the current is so small, and the accompanying heat is radiated so rapidly, that the ill effects in practice are almost inappreciable. It is in connection with this that the self-induction of the bobbin plays an important part. Were it not for this, the current in the bobbin which is being cut out would be reversed before the segment had reached a sufficient distance from the brush to prevent the current jumping across the heated arc, and thus causing the machine to flash.

The design and proportioning of the field magnets are the same in the closed and open coil machines, and it is in the commutator and commutation, therefore, that the most marked differences are found between the two types, and Mr. Black considers that in this lies the great superiority of the open coil machines. For example, in a new open coil 125-light machine there are only 24 segments in the commutator, while in one of the latest closed coil 100-light machines there are 160 segments; to go into details as to which is the easiest to insulate and keep in repair is hardly necessary. Referring to the disadvantages urged against the open coil machines, owing to the small amount of segments causing a discontinuity in the current, and consequently a greater strain upon the insulation of the line, Mr. Black considers that this claim has no weight. He referred to some experiments by Mordey, showing that by passing the current from a Brush machine through the secondary coil of a transformer no difference of potential was produced at the terminals of the primary. Mr. Black also described an experiment made by himself in which the currents from a closed coil dynamo having 78 bars in its commutator, giving, therefore, practically a steady current, was passed through the field coils of a 125-arc light machine and the fall of potential measured with a Weston voltmeter; the machine was then run self-exciting, and the drop through the field again taken. The currents in both cases gave identically the same readings on the voltmeter, so that if there is a discontinuity in the case of the latter machine, it is so slight that no instrument less sensitive than the telephone will show it, and consequently it is difficult to understand how the insulation of a conductor could be more strained by an open than a closed coil machine.

A vital question in connection with large units delivering current to the lines at an E.M.F. of 6,000 volts or more is in regard to the value which the E.M.F. will attain in case the current is suddenly broken. In this respect it was claimed that the open coil machine has largely the advantage. It was explained that opening the circuit is the same, in one sense, as the sudden throwing of a large resistance into the line, and when this is done the point of commutation is shifted back under the brush, owing to the reaction of the armature current being reduced.

Some experiments are described made with a view of learning accurately the value the E.M.F. would attain when the circuit of an open coil machine is suddenly broken, and it was found that the sparking lengths obtained agreed very well with the results of De La Rue and others from their experiments on sparking distances. The rise in voltage was only from 1,500 to 2,000 volts upon breaking the circuit, the small increase being accounted for by the fact that it takes an appreciable amount of time for the arc on the commutator to be carried from one brush to the other. Owing to each segment extending about 60° around the commutstor, the time required to short-circuit is just one-third what it would be with a closed coil machine, and consequently Mr. Black considers it a conservative statement to say the voltage would rise in the latter to fully double its normal value under the same conditions, which would necessarily injure the machine. An experiment was described where a Brush open coil 125-light machine was connected to 12 miles of underground circuit, supplying current to 125 arc lamps, the voltmeter registering 6,850 at the machine terminals; these experiments showed that the capacity of the underground circuit more than counterbalanced any rise in voltage due to the machine and line, the voltage at breaking being less than normal. Mr. Black states that the above considerations led the Brush Company to adhere to the open coil type in designing their large units.

Two Brush machines of 100 and 125 lights respectively were described, and it was stated that the electrical energy consumed in operating the regulator is less than one-tenth of 1 per cent. of the output of the dynamo, while the machine is absolutely automatic from one lamp to the full capacity, and the whole load may be thrown on or off with impunity. The characteristic curve of these machines was stated to be remarkable from the fact that after passing the bend the curve is almost perpendicular and probably the nearest approach to a constant current curve ever attained in practice. By winding more wire on the armature of the machine from which the curve was taken, a constant current of 9·6 amperes could be obtained at all loads without shunting any current from the field; but this would increase the internal resistance, and also make the machine much less efficient at light loads.

It was pointed out in connection with the efficiency of the machine that the C^2R losses at one-quarter load had been reduced from 4,018 to 3,367 watts, or, in other words, an electrical horse-power gained.

At full load the electrical efficiency reaches 94 per cent., which is accounted for by the liberal use of iron in the armature reducing its reluctance and by the large size of wire on both field and armature. A curve of commercial efficiency showed this to be at full load over 90 per cent., thus approaching very closely the efficiency of incandescent dynamos of equal capacity. The high efficiency at quarter load was alluded to, and also the new departure in arc dynamo design in working the magnetic circuit at a much less point of saturation than in the old types.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

TO DAY FRIDAY, April 5th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting at 28, Victoria-street. The following Paper will be read: "The Practical Measurement of Self-Induction," by C. V. Drysdale.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Argon," by the Rt. Hon. Lord Rayleigh, F.R.S.

MONDAY, April 8th.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting at the Palatine Hotel, Hunt's Bank, Manchester. The following Paper will be read: "Some Methods of Gathering the Energy in Electric Railways and Tramways," by M. Holroyd Smith.

TUESDAY, April 9th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper will be further discussed: "Torpedo-Boat Destroyers," by J. I. Thornycroft, F.R.S., and Sydney W. Barnaby. MM. Inst. C.E.

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[*] This research was carried out at the Physical Institution Laboratory of the Sorbonne.

[†] Abstract from the *Electrical World* of New York.

The Electrician.

(The Oldest Electrical Journal, 1861—1878).

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GOOD-FRIDAY WEEK.

"THE ELECTRICIAN" will be published on THURSDAY in Good-Friday week instead of on Friday. Communications intended for this issue must reach us not later than Wednesday morning's post.

Alterations to existing Advertisements and copy for new Advertisements should reach the Publisher on Tuesday, but in any case not later than Wednesday morning.

INCREASING THE LOAD FACTOR.

Whether it be the outcome of five-and-twenty years of universal education or the result of assiduous practice of the cult of enlightened self-interest, we do not know, but there are several symptoms abroad tending to show that the great British Public is in some respects, at any rate, no longer the public depicted by the caricaturists and scoffers. That "the public must never be regarded as incurable" is, we believe, the first axiom taught to embryonic practical statesmen, and in view of the extreme docility with which householders have within the last few years allowed themselves to be made the *corpus vile* of all manner of experimental sliding-scale tariffs, and in view of the rapidity with which they have learnt to profit by them, it would certainly seem as if the very same aphorism should figure prominently in the central station manager's commonplace book—if he keeps one. Here have our good friends the gas companies been engaged in the supply of their well-known mixture these 80 years and more, and they have rested content with the sweet simplicity of just charging a customer for what he consumes (according to his meter) and allowing a discount for prompt payments and big bills. On the other hand, the electrical engineer no sooner took to supplying the public with electric energy than he set to work and elaborated a large variety of cunning contrivances to beguile the householder into using, not merely a wholesome quantity of the commodity he had for sale, but in a way most convenient to the aforesaid electrical engineer. Considering the inherently scientific bias of electrical engineering, and still more the severely scientific training so many neophytes undergo, the electrical engineer, like Clive after his ten years' free run of India, may well be astonished at his own moderation—in the matter of formulating and enforcing ultra-scientific methods of charging for an electric supply. The consumer was indeed at one time in some danger of having to wire his house according to a formula; a sort of Thomson's law of maximum economy—for the central station. Eccentricities like this and crudities, such as the cool proposal to keep a customer within the limits of veracity by providing him with a fuse arranged to leave him in the dark the instant he exceeded the "maximum supply demanded," have passed or are passing away, and methods of charging for an electric supply, which threatened at one time to become as numerous and as variegated a progeny as Abbé Sieyes' political constitutions, are now rapidly being reduced to two, to wit, the easily understood old-fashioned unfair system of discounts to large consumers and the somewhat complicated new-fangled charmingly fair contrivance for making each man pay according to the capital outlay he entails upon the supply company or Electric Lighting Committee.

The principle, which we venture to think will prove its innate fitness by surviving, was first publicly enunciated by Dr. John Hopkinson in November of 1892. It was proposed by him for the good people of Manchester. As then stated, there were one or two obvious objections to the "Manchester" method. If the "maximum power demanded" was to be based on the number of lamps fixed, it would have a marked tendency to keep down the total lamp connections; no great evil, perhaps, from the central station manager's point of view, but nevertheless an additional and highly undesirable impediment in the way of the general adoption of the electric light by ordinary householders. On the other hand, the barbarous device of a nicely-adjusted cut-out being ruled out of court, nothing seemed ready to hand as an alternative save a recording ammeter. A little later, however, Prof. Kennedy suggested a modification of the ordinary type of recording instrument in the shape of "a current indicator with a non-return pointer." At this juncture Mr. Wright brought his mind to bear upon the question, the fruit of his cogitations and experiments being the now well-known "Brighton" method of charging and a simple, cheap, reasonably accurate, thermal demand indicator. The change which the evolution of this tariff has brought o'er the spirit of the dream, or rather nightmare, of the Borough Electrical Engineer at Brighton was recently set forth financially in the Corporation Electricity Accounts for 1894, and the more technical aspect of the matter is discussed in our columns to-day by Mr. Wright himself. The monthly load factor has increased some 3 per cent. or more; the current sold has quadrupled, whilst the maximum load has only grown threefold; the units sold per lamp fixed have risen 15 per cent. and the income per lamp 10 per cent.; and last but not least, nearly one-half the consumers will in this year of grace only be paying about 5d. per unit, and this at Brighton with coal at 20s. a ton. The dimensions of the evil which this mode of charging was designed to mitigate may be gauged by the fact that even at Brighton a small section of the community remain obdurate and unregenerate, probably from causes beyond their own control. Some 13 per cent. of Mr. Wright's *clientèle* only use the light at all during about three months out of the twelve, and their average maximum demand lasts less than one hour per diem. Were it not for these stiff-necked individuals the Brighton Corporation could, with its present machinery and mains, cope with the supply for the next two years and more. As it is, the inevitable winter demand of these inconsiderate customers renders imperative immediate additions to the existing plant.

The justice and expediency of the system are patent. It is not to the true interest of a central station manager to follow the market law, and allow "a reduction on taking a quantity"; a reduction as a reward for a regular demand, however small, should be the keynote of his policy. Again, the success of the system at Brighton has been indubitable, and we are not surprised that it has been adopted elsewhere. To completely convince the sceptics, the system only needs to be adopted in a large and varied district, such, for instance, as that covered by the Metropolitan Electric Supply Company. Since the "Brighton" tariff does not tend to keep down the lamp connections, but (and that to our mind is one of its main advantages) rather the contrary, it is within the bounds of possibility that the consumers might suddenly and simultaneously overstep their normal maximum demand. But the dead-weight of the purse interest is against any such freak, and one may, therefore, safely disregard such a contingency. Finally, as is shown by the curves given in Fig. 1 of Mr. Wright's article, the "Brighton" system of charging does not do much, if anything at all, to mitigate the severe descent of the monthly load-factor curve as the summer solstice approaches; a descent which is seriously accentuated in fashionable London residential districts by the pernicious habit of "going out of town." Failing an alteration in the English climate, Mr. Crompton, in his recent Presidential address, pinned his faith on motors and cooking as a means of keeping up the monthly load factor during this trying period. One is never authorised to despair of the ingenuity of one's fellow-men, and in good time, no doubt, another revolutionary central station manager will arise with a happy thought which will settle this little difficulty. Pending the advent of this happy thought we would suggest the careful cultivation of a larger and less fashionable *clientèle* as a measure likely to smooth out this ugly summer ripple.

REVIEW.

The Telegraphist's Guide to the New Examinations in Technical Telegraphy. By James Bell, A.I.E.E. (London: *Electricity*, 29, Ludgate-hill, E.C.)

This little handbook, which professes to meet "the whole of the requirements of the new technical examinations imposed on telegraphists aspiring to superior appointments in the Government telegraph service," is at once a little too full, or a great deal too meagre for its purpose, according as we regard it as designed for "cram" or for reference. The details of practical testing, admirable as they are in most respects, would be impossible to recollect unless enforced by daily experience, and thorough familarity with the appliances under consideration. On the other hand, the absence of any complete index, and the lack of explanations of the technical terms freely employed throughout the book, are serious drawbacks to its usefulness as a guide to practical men. In reality, its chief function will be to assist them to a knowledge of such instruments and apparatus as may not have come within their ken at the offices where the candidates happen to be stationed. In other words, they may be helped to pass an examination which, but for a book of this kind, they would fail to pass, not through technical ignorance, but from lack of opportunity. It will be of little or no use to the mere operator, however, whose chief business is to work the wire, not to maintain it in working order. To the telegraphist, unless he has had instruction in electrical science or training in telegraphic engineering, the language of Mr. Bell's "Guide" would be an unknown tongue; and of many passages in the book we are inclined to say, If the reader understands them he knows already all that Mr. Bell can teach him. We say this not in disparagement of his book, which has a certain value for a limited class of students, but because we think its value might have been greatly enhanced, for example, by the addition of a table of definitions of technical terms. The book is said to be a reprint of articles published in *Electricity*, and the references are vaguely to "preceding papers," not to paging. The blocks also are imprinted with the name of the publication: and as it often occurs by the side of a connecting wire the effect is rather funny. There is a serious misprint in Question 4, page 96. These faults should be rectified in any future edition.

ON THE EMPLOYMENT OF THE ELECTRIC LIGHT FOR RAILWAY PURPOSES.*

BY W. LANGDON.

Having regard to the general character of the title of this Paper, the author is desirous it should be understood that the data referred to are the result of experience gained on the Midland Railway. The Midland Railway was by no means the first railway company to employ the electric light for traffic purposes, and the author lays no claim to priority in this respect. On the contrary, he readily recognises the prior claims of others, and he earnestly trusts that his friends and *confrères* will feel no hesitation in bringing forward such information with respect to their own systems as may add to the value of the subject. It is well known that the Great Western Railway, the London and South-Western, the Brighton Company, the Lancashire and Yorkshire, the Caledonian, the Manchester, Sheffield and Lincoln, as also the Glasgow and South-Western, have for some time, more or less, entered upon the employment of the electric light, and that the London and North-Western is now applying it to its goods depôts. The most material advance will, however, be found in the central stations recently established, in the one instance by the Great Northern Railway Company, under the guidance of Mr. W. H. Preece, C.B., F.R.S., Past-President, at Holloway; and in the other instance that laid down for the Great Eastern Railway at Liverpool Street by our President, Mr. R. E. Crompton, C.E.

From all, no doubt can exist that, material information is to be obtained—information of value not only with regard to the question of economy, but also in the mode of application. In both the Holloway and Liverpool Street plants we have comprehensive schemes, the product of men of large experience and of the highest ability, from which results of an exceedingly gratifying character may well be anticipated.

The electric light is employed on railways, as in towns, under its two forms, viz., incandescent and arc lighting.

Incandescent Lighting.—Incandescent lighting has so far found its chief employment in the illumination of offices, waiting rooms, and other spaces of limited area. So employed, its claims upon our consideration are those which it has established in relation to our homes—a purer and more healthful light than can be procured from any other illuminant. In offices where a staff of workers are in constant attendance, or where, from the exigencies of the moment, work has to be carried on to a late hour of the night, it becomes to railway companies, as to all other employers of office labour, a factor of importance. To impute to the vitiated air breathed by those who occupy close rooms lighted by gas all the ills to which flesh is heir, would be absurd; still, so long as the air we breathe is robbed of its oxygen and otherwise polluted by the impurities cast into it by whatever may be the source of illumination employed, there can, in point of healthfulness, be no comparison between it and the electric light.

The argument against the electric light for the illumination of offices, waiting rooms, &c., is usually one of expense. With a small installation, or where the current has to be obtained from a supply company, the cost is, at present, in most instances, probably greater than that of gas; but it is open to doubt whether such is really the case when we take into consideration the cleaning and re-decorating of such places. We all know the effect of gas, and the inconvenience of being turned upside down periodically for cleaning purposes. If we save by the electric light but one cleaning in three, it is probable that even the drawbacks of a small installation, or the present cost of current when obtained from an outside source, are fully met.

If to these arguments we add that of health, we have a factor which carries with it far greater weight, and merits far more consideration at our hands. Health is money in more ways than one. It is money to the employer. It is more than money to the employed. It means to the employer more constant attendance, greater energy, and greater devotion to work on the part of the employé—gains alike to master and man.

Whether the incandescent light may not yet prove of considerable service for the upper floors of goods warehouses, where light is only occasionally required, is an open question; and although in such places its advantages in a hygienic sense may be disregarded, it is, with a sufficiently large installation, quite within the realms of economy.

Wherever electric lighting is produced by a local generating plant, every increase in the output of current tends to reduce cost. All such additions mean very little additional expenditure in production of current. The first cost is no doubt more than that for gas, but when we reach that point where the annual cost of the light produced is less than that of gas, such extra first cost is soon recovered.

The directors of the Midland Railway Company have only recently installed the incandescent electric light throughout the offices, waiting rooms, &c., of the Derby station and headquarters offices. There is but one opinion of the result. The staff already feel the benefit of it in point of healthfulness and comfort, and the rooms and offices are practically as clean at the present moment as when the light was started.

In the "shipping" offices—offices usually located on the platforms of goods sheds, for the purpose of dealing with invoices, &c., and, as a consequence, necessitating very late, and sometimes all-night attendance—the advantage of the electric light is still more intensely felt, for in these offices an abundance of light is a necessity.

Arc Lighting.—There is reason to believe that arc lighting is destined to be of great advantage in railway working. In the loading and unloading of stock, and in the marshalling of trains, it is an invaluable adjunct. To be able to unload a train, load its contents into trolleys ready for delivery, and, *vice versâ*, to transfer from the collecting vans to the railway trucks, marshal and despatch them with speed, is economy in capital, men, material, and time—results which are not confined to the depôt at which it originates, but which to a great extent influence the traffic of the entire system.

The advantage of the arc light in goods warehouses, yards, sidings, and marshalling grounds, resides in the simple fact that it is a larger and truer light than can conveniently be obtained from gas for a similar outlay. By this larger light, work is handled with greater accuracy and greater despatch. To be able to load a given number of trains in, say, three-fourths the time formerly occupied, is tantamount to increasing the capacity of the premises, warehouses, yard, &c., 25 per cent.; or, supposing a depôt required enlarging in order to meet an increased traffic, the introduction of the electric light should meet the contingency, and avoid purchase of land, erection of additional buildings, &c. In like manner, with new buildings, economy in time means economy in capital outlay: the buildings need not be so large, because the traffic can be disposed of in less time.

Probably to no part of a railway system is the electric light of greater utility, or more valued, than in yard shunting, or the marshalling ground. With a brilliant light at the junction points the marshalling process may be carried on with almost the same despatch and certainty as during broad daylight. Risk of life and limb is largely reduced, whilst it has been found to be in no small degree useful in preventing that petty pilfering to which the absence of light is often an inducement. The author believes it to be a fact that the first arc lighting plant installed for yard working, viz., that at Nine Elms, which was devised by Mr. W. H. Preece, C.B., F.R.S., past President, and installed by Mr. R. E. Crompton, our present President was laid down mainly with a view to suppress certain depredations on valuable goods which the absence of light appeared to foster, and upon which its introduction has had so marked an effect as to help largely to defray the cost of the installation.

Although, as already stated, by no means the first to employ the electric light, the Midland Railway was not long in recognising its advantages. In 1889 its adoption was recommended by Mr. G. H. Turner, the company's general manager, who at that time filled the post of goods manager, and who recognised in it one of those aids towards the rapid handling of material which at that time so largely occupied his attention in relation to the remodelling of many of the company's goods stations. In this remodelling of their chief goods depôts, the Directors have called to their aid all the most modern improvements, and amongst these that of the electric light. There is nothing of a purely novel character in the application of the electric light to these improvements, and the author feels that only in illustration of its general application and usefulness under aspects perhaps slightly varying from those which are associated with it in its use for public street lighting, can this Paper lay claim to consideration.

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* Paper read March 28th before the Institution of Electrical Engineers

The first electric lighting plant laid down on the Midland was that established for lighting the St. Pancras Hotel. The generating plant established for this service is in duplicate, and consists of a simple non-compound horizontal steam engine and two dynamos, each set being of 28-kilowatt capacity. The number of lights in the hotel is equal to 1,330 8-c.p. lamps at 110 volts, and the maximum load reached has been 320 amperes.

The light load is met by accumulator cells; the dynamos being so arranged that one of the two driven by each engine can be employed for charging them, while the other is furnishing current direct to the lamps.

The first arc lighting plant laid down was that experimentally installed by Messrs. Laing, Wharton and Down, as representatives of the Thomson-Houston system in 1888, at St. Pancras. The lighting was confined to the passenger station. In 1890 this plant was purchased by the Midland, and extended to the St. Pancras goods station and yard. Insulated overhead wires, partly okonite, partly vulcanite, were employed. The installation has from time to time been largely extended, and now consists of 242 2,000-c.p. (nominal) arc lights, employed on the St. Pancras passenger station, the St. Pancras goods station and yard, the Somers Town (or New St. Pancras goods) warehouse and yard, sidings and approaches.

The engines employed for this installation consist of two pairs of simple horizontal non-compound steam engines, coupled, served by locomotive boilers, three 50-light Thomson-Houston dynamos being worked from counter-shafting driven by each pair of engines. This counter-shafting was originally arranged so that it might be coupled for cross-driving if needed; but, up to the present, no such need has presented itself. The engines were made and placed in position by Mr. Sam. Johnson, the Company's locomotive engineer, and it is impossible to speak too highly of their performance.

The electric lighting plant now in use or under construction on the Midland is approximately as represented in Table I.

Steam may be said to be employed throughout, with the exception of Leicester and Wellingboro'. Leicester—which will be dealt with more in detail later on—and Wellingboro' are dependent upon gas. A small gas engine is also employed at Bradford and Birmingham (Central) for the light load; and, owing to want of space for extension of boilers at Bradford, we are now laying down two 40-H.P. gas engines to meet an extension of arc lighting there.

The boilers are in all cases of the locomotive type.

The type of steam engine varies.

At Bradford some 200 H.P. of the engines are identical with those previously described as in use at St. Pancras.

At Birmingham (Central Goods and Lawley-street Goods), and at Sandon Dock, Liverpool, horizontal two-cylinder simple engines by Davey Paxman are in use.

At Leeds, two-cylinder simple by Fowler; at Sheffield, single-cylinder steam jacketed by Marshall; at Derby, Willans and Robinson single-acting compound—all are non-condensing.

The Willans and Robinson engines at Derby drive direct; and, with the exception of St. Pancras and Bradford, where counter-shafting is employed, the driving is by belting direct from the engines. The engines employed for the arc lighting are generally 80-H.P., and are provided with two flywheels, each driving an arc dynamo.

At Leicester, with the object of testing the economy, or otherwise, of a gas-driven plant as against steam, a gas plant has been laid down. It has only recently been brought into use, and the installation is not even yet complete, the new passenger station being still in progress. A Dowson gas plant has been installed, and connection with the town gas has also been provided. The valves in the supply pipes are so constructed that either form of gas can be laid on to the engines without stoppage to the latter.

The generating plant consists of four 50-H.P. gas engines for driving three arc machines and one low-tension machine, and two of 25-H.P. for two small incandescent dynamos.

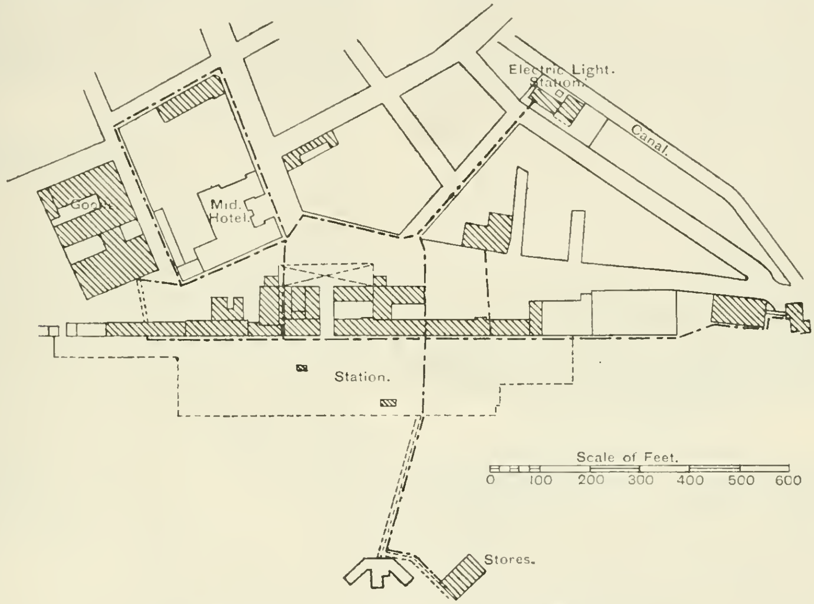

Fig. 1.—Midland Railway. Derby Offices. Electric Light Mains — - — -.

Arc Lighting System.—Throughout the service the arc lighting employed in the yards and shunting grounds is on the series system. In certain of the goods sheds the series-parallel—two lights in series—system is used.

Table I.

Engine B.H.P.		Locality.	Arc Lights.		Incandescent.
Steam.	Gas.		2,000 c.p.	1,250 c.p.	8 c.p.
200	90	Bradford	...	190	1,100
190	...	Leeds (Hunslet Goods Depot)	...	150	523
190	...	Sheffield (Wicker Goods Depot)	114	...	300
190	...	Liverpool (Sandon Dock) ..	...	126	100
190	25	Birmingham (Central Goods) ...	73	...	435
300	...	„ (Lawley Street) ..	...	200	400
320	...	Derby	...	...	4,500
...	250	Leicester (Passenger and Goods)	160	...	400
300	...	St. Pancras „ „	242	...	...
...	...	„ Hotel	...	...	1,330
200	...	Nottingham	55	75	300
...	40	Wellingboro'	35	...	100
2,080	405		679	741	9,488
2,485			1,420		

Brush series machines are in use at Leicester; the Thomson-Houston at all other points.

Incandescent System.—The machines laid down for incandescent lighting are from various makers—Siemens, Edison, Hopkinson, Elwell-Parker, and Holmes.

The incandescent lighting, with the exception of Derby, is on the simple parallel system. At Derby the three-wire system, with feeders, is in use. It will be seen from the skeleton plan (Plate A, Fig. 1) that the blocks of buildings to be lighted are somewhat scattered, and that the generating station itself is situated some distance away from the lighting. It is practically a small supply station with, at present, a very bad load-factor (Fig. 2)—much worse than that of a town supply station.

Here, as also at Bradford, Sayers's automatic compensators are employed to counteract the fall of potential as the current increases.

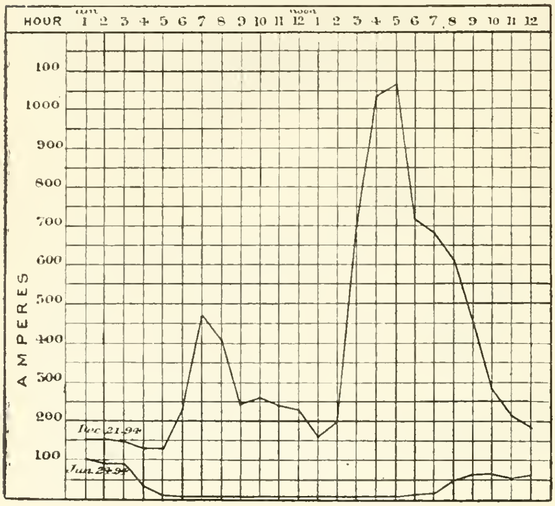

Fig. 2.

The Midland Bradford Station, as is perhaps well known, is electrically lighted throughout, with the exception of a few gas lights under some low awnings at the distant ends of the platforms. Originally the incandescent lighting was provided for by compounded machines in duplicate. To change over from the working to the duplicate set, involved careful handling on the part of the attendant. Discussing the matter with Mr. J. Sayers, my assistant, under whose supervision Bradford came, it was decided to insert a series machine in one main and to dispense with the compounding. In the end this resulted in the employment of Sayers's "compensator," and which, I believe, was the first self-exciting machine made without winding on magnets. The application of this machine has been attended with the most perfect success. The transference of the load from the active to the duplicate set is now simply that from one shunt machine to another, while the compensation of the loss in pressure consequent upon the increase in current is most perfectly met.

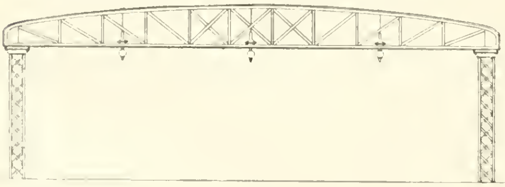

Fig. 3.

At Bradford the wiring is on the simple parallel system. At Derby Dr. Hopkinson's three-wire system is in use. The success attending the employment of Sayers's compensators at Bradford naturally suggested their employment at Derby. At Bradford the extent of the compensation is limited to 11 volts, with a maximum current of 320 amperes. At Derby we have to serve a network, and the compensation is more involved owing to the loss in the middle wire when either of the two sets of three separate groups of feeders is unevenly balanced. Dealing with one set, the arrangement is as follows:—The outside wires of the grouped feeders are connected through a series machine driven by motor at a constant speed of 820 revolutions. This compensates for the loss in each outside wire.

The loss in the middle wire is, of course, double-acting, raising the volts on the light load side and depressing them on the other. To meet this, Mr. Sayers takes the middle wire round the magnets of each of the two series dynamos, but in opposite directions one to the other. Any current passing in this wire therefore adds volts to one and decreases the volts in the other equally; and by suitably proportioning this winding it can be made to practically neutralise the loss in the third wire.

If both sides are fully loaded, and there is no loss, or no current passing in the middle wire, each series machine has to raise the voltage, on a current of 350 amperes in each, some 7 volts; but, as the third wire is one-half the section of the outer wires, it follows that, if one side should be fully loaded and the other not loaded at all, the compensators have to give 7+14=21 volts, and this they should do under the arrangement provided.

Such an extreme case never has arisen in practice; still, serious differences do occur—more so, perhaps, in such a supply as that under reference than in a town service—for the reason that, however equally you may plot out your scheme, it is quite impossible to foresee all those contingencies which, calling for extra attendance on the part of a special branch of the service, call for the load on that side accordingly.

A further advantage to be derived from the use of these compensators is to be found in the regular range of speed at which the engines require to be worked between light and full load. The volts of the main dynamos only require to be kept at the normal pressure—say 110. There is no need for running the speed up so as to increase voltage to meet the drop consequent upon increase of current. It is one of those arrangements which simplify the working of a station at moments of pressure.

Installation.—The establishment of the various installations, with the exception of that originally laid down by Messrs. Laing, Wharton and Down at St. Pancras, has been carried out by the Company's own staff, under the immediate supervision of the author and his assistants, Mr. W. L. Preece, and Mr. J. Sayers; and no small portion of the fittings required have been made in the Company's electrical workshops.

Arc lighting wires not employed for the interior of buildings are laid underground. When drawn into iron piping, the wire is not armoured, but is protected by an extra outer serving of flax, hemp, &c. When armoured wire is used it is protected by ordinary drain tiles, split, or by planks of wood, employed more with the object of indicating to those who may have occasion to disturb the ground in its neighbourhood the fact that there is something beneath it, than with any idea of its power to absolutely resist injury. The insulation of the cable thus employed is specified at 5,000 megohms.

Arc lighting wires inside buildings are insulated with vulcanised india-rubber to not less than 300 megohms, and are, as a rule, supported on Johnson and Phillips's oil insulators. All suspended lamps are also insulated from the suspension fixing by oil insulators made for the purpose by the same firm.

For goods yard and siding working the selection of the positions for the lamp pillars and the height the lamp should stand from the ground, are matters of importance. The former is only to be dealt with in a satisfactory manner by learning from those who have the handling of the work, and by personal observation, where the light is most needed.

Each group of points requires special consideration. Shunters should be able to see when waggons have passed over each point, so that they may readily "knock off" the next waggon or group of waggons as the required points are clear of the trucks previously despatched over them.

At the mouth of the Leeds goods yard, where there are four roads, a light girder bridge (Fig. 3), has been thrown across, from which three lights are suspended between the roads, and the lighting is in consequence very good. The point is an important one, as from each line several fans of roads radiate, and it is beneath this bridge that the main part of the shunting is done. Without the girder bridge it would have been impossible to adequately light the intervening spaces between the roads.

It will be noticed that two classes of lamps are in use—that affording what is termed 1,200 c.p., and that known as 2,000 c.p. The former requiring a current of 6·8 amperes, and the latter 10 amperes, the 10-ampere lamp will afford a larger body of light than will the 6·8-ampere lamp. In station buildings, where structural arrangements do not intervene, the 10-ampere lamp illumines a larger space than that produced by the lesser current, and is, as a rule, arranged at a higher elevation, and further apart in consequence. In goods yards and open spaces, theoretically, they should illuminate an equal extent of area. In point of fact, however, the illumination does not bear the same relation as when within inclosed spaces. Again, it may be said the 10-ampere lamp should be arranged at a higher elevation than the smaller lamp, but on the Midland it has been found convenient to employ only one class of pillar for outside work. The height adopted is 20ft.—*i.e.*, 20ft. between the arc and the level of the rails. The distance these pillars are apart, varies for the 6·8-ampere lights from 90ft. to 100ft., and for the 10-ampere lights from 100ft. to 120ft.

The distance between the lamps in the goods sheds must, in a great measure, be controlled by structural arrangements, cranes, &c. In open sheds, where these difficulties do not exist, a distance of 45ft. between 6·8-ampere lamps, and a distance of 60ft. between 10-ampere lamps, will be found convenient. Every case will, however, call for special consideration and treatment. To lay down a rule which shall be universal and at the same time useful, is practically impossible.

The lights employed on the St. Pancras passenger station are 10-ampere. At the head of the station those lamps are 60ft. apart, the space between them increasing towards the end of the platforms, where the passenger traffic is not so heavy, the distance between the two most distant lamps being 90ft. The height of these lamps from the platform is 14ft.

On the Leicester passenger station main platforms, where 10-ampere lights also are used, we are able to place the lights 90ft. apart, and at an elevation of 15ft. from the platform level. At Leicester the glass roof is lower than the St. Pancras roof, and the walls, being of glazed material, have a much greater reflecting power than in the case of St. Pancras, where the height of the lamps is 14ft. The side platforms of the new Leicester station are covered by the usual glass awnings, and the lamps have to be arranged to meet the structure. Here they are 13ft. above the platform and 75ft. apart. Fig. 5 represents the position of these lamps.

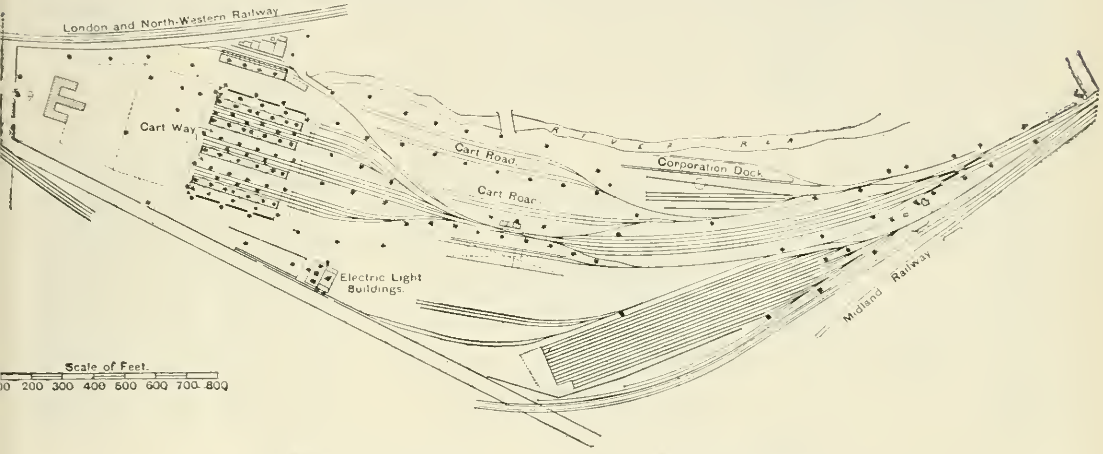

Fig. 4.—Midland Railway, Birmingham. Electric Lighting at the Lawley Street Depot.

Plate B, Fig. 4, is a plan showing the positions of the lights in the Birmingham (Lawley-street) goods depot and yard. The lights employed are 6·8-ampere. This plan will probably afford a better idea of the disposition of the lights for such yards and buildings than will any written description. The lamps are shown in red. Within the warehouses the cranes, with their radii, also shown in red, are lettered C, while the pillars are coloured black. The Lawley-street depot is still in an incomplete condition. A range of offices—now about to be constructed—will occupy the Lawley-street frontage, and the space between these offices and the main warehouse will be covered in by an awning.

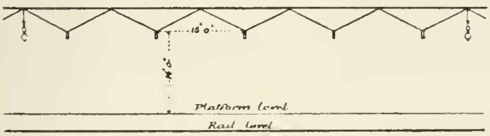

Fig. 5.

The lamps employed are double carbon, jointly affording 16 hours' lighting. 13mm. carbons are used for the 10-ampere lamps, and 12mm. for the 6·8-ampere lamps, for both top and bottom carbons.

In the earlier plants laid down the lamps are protected by sheet-iron hoods, A (Fig. 6, *see* p. 711). The lamp is suspended from a cross-piece of timber, B, by insulated hooks, or hangers, C, and it is further supported at its base by an insulator, D.

Later constructions have been equipped with four-sided lanterns (Fig. 7, *see* p. 711). The top portion of the lamp is insulated from the lantern at A by a block of dry wood and insulated hooks, and the base, as in Fig. 6, is supported on an insulator, B.

These lanterns have been glazed—

(*a*) With plain clear glass,
(*b*) With what is termed "blurred" glass,
(*c*) With fluted glass,

samples of which are on the table.

The clear glass can be used only to a limited extent. The naked arc is objectionable to men working within its immediate range. Clear glass is perhaps still more objectionable, from the strong shadows which attend its use. "Blurred" glass has been employed with the object of toning down the glare of the arc and breaking up the shadows. It is, however, not in this respect so successful as the fluted glass. With the flutings horizontally arranged the shadows are completely broken up, and the refraction is so good that the light immediately underneath the pillar is practically as good as that 10ft. distant.

The lanterns are made so that the chimney may lift off at A. All lamp pillars are provided at their base with switches which entirely sever the connection of the lamp wires with the line wires; and in all modern constructions the switch, when in the "Off" position, also places the lamp to earth. The lamp pillar complete is shown in Fig. 8 (*see* p. 711). The switch is enclosed in the base of the pillar.

Where lamps are worked in series it will, in determining the circuit arrangements, be found desirable to ascertain the period during which the lights are required for use, and to group them accordingly, so that they may be turned off and on in sections, if possible, from the switchboard in the dynamo or transformer room. The groups should also be so arranged that, combined, they may equal the capacity of a machine. The circuits applicable to indoor lighting should be so arranged as to admit of their being worked independent of the outdoor or yard circuits, the light being required indoors at an earlier hour than those out of doors.

For incandescent work the wires are, as a rule, run in grooved casing of the orthodox kind. The casing and cover are fixed by the outer and not by the centre fillet, the object in rejecting the centre screw being to exclude the aid it would afford to any *creeping* of the current across the centre fillet, should leakage at any time arise. Under such a condition it is clear the screw in the centre fillet would largely reduce the resistance between the two wires—that it would, in fact, become a sort of "half-way house" towards the passage of the current, and tend to ignite the wood. The wooden casing as at present employed affords a convenient mode of dealing with the wiring of rooms; but, in view of the description of casing which one not unfrequently sees employed, and, indeed, under any circumstances, it can hardly be regarded as a perfectly satisfactory mode. If an artistic rectangular casing or tubing of metal which would not readily melt could be produced at a reasonable price, it would, no doubt, prove exceedingly serviceable.

Apart from the points referred to, there is, in the application of the electric light to railway working, little of a sufficiently special character to call for further reference. Numbers of the fittings employed, switches, switchboards, controlling arrangements, &c.—most of which are made in the Company's own shops—are to be found in connection with each installation; but in this the installations on the Midland do not differ from all other installations, inasmuch as most have one or more specialities peculiar to themselves. Any such specialities are best investigated on the spot, and the Midland Railway Company will at all times be pleased to afford facilities for an inspection of any one of their works.

The question which will probably most interest railway companies is that of

Cost.—To lay down an electric-lighting plant is probably more costly than to establish means for illumination by gas; but when we take into consideration the relative cost of working, the light derived from each source—light for light, or candle-power for candle-power—the advantage is so largely in favour of the electric light as to more than fully compensate for any larger first outlay which may be incurred.

The tabulated statement (II.) will afford data with respect to the output and cost of working of several of the electric lighting stations on the Midland. Certain charges for labour, engine and boiler repairs, and for coal, owing to charges for these items being combined with similar charges for hydraulic machinery located in the same building, it is possible, are not so strictly allocated as is desirable for a Paper of this kind; still they are not largely inaccurate. They should, however, be regarded as maximum charges.

Table II.—Midland Railway.—Electric Lighting.

Details of Cost, Half-Years ending June 30 and December 31, 1894, including Maintenance and Renewal.

Installation.		Total units.	Total cost.			Cost.						
						Per unit, incl'ding all charges.	Per arc lamp hour.	Per unit for incandescent lighting.	Per unit for labour.	Per unit for material.	Per unit for repairs.	Per unit for coal.
			£	s.	d.	d.	d.	d.	d.	d.	d.	d.
Somers Town	Half-year ending June 30	170,171	2,294	5	10	3·23	1·61*	—	1·15	0·65	0·29	1·00
	„ „ Dec. 31	187,326	2,506	6	4	3·20	1·60*	—	1·09	1·03	0·27	0·82
Bradford	„ „ June 30	82,984	1,115	15	0	3·23	1·39	2·7	1·19	0·56	0·47	0·80
	„ „ Dec. 31	100,388	967	5	6	2·36	0·98	2·0	1·06	0·56	0·18	0·44
Birmingham (Central)	„ „ June 30	70,774	950	10	11	3·22	1·60*	3·3	1·43	0·68	0·35	0·48
	„ „ Dec. 31	90,847	945	4	6	2·49	1·22*	2·7	1·03	0·64	0·34	0·37
„ (Lawley-st.)	„ „ June 30	89,960	1,113	9	5	2·97	1·00	—	1·33	0·80	0·20	0·60
	„ „ Dec. 31	102,481	1,103	14	2	2·58	0·85	—	1·25	0·62	0·24	0·44
Hunslet	„ „ June 30	70,985	1,157	4	7	3·90	1·41	3·6	1·80	0·91	0·27	0·79
	„ „ Dec. 31	75.864	1,237	6	1	3·90	1·47	4·0	1·89	0·85	0·55	0·65
Derby	„ „ June 30	60,389	873	8	9	3·40	—	3·4	1·70	0·76	0·19	0·65
	„ „ Dec. 31	77,740	1,082	14	9	3·34	—	3·3	1·45	0·94	0·40	0·53

* These are 10-ampere lamps, 2,000 c.p. All others are 6·8-ampere, 1,200 c.p.

Nor are the charges in any case comparable with those of city supply stations. The arc lighting load, varying throughout the night according to traffic demands, is not so constant as that of of a town service; while that for incandescent lighting lacks the continued evening service associated with town lighting. At goods stations and for office lighting the latter rises to its maximum in the depth of winter for a period not exceeding an hour and a-half daily, viz., 4 to 5:30 p.m.; while in summer the demand is still less. Still, the result, as compared with the cost of current obtained from a public supply source, is greatly in favour of an independent generating plant.

In criticising Table II.—viz., that of cost—we must also bear in mind the fact that the cost per unit carries with it the cost of carbons and carboning the arc lamps, together with cleaning, repairing, &c., and that the cost for incandescent lighting also, as a rule, covers the renewal of lamps. The only exception rests with Bradford, where the lamps in the hotel are replaced by the hotel department, and their cost is not, therefore, included in the cost shown in the tabulated statement.

Again, it should be understood that the appropriation of charges to incandescent and arc lighting, where both are in operation, is unavoidably somewhat arbitrary. There are many items of cost which apply to both, such as labour in attendance upon the machinery, cleaning, &c. These have to be divided and appropriated as is considered fair and reasonable. The question will arise, Is one favoured at the cost of the other? The result must speak for itself.

Still one more condition! The output is obtained from records taken hourly, not from meter. The data are not, therefore, absolutely correct; but, taken over a period of 12 months, they are sufficiently reliable to afford a fair index of the cost.

Dealing with the table as it stands, we find the cost for arc lighting as under:—

Depôt.	Cost per lamp per hour.
	d.
St. Pancras (Somers Town), 2,000-c.p. lamps	1·61
Birmingham (Central Goods), 2,000-c.p. lamps	1·41
„ (Lawley-street), 1,200-c.p. lamps	0·93
Leeds (Huuslet), 1,200-c.p. lamps	1·44
Bradford, 1,200-c.p. lamps	1·19
Total	6·58
Average	1·316

The lighting at Liverpool (Sandon Dock) and Sheffield has so recently been brought into use that returns from those depôts are purposely omitted. That at Wellingboro' has only now started, and that at Nottingham is under construction.

The daylight output for incandescent lighting at all of the arc lighting depots is small. At Birmingham (Central), where the lights are required in the bonding stores throughout the day, and at Bradford, where the demand applies to the hotel, station offices, and waiting rooms, this is met by a gas engine.

Some of the recently-constructed goods depots afford an opportunity for comparing the cost of the electric light with that of gas. Gas has been adopted as an alternative form of light in case of failure with the electric light. Consequently, the gas lighting was what might justly be regarded as modern gas lighting, affording an amount of light which, though not nearly so great as that afforded by the electric light, is greater than that which attained, and still attains, under the old system of gas lighting.

Fig. 9 (*see* p. 712), which is a plan of one of the warehouses, shows the positions of these gas lights, together with those of the electric lights. The former are on the regenerative principle, and are each nominally 150 c.p.; the latter are arc lights, nominally of 2,000 c.p.

It is officially stated that 5 cubic ft. of gas, burnt under the principle referred to, will produce 25-c.p. light for one hour. There are 81 150-c.p. gas lights. The price of gas is 2s. 3d. per 1,000 cubic ft., less 5 per cent. On this basis, the cost of gas lighting would be 62d. per hour.

There are 30 arc lights, the cost of which, as per Table II., averaged 1·41d. per light per hour. The total cost per hour would therefore be 42·3d., as against 62d. for gas; the relative nominal candle-power being—

Gas	12,300
Electric light	56,000

At Lawley-street, Birmingham, there are 53 arcs of 1,200 c.p., and, as an alternative, if required, 130 gas lights of 150 c.p. each. The arcs here average a cost of 0·93 pence per lamp per hour. Gas is 2s. 3d. per 1,000 cubic ft., less 5 per cent. The result works out per hour—

53 arcs, affording 63,600 c.p.	49·29 pence.
130 gas, affording 19,500 c.p.	100·00 „

At Somers Town (New St. Pancras Goods) the gas used is manufactured at the Company's own gas works at Brent, near the "Welsh

Harp," and is priced at 2s. per 1,000 cubic ft. The result is as follows :—

29 arc lights, affording 58,000 c.p., cost per hour, 47 pence.
86 gas lights, affording 12,900 c.p., cost per hour, 61 ,,

If we extend these results so as to cover a period of a year—say 3,000 hours—we have a saving of £1,050 per annum on the three ground floors of the goods warehouses referred to; and it is important to observe that, whereas the charges for the electric light cover all charges—repairs, cleaning, &c.—the charge for gas is for gas *pure and simple;* there is no provision for cleaning or for repairs.

Gas Plant.—In the early portion of the Paper, reference has been made to a gas plant recently laid down at Leicester. This plant (Plate C, Fig. 10, *see* p. 712) consists of four Crossley gas engines, required to deliver under Dowson gas 40 H.P., and under coal gas 50 H.P., on the pulley of the dynamo, for the purpose of driving three 50-light 2,000-c.p. Brush series high-tension dynamos, and one low-tension dynamo employed chiefly for arc lighting; and two 14-H.P. nominal Crossley gas engines, required to transmit 25 H.P. to the pulleys of two Siemens incandescent machines.

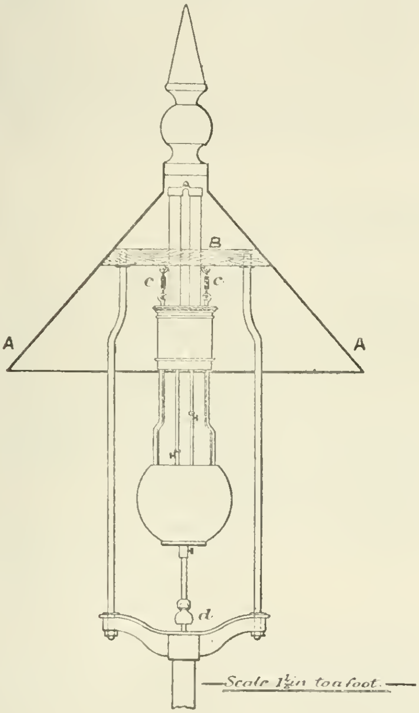

Fig. 6.

The service pipes are in duplicate, that is, one is in connection with the town gas, the other in connection with a Dowson gas plant. The engines are provided with valves which admit of the gas supply being changed over at will from coal gas to Dowson, or *vice versa.*

The object of this arrangement is to test the cost of gas as against that of steam.

In construction, an ordinary gas plant saves the cost of boilers and chimney shaft, and occupies less space, thereby effecting an economy in cost of building and cost of land. In maintenance there ought to be a saving in labour; no stoking is required when working off coal gas; and, as a rule, the attendance upon engines and dynamos is shared by the electrical attendants—engine drivers and stokers are non-existent. Thus it would appear that there should, where coal gas only is used, be a saving of from two to three men.

With a Dowson plant more space is occupied than if coal gas only is relied upon, and a man is also required for stoking and attendance upon generators. It remains to be seen if sufficient economy attaches to the employment of Dowson gas to compensate for the additional cost of plant, space, buildings, and as regards maintenance, repairs, and labour.

The experience so far gained is scarcely sufficient to justify a definite expression of opinion; but the following test figures may be of some service. They should be accepted with reserve.

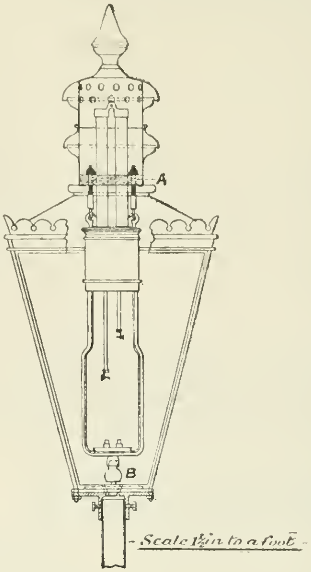

Fig. 7.

The test extended over a period of four weeks during December, 1894, and it shows the following to be the cost of running, exclusive of repairs or renewals, but inclusive of carbons.

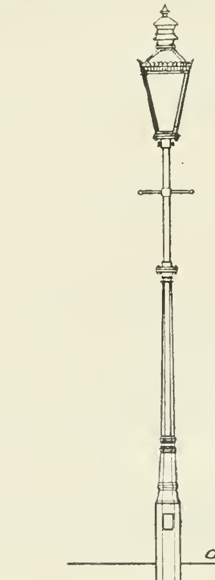

Fig. 8.

Dowson gas was used during week-days, and coal gas on Sundays, or very occasionally.

Arc lights, 2,000 c.p. ....1·2d. per lamp hour.
Incandescent lights ....2·3d. per unit.

It should be added that, although the output is not at its maximum—the whole of the proposed lighting not being yet established—the result here given is for a busy period.

There will be periods during which the output will be much less, and consequently the result per lamp-hour not so good.

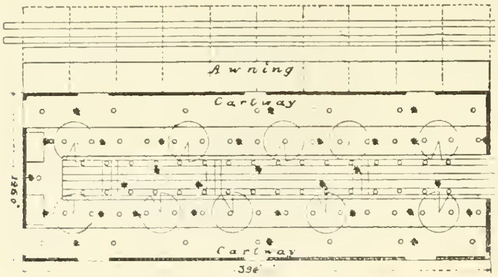

FIG. 9.

As suggested, it is somewhat premature to attempt to draw a reliable comparison between this cost and that resulting from steam power; still, the figures are such as to inspire confidence in the experiment. At some future date the author will be glad to communicate the result of further experience.

It would appear that what is needed is a generator the energy derived from which may be applied alike to incandescent lighting, arc lighting, or motive power, for the latter is an application which will have to be provided for. Is this to be most economically and most successfully met by an alternator or by a direct-current machine? Are we to look for help in this direction from "rectified" currents?

If a system, having for its basis one common generator, can be established without too great a sacrifice in efficiency, small installations, such as would be of great service to railway companies in many busy centres, could then be brought within a more economical compass than is now the case. Three units—one for the light load, another for the full load, and a third of a similar capacity as spare—would probably meet the requirements of every depôt; whereas, at present, spare units for both arc and incandescent work are necessary.

For instance, at Birmingham (Lawley-street) the plant, when all is complete, will consist of six 50-light arc lighting machines and two incandescent machines. Now, if all this could be met by three generators—one for the light load, arcs and incandescents combined, another for the full load, and a third as spare—the engine and dynamo space would be largely reduced, and labour and repairs correspondingly lessened.

As opposed to this would be the cost of transformers and transforming rooms. To help this we might possibly have reduced cost in cables; so that, regarded as a whole, provided that which is sought can be secured without too great a sacrifice in efficiency between the generative output and the production of light, or other means of consuming the energy, there would appear to be reason in regarding such an arrangement as highly favourable to economy.

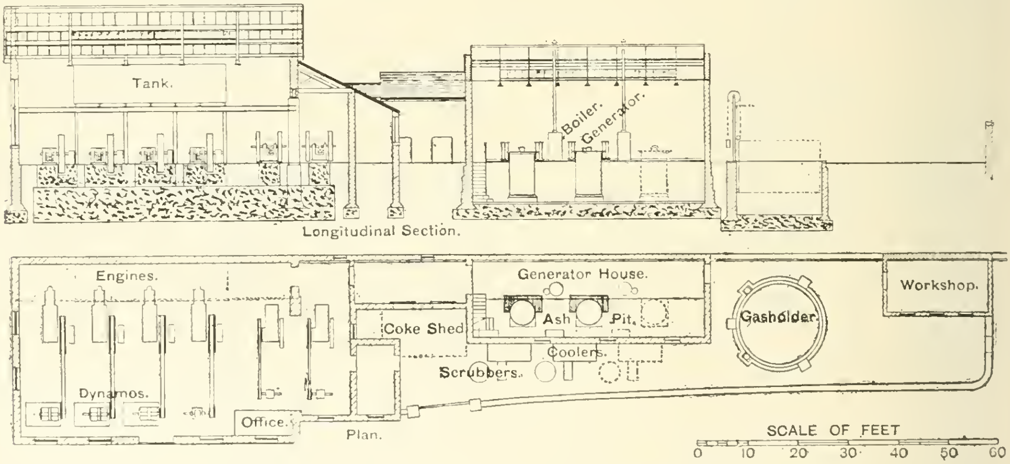

FIG. 10.—Midland Railway, Leicester. Electric Light Buildings.

Conclusion.—It is submitted that the experience so far gained establishes beyond doubt advantages largely in favour of the electric light as an illuminant for dealing with railway work wherever a large body of light is required.

At the same time, we must be sensible of the fact that daily experience teaches us to look for further developments in the machinery employed; and although this does not necessarily entail replacement of existing plant, it is as well to mark well that which it is desirable should be achieved. One improvement should be the abolition of belt-driving. All driving should be direct from the shaft of the engine.

The result will be less danger of interruption, less space, greater regularity. The speed of dynamo machines for arc lighting in series is now being brought within the compass of high-speed steam-engines. This accomplished, the propriety of direct driving for series, as well as series-parallel-arc commends itself to our consideration.

A further advance is to be looked for in the unification of the class of generator. At the present moment it is necessary, where series-arc and incandescent lighting has to be provided, to lay down independent power and independent machines for each, or to drive the arc lights from alternating or transformed alternating currents. To drive arc lights on the series-parallel system for any material distance from the generating plant would entail so large an outlay in cable as to strongly militate against its adoption for such small plants as railway companies require.

Few, probably, will doubt that electrical energy is destined—and that at no distant date—to become a useful and economic agent at all important railway centres, not merely for lighting, but for traction and other purposes at present met by horse labour, hydraulic power, &c. In determining the ultimate design of generator and mode of working, this probable demand should be present to our minds, both with regard to the electrical system and the design of buildings for generating plant. That the demand for electrical energy will increase we may be sure, and our provision should in all cases be such as will admit of extension.

Attached to this Paper will be found copies of some rules and regulations in relation to restrictions, duties, and the management of electrical depots such as are required for use on railways, which experience has dictated, and which may possibly be of service to others. Appended are also some precautionary instructions which have been issued for the avoidance and treatment of accidental shock from electrical current.

The Telautograph.—We understand Mr. Elisha Gray states that he has succeeded in working his system of electrically transmitting writing to a distance, with *two* wires, in place of the four conductors previously required.

PARLIAMENTARY INTELLIGENCE.

THE SELECT COMMITTEE ON THE TELEPHONE SERVICE.

The Committee, presided over by Mr. Arnold Morley (the Postmaster-General), continued their inquiry on Friday.

Bailie SAMUEL CHISHOLM, Glasgow, examined by Sir Charles Cameron, said he was a member of the Special Committee to which had been remitted for consideration and report a motion "That in terms of the Treasury Minute of May 23, 1892, the Corporation of Glasgow, as a Local Authority, resolve to apply to the Postmaster-General for a licence to supply the community with an efficient telephone service." As a result of their consideration of the subject, the Committee resolved to recommend that an application be made to the Postmaster-General in the terms of the foregoing motion, and on August 12, 1893, an application was made for the requisite licence "to empower the Lord Provost, magistrates and Council to establish a telephone exchange service within the city and royal burgh of Glasgow." That application was still before the Postmaster-General, and the Corporation had, both by correspondence and interviews with him, done everything they could to secure that their request should be acceded to, but up to the present time without success.

Sir C. CAMERON: Amongst the considerations which influenced you in making this application has been the very unsatisfactory state of the present telephone service ?—Yes.

Can you give as examples any cases in which dissatisfaction has been expressed ?—I have continually heard complaints from subscribers and others.

Sir JULIAN GOLDSMID: Is not complaining a Scotchman's privilege ?

Sir C. CAMERON (to the Witness): In the course of the interviews which you had with the Postmaster-General, I believe you referred to some cases in which subscribers had expressed their dissatisfaction ?—Yes. A friend of my own, who is a member of the Glasgow Corporation, was so dissatisfied with the continual impossibility of getting connection that, after putting up with it for a long time, he became so provoked that he just smashed the whole thing down. Others have done something of the same kind.

What are the chief complaints that the Glasgow telephone users make about the telephone service ?—The great delay and difficulty in getting into communication with the parties with whom they wish to correspond, the interruptions which occur during a conversation, and the sudden discovery that a third party—it may be an interested party—has been listening to your conversation, have produced a wide feeling of dissatisfaction. Only by the adoption of the twin-wire system can the present condition of affairs be improved; but that would be very costly, and it would involve giving the practical control of the public streets of the city to a private company, which, I think, would be intolerable, as it would involve interference with the various pipes, mains and conduits and underground apparatus belonging to the Corporation. Even if the all but insuperable difficulty with the Corporation as to the control of the streets was overcome, the present financial position of the Telephone Company would not warrant their making the necessary outlay.

As a matter of fact, the Telephone Company is very heavily capitalised, and that is what has prevented it from lowering its charges; whereas the Corporation can raise money very cheaply, and you could work the telephones practically at cost price ?—Yes.

Can you tell us what is the telephone subscription in Glasgow at present ?—£10.

Do you consider that that is a much higher charge than is conducive to the general use of the telephone ?—Yes; we feel satisfied that if it were reduced to a more moderate amount, it would be brought within the reach of the ordinary citizen. Ten years ago the subscription was £20, and at that time there were somewhere over a thousand subscribers. The reduction in price was made in consequence of the competition, and within the last ten years the number of telephone subscribers has largely increased, until now it amounts to between 3,000 and 4,000. The Special Committee took evidence as to Continental experience in Norway, Sweden, and Switzerland, where very much lower charges prevail, and they found that in Stockholm, with a population of 228,000, there were upwards of 8,000 subscribers, whereas in Glasgow, with a population of 814,000, there are not more than 3,500 subscribers. Judging by this and other experience, the Committee arrived at the conclusion that the Corporation could provide a thoroughly efficient twin-wire service for an annual charge of not more—and possibly less—than £5 per user, which would bring the advantages of the telephone within the reach of many who regard the present rate as prohibitory.

In the Agreement which has been entered into between the Post Office and the telephone companies, the rights of the Postmaster-General are expressly preserved, and you do not come here to say a word against it. What you want to protest against is the non-granting of a licence to the Corporation. Since the date of your application, have you had any official communication that your application could not be entertained ?—No.

Nor the smallest evidence that there was any change in the previous policy of the Post Office ?—No.

I believe the speeches of the late Postmaster-General, Sir James Fergusson, and Mr. Goschen, were, in your opinion and in the opinion of the Telephone Committee, calculated to encourage them in the belief that the Post Office was not about to adopt a policy of hostility to competition and to the granting of licences to municipalities ?—Yes.

And is it the opinion of the Corporation that the refusal of the present Postmaster-General to grant them a licence is responsible for the continuance of the present monopoly ?—It is. At the present time it costs the Corporation about £1,600 for the various telephone connections which they rent from the National Telephone Company.

As a pious opinion, are you in favour of the Post Office having the telephones ?—I am. All that the Corporation desire is to have a licence terminating at the same time as the licence of the Telephone Company, and then we should be prepared to set up a first-class service, and to enter into an agreement with the Post Office to hand it over to them if required on the most reasonable terms and without the object of doing more than covering our outlay.

Do the Telephone Company pay any wayleaves to the Corporation ?—No; they take our £1,600 a year, and do not pay anything for the right of crossing our streets and fixing their wires.

By Mr. MOULTON: He attached very great importance to the provision contained in the Telegraphs Act of 1892, which required that a telephone company should get the consent of a Local Authority before interfering with the roads, and he considered that the whole of the benefit of that provision was taken away from Municipal Authorities by reason of the telephone companies being able under the Agreement to require the Postmaster-General to connect its exchanges.

Mr. MOULTON: The Postmaster-General has not to get your consent, has he ?—I believe not.

Sir JULIAN GOLDSMID: Would he not come to your Municipal Authorities and endeavour to arrange ? I presume he would try to make an arrangement.—You will have to ask the Postmaster-General about that.

Sir JULIAN GOLDSMID: You know nothing about it ?—Clause 9 of the Act of the 26th and 27th Victoria expressly provides that the Postmaster-General shall not go under the streets without the consent of the Corporation, and under Clause 12 of the Agreement he cannot lay down telephone wires without the consent of the Authorities having the control of the streets. Therefore, Mr. Moulton's contention is worth nothing at all.

Mr. MOULTON: The powers of the Postmaster-General can be used for connecting exchanges.

Examination continued: In the Agreement between the Postmaster-General and the telephone companies there was no protection to the public as to the charges that should be made, and that was a most unsatisfactory state of things.

By Mr. BENN: Supposing that the Postmaster-General declined to grant a licence to the Corporation of Glasgow, they would very seriously object to the Agreement between the telephone companies and the Postmaster-General.

By Sir JULIAN GOLDSMID: He had not taken the trouble to make inquiries as to the number of complaints in proportion to the number of messages, but he could well believe that the number of telephone exchange calls per day had averaged 28,213 last year.

Sir JULIAN GOLDSMID: I am given to understand that the percentage of complaints is 3·79, so that that would not be an enormous number of complaints.

By Mr. TULLY: If the Glasgow Corporation obtained a licence, and the telephones became cheaper, he did not think the telegraph service would suffer in consequence.

By the CHAIRMAN: He was aware that the Telephone Company had come to terms with the Corporation of Manchester under which the Corporation were to do all the underground work themselves, and the Company were not to interfere with the streets at all.

Would not that be possible in the case of Glasgow ?—I do not think the Corporation of Glasgow would like that.

That would be possible as an alternative to a municipal system, would it not ?—It would be possible.

Councillor JAMES COLQUHOUN, LL.D., a solicitor practising in Glasgow, was the next witness examined. Having corroborated the evidence of the previous witness as to the unsatisfactory nature of the telephone service in Glasgow, he said that in his opinion the overhead system of single wires was entirely responsible for those difficulties, and that a more perfect system would not be obtained until the twin-wire system was adopted and the wires placed underground. Another reason which led the Corporation to apply for a licence was the trouble which the National Telephone Company gave to the Corporation in connection with the proposed introduction of electric motive power for the tramcar service. Not only did the tramways belong to the Corporation, but the tramcars were also being worked by them, and in their last Tramway Act power was taken to work the service by electricity. When the Bill was before Parliament, it was objected to by the Telephone Company on the ground that a system of overhead electric wires in connection with the tramways would affect their telephone wires, and they coolly proposed that the Corporation should be at the expense of providing for the necessary insulation, with the result that for the present, at any rate, the idea of an overhead electric system in connection with the tramways had to be given up. He knew of no good reason why a municipality should not get a licence for the working of the telephones, and work it just as efficiently as any private company which had obtained a license from the Postmaster-General. Whatever business became practically a monopoly ought, in his opinion, to be in the hands of the State or the municipality, and there could be no doubt but that the National Telephone Company, Limited, practically secured such a monopoly by the refusal of the Postmaster-General to grant any additional licences. The Corporation of Glasgow had a very large fund, out of which could be advanced whatever was necessary for a telephone installation; and a licence to the municipality would have this great advantage over a licence to a private individual or company: that the National Telephone Company could not buy them up as they had bought up all the other private companies and individuals who were fortunate enough to obtain licences. He believed that the granting of licences to Glasgow and other municipalities would at once lead to a considerable reduction in the charge for telephones, and also to a great increase in the number of those using them. If such licences were granted, he had no doubt but that all the municipalities would be found quite willing to co-operate with each other in having their exchange systems connected through the Post Office trunk line. No objection could be raised to the granting of a licence to the municipality of Glasgow on the grounds that it would create a new vested interest and increase the difficulty of the Post Office taking the telephone system into their own hands, as the licence for which the Corporation were applying could be granted so as to expire at the same time as the licence now held by the National Telephone Company. He did not see any difficulty in the way of exchanges belonging to the different licensees being worked in the same area. One advantage would be that a healthy competition would be introduced, the most approved instruments would be used, the rate would be moderate, the number of subscribers would become very great, and in all probability, if there was no interchange of messages between the exchanges, a subscriber could afford to subscribe to both. There could be no doubt but that the huge capital and large debenture debt of the National Telephone Company were a great hindrance to the introduction of a cheap telephone service. He looked upon the capital of the National Telephone Company as one of the monstrosities of the age.

Sir JAMES ALEXANDER RUSSELL, LL.D., a member of the Town Council of Edinburgh, who had filled the office of Lord Provost, said that during the last 13 years over £2,000 a year had been paid for telephones used in the service of the Corporation. At first the charge for the use of the telephone was £15 a year, and now it was £10 a year for each instrument within a half-mile radius from the exchange, with a supplementary charge of £2. 10s. for each additional half-mile. There were 1,420 subscribers in Edinburgh and Leith in a population of 340,000. He had never met any telephone user who was satisfied with the service. They complained not merely of delays at the exchange, but especially of indistinct speaking, and of hearing others than those with whom they wished to speak. He believed that many of these complaints would be removed by a twin-wire service. This, together with a more reasonable charge, would undoubtedly lead to an enormously increased number of subscribers, and would be a great advantage to the citizens. The National Telephone Company had a monopoly without the checks which Parliament usually put upon monopolies, and so long as this monopoly continued the community would suffer. Overhead wires were especially objectionable in such a place as Edinburgh, and although the Telephone Company paid considerable rents for leave to support their wires on the roofs of the houses, the public would not be satisfied until the wires were placed underground. The Corporation had great objections to any other body than themselves having the right to open the streets, and if an underground system were adopted while the monopoly remained in the hands of the National Telephone Company, the Corporation would be forced either to consent to the Company obtaining the power of using the streets or be in the invidious position of denying the use of the telephone to their fellow-citizens. The Corporation had always cheerfully consented to the Postmaster-General laying the telegraph cables under the streets, but they were few in number, and, consequently, the inconvenience was trivial; but the case would be quite different if hundreds of telephone wires had to be put underground. The Lord Provost's Committee had resolved to recommend the Council to apply for a licence to set up a municipal exchange in competition with that of the National Telephone Company, as they believed that the Corporation could provide a cheaper and more efficient service; they would have no other interest than the good of the citizens; they could obtain capital more cheaply than any commercial company, and they would not require to make a profit. As the owners of the water, gas, electric light, and tramway services, the Corporation had obtained entire control of the streets, and would resist to the utmost any attempt to interfere with that exclusive control. He greatly regretted that the Post Office had delayed so long in taking possession of the trunk lines; but he regarded inter-town communication as a minor feature of telephone service, its chief function being to provide communication between persons living within the same local area. Whilst he considered that the telephone ought to be taken over and worked entirely by the Government, he admitted that that alternative was not practicable in the present circumstances. There were only two alternatives—either to grant licenses to the Local Authorities or to take it into the Government's own hands. The former course was quite consistent with the Agreement and existing licence to the National Company, but the latter course appeared to be inconsistent with the Agreement. If, however, it should ultimately be found desirable that the Government should take the whole service into their own hands, there would be much less difficulty in arranging this with corporations, who would have no profit-making interest, than with private companies, who would have to relinquish present and prospective gains. In addition to this, the Corporation would have no interest in refusing messages coming from exchanges other than their own, and the telephone users had expressed their willingness, if necessary, to sacrifice the advantage of communicating by trunk lines for a good and efficient local service, and use the telegraphs for communicating with distant places. The Corporation promoted a Bill in 1893 for leave to use cable or electrical power on their tramways; and in the same year the Edinburgh Street Tramways Company had been put under obligations and restrictions as to the use of electricity for motive power at the instigation of the Telephone Company, and rather than submit to similar restrictions the Corporation dropped their electrical powers in consequence of the threatened opposition of the Telephone Company. In this way the Corporation were hampered in their action with regard to the conduct of their tramway system, and were practically restricted to cable motive power. The Telephone Company also opposed the Edinburgh Improvement Bill, and in the case of their electric lighting Order in 1891 the Corporation had to encounter the hostility of the Telephone Company, and were compelled to insert an onerous clause for the protection not only of the Postmaster-General's lines, but also of the telephone lines, which put the Corporation under serious obligations in the carrying out of their electric lighting powers, and inflicted great hardship upon them.

Bailie KINLOCH ANDERSON, another member of the Edinburgh Corporation, concurred in the views expressed by the previous witness.

Mr. GEORGE BISSET, City Treasurer of Aberdeen, and Chairman of the Committee which had charge of the interests of the Council in connection with the telephone service, and principally of the arrangements with the National Telephone Company for the erection of their wires, said the Town Council paid annually in subscriptions to that Company a sum of over £200. The telephone service had been largely taken advantage of in Aberdeen, and at present there were 1,000 subscribers in a population of 125,000. The telephone service in Aberdeen was wholly inadequate, or, to use the words of the Chairman of the National Telephone Company before the Select Committee in 1892, was "monstrously bad." The wires were all overhead and single wires, and in stormy weather they got into contact, with the result that the communications became interrupted and confused, and instead of the telephone being a benefit it became a nuisance. During the recent severe storms, the telephone in his office kept ringing almost continuously, and it was impossible to make any use of it. There was a great deficiency of district wires. If anyone wished to be connected through the exchange with another subscriber, he found, in the busy part of the day, half-a-dozen people speaking along the same wire to the exchange, and, in consequence of this, one had to call perhaps half-a-dozen times before getting connected with the right party. The staff in the exchange was also inadequate, and the service was much more costly than it ought to be. They had to pay £8. 10s. a year for a single-wire overhead system, whereas reliable estimates which had been obtained by the Corporation showed that the latest and best system could be laid down to serve everyone within the municipal area for a capital of about £6 per user, whilst an annual charge of £5, or perhaps less, would be sufficient to meet the cost of the service. It was hopeless in the present condition of the National Telephone Company to hope for a cheap or efficient service from them; and the Town Council were agreeable, if the Government desired to carry on the telephone service, to afford every facility to the Postmaster-General, but they would not consent to their property being interfered with by a private company holding a monopoly and earning large dividends. If the Government were not prepared to undertake the work of the telephone service, licences ought to be granted to the various municipalities with a view to putting the public in possession of a cheap and efficient telephone service. The Corporation of Aberdeen would be willing, if they obtained a licence, to agree to the conditions of surrender to the Postmaster-General which are laid down in the present licences granted by him.

Sir JOHN LENG, M.P. for Dundee, in answer to Sir Charles Cameron, said that in 1884 they had a company in Dundee whose charge was £20. This was much too high, and the leading merchants started a competing system, charging £10. The original company at once reduced its rates to £5, and the local company to £5s. 10s. The original company, with the £20 charge, only had about 30 subscribers, and the local company, when it started with its £10 charge, had about 80. The reduction of charges brought about a large increase of subscribers, particularly to the local company. When the companies were amalgamated the local company had 600 subscribers, and the other about 400. The local company, before being amalgamated, paid 9 per cent. for the four years they existed, and in the amalgamation the shareholders got their capital back, with 40 per cent. bonus. There were no complaints of the competing systems. The people were glad, and hoped it would continue. The increase of the charge from £5 to £10 caused a great many small traders and others to give up the telephones; but since then the number of subscribers had increased to almost what it was at the amalgamation. There were no strong complaints as to the service presently given in Dundee; but the service was very defective, being the single-wire system.

The CHAIRMAN said the Company were greatly extending their twin-wire system.

Sir JOHN LENG said it was most important that they should be extended in the city.

The CHAIRMAN: If the Corporation of Dundee got a licence they would be confined to the municipal area.

Sir JOHN LENG said he thought all the municipalities would confederate, and then the Government would probably place the trunk wires under such arrangements that the services in the localities would be such as the private companies give. There would be difficulties as to the places between municipal boundaries, but he thought it would be in the interest of the Telephone Company to come to the municipalities. The inhabitants of Dundee were strongly in favour of municipalisation of the telephone system, and he saw no reason why arrangements should not be made with the Post Office for the working of the telephones in large towns and cities without detriment to it as a national institution.

The Committee adjourned until to-day (Friday, April 5th.)

Electric Lighting in Vienna.—According to the report of the Austrian Allgemeine Electricitäts Gesellschaft of Vienna, for 1894, current was being supplied, at the commencement of this year, to an equivalent of 56,818 lamps (including 2,098 arc lamps), as compared with 41,193 lamps a year ago, the number of customers on the books being 1,058, an increase of 269 on the year. Electrical energy was also being supplied to 116 electromotors, this being an increase of 59 during 1894. The total length of the Company's mains now extends to 47¼ kilometres, 10 kilometres of new mains having been laid during the year. The net profit for the year amounts to £24,552, which admits of a dividend of 12 florins per share.

CORRESPONDENCE.

EARTHENWARE INSULATORS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The articles and correspondence in your recent issues respecting the use of salt-glazed earthenware, glass, stoneware, and porcelain for insulating high-tension conductors have greatly interested us, for we are the largest makers of porcelain for electric purposes. Important systems of bare copper conduits insulated by our porcelain are now working satisfactorily under very high voltage, and we have never heard of one instance of electrolysis.

The question, "What is porcelain?" has arisen. All porcelain may bear the generic term of "earthenware," but all earthenware is not porcelain. Porcelain is a non-porous vitreous body containing other ingredients than earthenware. Earthenware, as it is commonly understood, is porous, and is not vitreous. The vitreousness of porcelain is obtained by the fusion and chemical combination of silica, alumina, and some anhydrous salt of an alkali, at an extremely high temperature. The great heat (practically the melting point of the material) at which porcelain is fired, when the component parts are properly proportioned, combines them and renders the ware perfectly homogeneous and impervious to the passage of an electric current; thus it is not possible to decompose it. It is undoubtedly the best insulating material known, and has long since superseded glass. The latter has the great disadvantage of being hygroscopic, whereas our porcelain is not so. It can be used unglazed, and will act equally well as an insulator, although for the sake of cleanliness it is usually glazed. Many of the "ginger-beer bottle materials," sometimes called stoneware, depend on a salt or other glaze for insulation; chips or faults in the glazing, which are inevitable, render them useless, and it is obvious how dangerous it is to depend on this unreliable covering for the insulation of high-tension conductors.

Your remarks in your number of March 8th, contrasting the insulation of a telegraph with that of an electric light circuit, are quite true, and, as you say later on, there is no cause for alarm about the use of porcelain switches and other fittings. But the proportion of porcelain switches, fuse-blocks and other fittings in use is very small indeed. Almost all are made, for the sake of cheapness, of porous earthenware, depending upon a necessarily imperfect coating of glaze for whatever resistance it may possess. Some which we have examined are so porous as to absorb quite 10 per cent. of their weight of water in a short time. By far the greater number of the so-called china fittings in use are made of material which no telegraph engineer would think of using for his low tension circuits.—Yours, &c.,

Bullers (Limited).

Hanley, March 29, 1895.

THE USE OF "RECTIFIERS" IN CARDIFF.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am afraid that it will require a very much stronger argument than your correspondent, Mr. E. Price, is able to produce, to make me alter my judgment as to the advisability of using "rectifiers" under the conditions ruling in Cardiff. Whatever results may have been obtained at Portsmouth, here they are expensive and dangerous. The conditions at Portsmouth, however, are, I believe, quite different from those that rule here. At Portsmouth, I understand, the rectifiers are in the same building with the dynamos; here they are about a mile from the dynamos. I presume I need hardly point out that the difference in the conditions makes a great difference in the chances of successful working.

May I ask, however, whether at Portsmouth they have ever had the 40 arc lamps, fed by one rectifier, extinguished together for say 10min. to 15min.? That has been our experience in Cardiff only as late as last evening, 29th inst., and the occurrence is one of a series of such occurrences that have taken place at irregular intervals since the lamps were first started.—Yours, &c.,

Sydney F. Walker.

Cardiff Electrical Works, Cardiff.

LEGAL INTELLIGENCE.

Lewis v. the London Electric Supply Corporation (Limited).

This action was heard on Wednesday before Mr. Justice Charles and a Common Jury in the Queen's Bench Division. It was brought by Mr. Henry F. W. Lewis, an electrical engineer, against the Corporation, to recover £34. 12s., arrears of salary alleged to be due; and plaintiff further claimed damages for alleged wrongful dismissal. The statement of defence traversed the whole of the allegations of the statement of claim.

Mr. LAWSON WALTON, in opening the plaintiff's case, said that his client was an electrical engineer. In December, 1892, he was engaged by the defendant Corporation in the responsible and important position of general manager. At the time it was necessary, owing to critical financial position of the Corporation, that they should retain the services of a gentleman of exceptional ability and qualifications. Mr. Lewis was invited to offer his services, and he accepted the position, it being arranged that his salary should be £600 a year, or £50 per month. The engagement commenced in December, 1892, and continued throughout 1893, and right down to July, 1894, when the financial misfortunes which had been dogging the steps of the defendants overtook them. The debentures were in Lord Wantage's hands, and upon his application a Receiver was appointed, who in July last took possession of the works and assets. Lord Wantage came to the conclusion that it would be necessary for him to reduce the staff, and amongst those he decided to get rid of was the plaintiff, and accordingly he was informed that his services would be no longer required. Lord Wantage had offered the plaintiff £150, being three months' salary in lieu of notice, but the plaintiff felt that he could not accept it, as he thought that his remedy was against the Corporation. The question for the jury was what notice was a person in the position of the plaintiff entitled to receive.

Mr. JAMES STAATS FORBES, Chairman of the Corporation, gave evidence as to engaging the plaintiff as general manager in December, 1892. At the date of the engagement no notice for terminating it was stipulated for. The position Mr. Lewis had lost was difficult to obtain, and some time might elapse before he would secure another such appointment.

Mr. BANKES, for the Corporation, intimated that he should call no witnesses.

His LORDSHIP having summed up, the jury found that the plaintiff was entitled to six months' notice to terminate his engagement, and returned a verdict in his favour for £300, in addition to £34. 12s. for the arrears of salary.

Judgment was therefore entered for the plaintiff for £334. 12s., with costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

Tenders Invited.—The President of the Rangoon municipality will receive, not later than November 4th next, tenders for the lighting of Rangoon by electricity. Tenders have to be sent in to the Municipal Committee of the Rangoon municipality, Rangoon, India.

———— The Directors of the Lancashire and Yorkshire Railway invite tenders for the supply of the Company's ordinary requirements for the period of 12 months ending April 30, 1896. Tenders must be sent in to Mr. C. W. Bayley, secretary, Hunt's Bank, Manchester, not later than 10 a.m. on Monday, April 8th.

———— The Gas and Electric Lighting Committee of the Corporation of Leicester invite tenders for the supply of about 6,000 yards of high and low-tension cable. Tenders to Alderman Lennard, chairman of the Committee, not later than 11 a.m. on April 6th.

———— The Belgian Posts and Telegraphs Department, Brussels, invites tenders until the 10th inst. for the supply of a quantity of insulators, porous pots, galvanised iron wire, &c.

———— The Royal Portuguese Railways Company, of Santa Apolonia, Lisbon, is inviting tenders until the 18th inst. for the supply of 500 galvanised iron insulator supports, and a similar quantity of porcelain insulators.

———— The Corporation of South Shields invite tenders for a 10-ton hand-power overhead travelling crane for the electricity works. Tenders to be in by the 22nd inst.

Tenders Received.—The Llanelly Urban District Council have received a number of tenders, ranging from £6,000 up to £10,000, for the proposed lighting of the town by electricity. The tenders have been referred to.

Business Change.—Notice is given that the business of the Wray Electrical Engineering Company, of Soho Works, Thornton-road, Bradford, has been taken over by the Phœnix Dynamo Manufacturing Company, who will complete all existing contracts, pay and receive all debts, and carry on the business at the new and enlarged works at Hubert-street, Leeds-road, Bradford. Mr. Rankin Kennedy is manager of the new company.

Vacant Appointments.—The Asylums Committee of the London County Asylum, at Claybury (Essex), require a working foreman engineer to take charge, under the Asylums engineer, at a salary of £156 per annum, with house, coals and gas. Some further particulars are given in our advertisement columns, and the applications must be sent in not later than 9 a.m. on Monday, April 22nd, to Mr. R. W. Partridge, Clerk to the Asylums Committee, 21, Whitehall-place, London, S.W.

———— The Governors of the South-West London Polytechnic, Manresa-road, S.W., invite applications for the appointment of Head Master of the department of Mechanical Engineering, at a salary of £250 per annum. Some further information is given in our advertisement columns, and applications must be made not later than the 29th inst.

Agencies.—Messrs. Lea, Sons and Co., of Shrewsbury, have appointed Messrs. Francis and Spilsburg, of 20, Bucklersbury, London, E.C., as their agents for London and the Southern districts of England, and for Ireland.

———— The National Electric Engineering Company (Limited), of 2, Holborn-place, London, W.C., have been appointed sole agents for London and district for the "Demon" gas engine.

Personal.—Mr. A. A. King, who has been for some time past with Messrs. Poole and White (Limited), has been appointed representative in the northern provinces for Messrs. B. Verity and Sons.

———— Mr. Arthur F. Guy, who has for some time acted for the Boudreaux Dynamo Brush Company in this country, has been selected by Mr. W. H. Preece as clerk of the works for the electric lighting plant now being put down at the head post office at Manchester.

Dissolutions of Partnership.—The firm of Crozier, Mills and Co., of 58, Collingwood-street, Newcastle-upon-Tyne, electrical and engineering merchants and agents, has been dissolved. The firm is continued by Messrs. E. J. Crozier and W. J. Stephens, who will discharge all liabilities.

———— In reference to the Note in our last issue, dealing with the dissolution of partnership between Messrs. Sotheby and Ridout, we are asked to mention that the business will be continued by Mr. Ridout and others, under the style of Ridout and Co.

———— The partnership of Messrs. Newton and Co., electrical and optical instrument makers, of 3, Fleet-street, London, E.C., has been dissolved. Mr. H. C. Newton continues the business.

———— The partnership of Turner and Trille, electrical and mechanical engineers, Marathon Works, Don-street, St. Helier, Jersey, has been dissolved, the assets and liabilities and goodwill of the business being taken over by Mr. S. M. S. Turner.

Bankruptcies.—A receiving order has been made against Edgar Heyworth Berry, trading as E. H. Berry and Pope, electrical engineers and contractors, of 22, St. Matthew's-street, and St. James's Hall, Burnley, Lancs.

———— The discharge in bankruptcy of W. D. Gooch, electrical engineer, of 2, Willes-road, Kentish Town, London, N.W., has been suspended for three years.

———— A receiving order has been made against George Wade Share, trading as G. W. Share and Co., at 72, King William-street, London, E.C., in telegraph and telephone wire. The first meeting of the creditors takes place at 11 a.m. this day (Friday), and the public examination at 11:30 a.m. on the 30th inst., at Bankruptcy-buildings, Carey-street, London, W.C.

———— A meeting of the creditors of Samuel Elliott was held last week. The debtor attributes his failure to losses and expenses incurred in exploiting patents, and heavy law costs. It is expected that the total indebtedness will reach about £80,000. The debtor's business of joinery and moulding manufacture at Newbury was stated to be old-established and very valuable, and it is expected that a company will be formed for taking over the business as a going concern, with a view to the benefit of the creditors. Mr. H. W. Bayne, of 101, Leadenhall-street, London, E.C., was appointed trustee of the estate, with a committee of inspection.

———— In the statement of affairs in the failure of Walter Andreae and Co., electrical engineers, 132, Harlingham-road, Fulham, and 62, Vauxhall Bridge-road, the chief creditors are members of the Andreae family.

———— George Frederick Rogers, against whom a receiving order was made on the 4th ult., has submitted accounts showing his liabilities to be £27,983, of which £19,800 are unsecured, with assets £312, debts to the amount of £7,241 being returned as bad. The debtor is a telegraph engineer and general merchant, dealing in hardware goods. He states that he commenced business at 5, Great Winchester-street, E.C., in 1876, with £5,000 capital, his own money. He attributes his insolvency to liability on accommodation bills for which, he states, he received no consideration; to loss on trading and investments; to law costs, bad debts, and depreciation in the value of securities in the hands of creditors treated as partly secured. He admits that he became aware of his insolvency so far back as 1888, and the whole of his debts appear to have been contracted since that year. Mr. C. W. Meiter is trustee of the estate, with a committee of inspection.

Liquidations.—It has been resolved that the firm of Hughes, Sutton and Digby (Limited), electrical and mechanical engineers, be wound up voluntarily. Mr. E. J. Townsend, of 157, Fenchurch, London, E.C., is liquidator.

———— A meeting will be held at the Royal Hotel, Duke-street, Kilmarnock, on the 29th inst., at 12 o'clock, to receive an account of the winding up of McCulloch, Sons and Kennedy (Limited), electrical and mechanical engineers.

———— Mr. Frank Drury, of 11, Queen Victoria-street, London, E.C., has been appointed in the voluntary liquidation of D. W. Forbes and Co. (Limited), electrical and mechanical engineers. Claims have to be sent in to Mr. Drury by April 27th.

Allgemeine Electricitäts Gesellschaft (Berlin).—A general meeting of this Company is to be held on the 30th inst., when the question of a large increase in the capital of the Company is to be considered. The additional capital is required for the purchase of land on which to erect large new engineering works.

Lehmann Bros.—This is the new style of the old firm of Mr. T. Lehmann, of 38, Hampshire-street, Torriano-avenue, London, N.W., who is well known as the maker of the "British Association" Standard Screw Thread in taps, screw-plates, screws, electrical accessories, &c. Mr. Lehmann has transferred the business to his sons, both of whom have been in the business for some years past. The new firm ask for the continuance of the orders from the trade which have been enjoyed for so many years by the old firm.

Aluminium.—Mr. Carl Oppermann, of 2, Wynyatt-street, Clerkenwell, London, E.C., sends us his latest price list of aluminium, which he keeps in stock in pure ingots for casting purposes; in alloyed ingots containing from 3 to 5 per cent. of copper; in pure sheets, hard or soft, in various thicknesses; in pure rods up to 10ft. in length; in pure wire, in coils from No. 8 to No. 24; and in pure tubes from $\frac{1}{4}$in. to 2in. diameter. Mr. Oppermann manufactures a number of articles in aluminium. Accompanying the price list is some useful information regarding the manufacture of this metal.

Cooking by Electricity.—An illustrated interview with Miss Fairclough, who is well known in connection with electric cooking apparatus, appears in the *Young Woman* for April.

Catalogues.—We have received a couple of catalogues and price lists from Mr. G. Straus, relating to apparatus and accessories for telegraphs, telephones, and lightning conductors. These catalogues are well illustrated, and the contents are conveniently arranged.

Arlecdon and Frizington.—The report of Mr. J. S. Brodie, of Whitehaven, on the proposed lighting of this district by electricity, was before the last meeting of the Urban District Council. Estimates for three separate schemes had been prepared; one proposed to use the water power at the Cogra reservoir by means of a 9in. main; a second, to tap the same source with a 12in. main, and the third for the erection of a steam-power station at Steel Bank equal to the supply of all the public lighting, and 500 16-c.p. lamps for private consumers. The electric light, if used, will supplant the oil lamps now in use. The scheme is to be discussed at the next meeting of the Council.

Athens Permanent Industrial Exhibition.—The Department of Science and Art has received through the Foreign Office a copy of a note from our Consul at the Piræus, relating to a permanent industrial exhibition which has been organised by the "Société Biotechnique" at Athens, to be officially opened on April 28th. This exhibition, although intended only for native products, will be accessible to foreign exhibitors of such articles as may assist in the development of Grecian industries. All expenses connected with the exhibits will, however, have to be paid by exhibitors, who will, moreover, have to pay a tax of two drachmæ for each article worth 100 drachmæ. Articles worth more will be charged half a drachma per 100 in addition. The Committee of the Exhibition undertakes to sell the exhibits at a commission of 5 per cent. The exhibition will be open each year from March 13th to July 12th, and from September 27th to January 27th.

Bangor.—At the meeting of the Bangor City Council on Wednesday, the report prepared on the gas undertaking, by Mr. T. Newbigging, C.E., was discussed. Among other things, it advises the securing of additional land for the construction of a tank and gasholder. Mr. Newbigging considers that the circumstance that the gas concern was not self-supporting was not due so much to the deficiencies in the conduct of the works as in the large capital on which interest and sinking fund has to be provided. He has no faith in the electric light as a substitute for gas in a small town like Bangor, and the Council would, therefore, be well advised to make the best of their own gas undertaking. In the course of the discussion which followed, Mr. Richard Davies said there was reason to believe that Mr. Newbigging had been influenced in the preparation of his report. He had evidently received information from the gas manager. An amendment against the adoption of the report, and of certain recommendations of the Water and Gas Committee based upon it, was ultimately carried by a large majority. The Water and Gas Committee reported that they had had an interview with Mr. Duce, electrical engineer, whose offer was accepted to furnish a full report as to the means and cost of an installation of electric light plant suitable for Bangor. A suggestion had also been made to construct an electric tramway from the town clock to the proposed pier at Garth. A proposal was adopted authorising the Council to engage the services of a consulting engineer as soon as they received Mr. Duce's report.

Belfast.—At the last meeting of the Corporation, Mr. Alderman Pirrie moved the adoption of the report of the Electric Light Committee, and stated that they had 4,200 lamps actually on supply, and applications for an additional 1,100 were under consideration. The average total cost of their weekly supply was about £26. 10s., and the income about £27. 15s. The report was adopted.

Bolton.—In his report to the Gas Committee, Mr. Rider, the borough electrical engineer, recommends an extension of the electric lighting area, and the purchase of a new 300-H.P. Willans engine and a 180-kilowatt alternator. The proposed extensions will necessitate nearly 3½ miles of additional mains.

Bray.—Severe comment was made at the last meeting of the Township Board at the persistent opposition of the Railway Company to the proposal included in the Bray Improvement Bill. This opposition has been unsuccessful, and the Bill has, it is said, passed in its entirety.

Bristol.—The accounts, which have just been issued, of the working of the Bristol electric lighting scheme for 1894, show that the capital expenditure during the past year amounted to £32,200, bringing up the total capital expenditure to the end of the year to £82,186. The total maintenance and working expenditure for the year has been £6,168, and the credit £6,624, the amount carried to net revenue account being £4,506.

Burglary.—The publishing offices of *The Electrician* were broken into on Sunday night last, and although little damage was done, some remittances from our clients may be missing. If any remittance has not been officially acknowledged, the senders will oblige by communicating with the Publisher.

Calcutta.—Messrs. Kilburn and Co., agents for the Indian General Steam Navigation Company, at Calcutta, have, owing to several serious fires which have broken out on board some of the jute-laden flats in their occupation, decided to disuse oil lamps, and have put down a considerable electric lighting plant to facilitate loading and unloading at night. At a recent trial the effect of the light and the running of the plant proved most successful.

Chelsea (London, S.W.).—The Works Committee of the Vestry has received from the Surveyor a lengthy report on the lighting of the parish by electricity. The Committee are discussing the report, and will bring the matter before an early meeting of the Vestry. Offers have been received from the Chelsea Electricity Supply Company, and from the London Electric Supply Corporation, to supply current to the public lamps at the following rates :—£30 per annum per lamp for current for 15-ampere arc lamps, £25 for 12½-ampere lamps, and £20 for 10-ampere lamps, with £6 per annum per lamp for maintenance. An incandescent gas company have been asked to tender for the lighting of the public lamps, but decline to make any offer in regard to maintenance. The Surveyor to the Vestry points out that the question of maintenance in regard to incandescent gas burners is of vital importance.

Cheltenham.—Mr. Alderman Norman hopes to be able next week to invite the members of the Corporation to inspect the machinery at the electric lighting station, and within a month to give the public an opportunity of viewing the works. A handsome electrolier has been presented to the public library by Baron de Ferriers.

The Church House.—At the monthly meeting of the Council of the Corporation of the Church House, are port was presented by the Site and Works Committee respecting the arrangement of the electric lights in the Great Hall block now building, and the progress of which is considerably advanced. A large number of lights will ultimately be used to illuminate the building. The Committee's report was adopted.

Cork.—The relations between the Corporation and the local Gas Company are strained, and, unless the company are prepared to meet in a courteous spirit the suggestions made by the Corporation, the Chairman considers that it will be their plain duty to listen to overtures made by electric lighting companies. He announced at the last meeting that a letter had been received from Messrs. D. and G. Graham, of Glasgow, which it may be necessary to put before the Council for their consideration. Already many of the factories, mills and works in Cork and the neighbourhood are lighted electrically.

Dover.—The progress towards completion of the electric lighting works is now so far advanced that it has been decided by the Town Council to request the Board of Trade to send an inspector to make the usual inspection prior to the formal opening.

Ealing.—Last week the Local Government Board held an inquiry into the application of the District Council for sanction to borrow an additional £7,000 for electric lighting purposes. The money is required to discharge liabilities which had arisen in consequence of the very general adoption of the light.

Eccles.—The minutes of the Electric Lighting Committee, which were discussed at the last meeting of the Town Council, included a resolution which had been carried, appointing Mr. S. B. Clirehugh as electrical engineer to the Corporation, for the purpose of the preparation of a detailed scheme for electric lighting, to prepare the necessary plant, specifications, and estimates of cost. Mr. Clirehugh has accepted the appointment on the terms arranged. The Committee further proposed to make visits to Manchester, Wolverhampton, St. Pancras, and other stations, with a view to the acquisition of information regarding the working of these undertakings, but an amendment was carried that only Manchester and Wolverhampton should be visited ; otherwise the Committee's recommendations were agreed to.

Electric Launches at the Boat Race.—As usual at the Oxford and Cambridge boat race, the electric launch was in evidence, and the Battery and Motor Company, whose primary battery launch, the "Velvoca," we have previously referred to, inform us that the launch was chartered for the first time this season. The Company state that—"The boat had not been under cover, out of the water, or her battery removed, or in any way handled since she was launched last spring. The same set of zincs is in use that we had in during the closing part of last season ; they have remained in the batteries, and have not been re-amalgamated or handled in any way. At the beginning of the winter the boat was simply moored beside our landing stage, and remained there till required for use this spring, when she was cleaned up, charged, and at once taken out. Those who are acquainted with the amount of work that is necessary to be done to a storage launch will from this statement appreciate some of the advantages of our system."

Fire.—A destructive fire broke out on Tuesday morning at Cuba-street, Millwall, London, E.C., upon the premises of Messrs. J. G. Statter and Co. A large building, 112ft. long and 60ft. wide, used as workshops and stables, was completely destroyed. The cause of the fire is unknown.

Hampstead (London, N.W.).—The Electric Lighting Committee of the Vestry, at the last meeting, presented two recommendations on the subject of lighting by electricity the High-road, Kilburn, and it was finally resolved to inform the District Council that the Lighting Committee's estimate of the cost of necessary mains, lamp standards, and fittings for 24 arc lamps was £1,460, and that the cost of working and maintaining was £41 per lamp per annum, and ask the Willesden Council's contribution of one-half towards the estimated outlay and upkeep. A recommendation was further made for the extension of the present lighting area to the High-road, Kilburn (portion of), West End-lane, Haverstock-hill, Belsize-grove, and Belsize Park-gardens, at a total estimated cost of £5,260. The plans and specifications for the work have been prepared by Mr. Chattock, the Vestry's electrical engineer. The Chairman of the Committee stated that a very large number of applications for current had been received, one tradesman requiring as many as 1,000 lights. The Committee's recommendations were adopted, and the Vestry resolved to obtain the necessary testing instruments, &c., required for these extensions. A letter was received from Mr. W. H. Preece in reference to the resolution come to by the Vestry, and reported in our last issue. Mr. Preece pointed out that if it was intended that the Vestry's electrical engineer should superintend and carry out the plans submitted by him (Mr. Preece), or plans of which he approved, such a procedure was in accordance with his wishes, and he would continue to act as consulting engineer at a commission of 2½ per cent. on the cost of the work so carried out, but if it was intended that Mr. Chattock should prepare his own plans, submit his own estimates, and act irrespective of the writer, then he (Mr. Preece) must decline to act as consulting engineer on any terms. The letter was referred to the Lighting Committee, who will report to the next meeting of the Vestry.

Hull.—Mr. A. Gibbings, the Corporation electrical engineer, in a report recently published, recommends that additional plant be obtained from the contractors who supplied the original machinery, which has proved so successful. He recommends (and in this recommendation has the support of a sub-committee) that offers should be obtained from Messrs. Willans and Robinson (engines), Messrs. Davey Paxman and Co. (boilers), Messrs. J. H. Holmes and Co. (dynamos), and Messrs. Crompton and Co. (instruments, switchboards, &c.). Several members of the Electric Lighting Committee, however, wish that local firms may have an opportunity of tendering for the plant. When an amendment to this effect was put to the vote, an equal number of members voted for and against. Much valuable time will be lost at a period when such additional plant as is necessary should be in process of construction ready for the coming winter supply.

Kendal.—The Electric Light Committee of the Town Council have recommended that application be made for an electric lighting Provisional Order not later than 1897. The object of the recommendation appears to be an endeavour to anticipate the application of the Windermere Company to supply the district with electric current, and Mr. Monkhouse, a member of the Council, pointed out that when the Windermere Company's application came before the Board of Trade the Council would be asked whether they were prepared to supply the light, and the answer would have to be, "Yes, in two years." He thought the Board of Trade would say that there was a company ready to at once commence the necessary works, and he hoped that the Council would not put it in the power of the Company to say that they were fencing with the subject. Another member said that at the meeting of the Committee, at which the recommendation was approved, it was thought that if they could get a second year's respite it would be more satisfactory to those interested in the Gas and Water Committee!

Kidderminster.—At the monthly meeting of the Town Council, on Wednesday, the Improvement Committee reported that they had received a communication from Messrs. A. Dickinson and Co., consulting engineers, of Birmingham, to the effect that they had clients who were prepared to promote a Provisional Order for the construction of an electric tramway from Kidderminster to Stourport, and asking for the approval of the Council. The Committee recommended that, subject to the rights and interests of the Town Council being properly protected, they were disposed to give the scheme their favourable consideration.

Landing Rights for Atlantic Cables in America.—The *New York Law Journal* of March 23rd contains a full account of the appeal in the action De Castro v. the Compagnie Français du Télégraphe de Paris à New York. The defendant Company is organised under the laws of France, and had secured, by legislative Act of the State of Virginia, permission to land its cables in that State, and to acquire land for purposes in connection with the working of the cable. The plaintiff offered to procure for the Company the official sanction of the Federal Government, for which service he was offered a large sum of money. In the original action the Court held that the Federal Government had no power to either grant or deny the ratification of the action of the State of Virginia, and that therefore the Company was not liable to the plaintiff. The appeal was dismissed with costs.

Leicester.—Sir Courtenay Boyle has accepted the invitation of the Chairman of the Gas Committee of the Corporation, to visit Leicester on the occasion of the opening of the municipal electric lighting station.

Margate.—A conference was held recently between representatives of the Town Council and the Municipal Electric Light and Power Corporation, with the result that the Electric and Street Lighting Committee recommend that the Council give an undertaking to the Board of Trade that in the event of an Electric Lighting Provisional Order being granted to them next year, the work of installing the light for public and private use shall be proceeded with forthwith. The Council have already acquired a suitable site for a supply station. The recommendations of the Committee were adopted, and the assistance of an expert is to be obtained to advise the Council.

Mill Lighting.—Mr. W. R. Brown, of Macclesfield, has secured an order to instal plant and light the bridgewater at Walkden, near Manchester. Nearly 500 16-c.p. lamps will be required, the machines to be used being of Mr. Thomas Parker's latest type.

Newport (Salop).—At the last meeting of the District Council it was unanimously resolved to inquire into the desirability of either acquiring the undertaking of the local gas company or of introducing an electric lighting scheme for the town. General complaint was made against the present excessive charge for gas, which is 4s. 6d. per thousand in the district.

Obituary.—The remains of Mr. Thomas Richard Harding, J.P., head of the firm of T. R. Harding and Sons (Limited), of Tower Works, Leeds, were interred on Tuesday last at Doddington, Yorks. Mr. Harding was much respected, and the funeral procession was headed by over 100 of the employés at the Company's works.

Portsmouth.—The complete extension of the Electric Lighting Committee has been unanimously adopted by the Corporation. The following is the estimated capital outlay required for the extensions:—Cables (high and low tension), £6,417; three-way ducts (stoneware), £4,506; lamp columns, fittings, &c., £1,831; transformers, junctions, and drawing-in boxes, £2,775; rectifiers, switches, &c., £1,375; contingencies, £1,096—total, £21,000. Mr. George Ellis, in presenting the scheme to the meeting, said there was no doubt that the large extensions they had now decided upon would bring such an influx of customers as to warrant considerable reduction in the charges at an early date. If the demand was increased from their present total of 7,000 to 10,000 16-c.p. lamps, it would immediately justify a reduction to 4½d. per unit, and if a further increase to 14,000 lamps should ensue, current would be supplied at 4d. per unit. The Committee at present, however, proposed that a reduction of 1d. per unit for current for private lighting should be made, the alteration to commence as from September 29th next, this to be accompanied by a reduction of £2 per lamp for public lighting. The following thoroughfares are included in the extensions:—Alexandra-road, Cambridge-road and Edinburgh-road (linking existing lighting); Commercial-road to Stubbington avenue, Buckland-road, Fratton-road, Lake-road, Arundel-street, Fratton-street, Russell-street, St. James's-road, Brougham-road, Cottage-grove, Grove-road, Somers-road, Kent-road, Marmion-road, Victoria-road, Albert-road, Fawcett-road, Clarence-parade (terminating at the junction of Clarendon and Burgoyne-roads), from Infectious Hospital to Asylum (incandescent only).

Railway Station Lighting.—A new local station has just been completed by the Great Northern Railway Company at King's Cross, London, N.W., from plans prepared by and under the supervision of the Company's chief engineer, Mr. R. Johnson. The new station is to be lighted throughout by electricity, current being obtained from the Company's supply station at Holloway. The electric lighting of the extensive Finsbury Park station is approaching completion, current for this station being also supplied from Holloway. The work of installing the electric light at the Company's Hornsey station is also in progress.

Rochdale.—The Electric Lighting Sub-Committee of the Town Council have reported adversely on the proposal to light the public buildings of the town by electricity. The subject, however, is likely to be further discussed at a future meeting of the Council. The report on the subject was drawn up by Mr. S. S. Platt, the borough surveyor, the chief objection to the carrying-out of the work being its expense.

Rottingdean.—At the next parish meeting it is proposed to discuss the question of the lighting of this village, which adjoins Brighton, by electricity.

Salford.—It is stated that in about a month, progress with the electric lighting works will be sufficiently forwarded for a test to be carried out. The plant which the Corporation are installing is estimated to provide current equivalent to 12,000 8-c.p. incandescents, and there is room for expansion at the station in Walness-road. Mr. Turner is the Corporation's electrical engineer who is superintending the works during construction, and will, on completion, take charge.

Shoreditch.—At the meeting of the London County Council on Tuesday, the Finance Committee recommended:—That the application of the Shoreditch Vestry for a loan (among other amounts) of £930 to provide an enlargement of the site for an electric lighting station, be granted at the rate of £3. 10s. per cent. per annum, the principal being repaid by half-yearly payments within a period of 54 years.—The recommendation was adopted.

Southport.—Mr. Rienzi Walton, C.E., held a Local Government Board inquiry at Southport, on Wednesday, respecting the application of the Corporation to borrow £15,500 for electric lighting, and £7,000 for other purposes. This sum will enable the Corporation to overtake the unexpectedly heavy demand for current for private lighting, and to sanction certain extensions. The Town Clerk said that the electric light loan would be for a period of 25 years. There was no opposition.

St. Pancras (London, N.W.)—It has been decided by the Vestry to construct another sub-station, to be situate in the Highgate main road. At the last meeting of the Vestry the Chairman of the Electrical Committee announced that the working of the Vestry's electric lighting undertaking for the past year, to December 31st, had resulted in a profit of £1,700. At an estimated cost of £621 the Vestry have decided to lay mains in Oakley and Ampthill squares and Judd-street, in order to meet the demand for current in these thoroughfares.

St. Saviour's, Southwark (London, S.E.).—The handsome block of public baths and washhouses which have been erected in Lavington-street are now completed, the total cost having reached £40,000. The buildings are lighted throughout by electricity, the installation having been carried out by Messrs. Strode and Co., of 48, Osnaburgh-street, London, N.W., who have put down a Siemens dynamo, which is used for charging a battery of 55 "D P." accumulators of Messrs. Johnson and Phillips's make. 237 lamps are supplied with current equal to nearly 5,000 c.p. Electroliers, in keeping with the fittings in the buildings, have been put in by Messrs. Strode and Co., and the installation is very complete and effective. Steam power is supplied by two of Messrs. Marshall, Sons and Co.'s engines, one of which is used for driving a Siemens dynamo and the other for working the laundry machinery.

Telegraph Clerks' Grievances.—A mass meeting of telegraph clerks of the Midland counties was held on Wednesday evening at Birmingham, to "express keen disappointment at the refusal of the Postmaster-General to remedy the grievances of the service," and pledging the meeting to endeavour to bring about the abolition of classification and the introduction of a more adequate scale of pay. It was also resolved that "the present condition of the telegraph service imperatively demands an inquiry by Royal Commission."

Telegraph Tariffs in Turkey.—A uniform tariff for telegrams in the Turkish Empire has been drawn up by a specially-appointed commission in Constantinople. The project has been submitted to the Turkish Posts and Telegraphs Department.

Torquay.—On Tuesday the Electric Lighting Committee submitted to the Town Council a special report, by Mr. W. H. Trentham, on the proposed lighting of the town by electricity. Mr. Trentham's estimate of cost for plant and apparatus, including interest and sinking fund, is £5,628, or, for a slightly enlarged scheme, £7,986, with an estimated annual expenditure of £1,138, which is calculated to show a profit of nearly £100, in addition to providing steam for use at the baths. In discussing this report, it was pointed out that the Gas Company had already taken time by the forelock, and reduced the price of gas. As the report had not been before the Council a sufficient time to admit of discussion, it was referred back to the Electric Lighting Committee for further consideration.

Treeton (near Rotherham).—At the last meeting of the Parish Council it was resolved to adopt the Lighting Act. The Chairman stated that, as steam-power was available, the Council were in favour of lighting the parish by electricity.

Wells.—Owing to friction between the Town Council and the local Gas Company, the former body recently decided to give all possible facilities to Mr. A. D. Dixon Brown in his proposals for lighting the district by electricity. This step has brought the Gas Company to its senses, and it is now stated that an offer to continue the public lighting of the town for £350 per annum has been made, but that the Council have decided that it cannot be entertained.

Whitechapel.—On Monday last the adjourned discussion on the proposed extensive electric lighting scheme was resumed by the members of the Vestry, and after a long and important debate the scheme was referred back to the Streets Committee for further consideration. The chief point raised by the objectors to the scheme was that the total cost was uncertain, and that the revenue to be derived from the supply of electric current to possible consumers was problematical, and had not been even approximately ascertained. It is understood that those members in favour of the scheme are taking steps to surmount these objections, and it is probable that the subject will again come up for discussion on an early date. Several of the members of the Board are enthusiasts on the subject, and are convinced that a comprehensive scheme would result in a satisfactory surplus over expenses.

Worcester.—The contest over the bill for extras presented by the contractor in connection with the erection of the Powick electric generating station has been settled. It will be remembered that the matter was referred back to the Electricity Committee, and the Town Clerk now advises the Corporation that, as there was no suggestion of fraud on the part of the Surveyor, the Council were obliged to pay the contractor's charges, as they had been certified as correct by that official. The report was ultimately adopted.

COMPANIES' MEETINGS AND REPORTS.

The Direct Spanish Telegraph Company (Limited).

The forty-third ordinary general meeting of this Company was held on Friday at the offices, Winchester House, Old Broad-street, under the presidency of Mr. Edmund Etlinger.

The MANAGER (Mr. Charles Gerhardi) read the notice calling the meeting, and the minutes of the last general meeting, which were signed by the Chairman as correct.

The CHAIRMAN: Before I comment on the report and accounts, I wish to state that our Chairman is unavoidably absent on business. He intended to arrive home last night on purpose to attend this meeting, but he has been detained in Paris on business, and I have therefore been asked to preside. You have the accounts before you, and you will see by them that, after making provision for debenture interest and debenture redemption fund, there is a balance to the credit of revenue of £4,076. You will probably also notice that this balance is not one that we could exactly wish; it is smaller than we have been accustomed to. In the corresponding half of 1893 we had £4,996, and therefore the balance is now less than that by £919. This state of things does not arise from our expenses having increased in any way; on the contrary, our total expenses, after making provision for the redemption of debentures and debenture interest, are £348 less than they were in the corresponding period of 1893, and they would have been less still had it not been for some exceptional items which you find in the revenue account. One of those items is "Removal of superintendents of stations, £88." That arises from the necessity we felt under of making a change in some of the superintendents from one office to another, and one gentleman, in fact, has left us. Another item is £117 for interest and exchange. You will probably remember that that item has always stood on the credit side of the account, but this time it is on the debit side, for a reason I will explain presently, when I am dealing with the balance-sheet. I may say that, owing to the large amount of money due to us throughout the half-year under review, we were obliged to find money on this side to carry on with, until such time as the money arrived from abroad. Since the report was written the money has arrived. A third item of expense has been in connection with the issue of our debentures—£31; but the cost of this issue will be spread over 5 years, so that this item will disappear in four years more. The reason our balance is less this time is entirely owing to the fact that the traffic has been poor. Our total receipts (I include them all, because only £5. 17s 6d. has been received in transfer fees, in addition to the traffic) amounted in the past half-year to only £10,477 as compared with £11,746, showing a falling off of £1,268. The reason why the traffic has been so small brings us back to the unfortunate phrase we have had to use for the last three or four years at our meetings—"depression of trade." Trade has continued bad, and consequently telegraphy has suffered. When I had the pleasure of addressing you last September, I mentioned that the receipts for that month showed a vast improvement, and that was the case, and I was bold enough to say that I hoped that that would prove to be the commencement of better things. Unfortunately, I was wrong. The traffic for September, as I said, was good: but it turned out bad in October, November, and December, and we have therefore suffered this diminution in our receipts. I may, however, as well say now—although I do not wish to prophesy, having burnt my fingers by doing so last time—that at the present moment things have improved. That is to say, last January we only lost £31 in our traffic receipts as compared with those for the corresponding month of 1894, and in February there was a reduction of £8, but in the present month we have a surplus of £485. I need hardly say that if that surplus continued we should soon be in smoother water, but whether it will or not I will not prophesy—I will only say that I hope it will. Turning to the balance-sheet, the amount outstanding due to us, on the credit side, on December 31st last, was £41,595. For a small company that is undoubtedly a large amount, but I will explain how it arose. It is larger than we have been accustomed to see. I may say that the payments we receive from abroad are not always quite punctual, although they have always been fairly and reasonably dealt with. At the end of 1891, by some accident, there was more due to us on traffic than was ever the case before; and you will see by the footnote we have appended to the balance-sheet that of this amount £22,459 has been received since the date to which the accounts were made up. If that amount had been received a few weeks earlier, the sum shown of £41,595 would have been reduced to about £19,000. I must also state that in that sum of £41,595 is included the amount chargeable by us to the harbour authorities at Bilbao for removing the cable from the position in which it was originally laid to another spot in order to avoid a breakwater which they were building. That was fully explained at the last meeting. Since then this matter has been pushed, but we do not expect an immediate settlement, it being the custom in that country for the Government first to decide whether the Harbour Board is liable at all. Once that is decided, however, we proceed in the usual way, but if the Government has to make up its mind it takes time. The item also includes an amount for the repair of the Bilbao cable. I will refer to this repair again specially in a moment. It occurred, I may say, at the end of the year. On the other side of the balance-sheet you find the counter entry of "outstanding liabilities," which, of course, is also proportionately larger. It stands this time at £24,547, while the year before it figured for only £14,900. That arises from the same circumstance as that which I mentioned just now regarding the outstanding accounts due to us, because if the foreign Administrations do not pay us, we do not pay those to whom we owe money. The moment we receive payment from abroad we distribute it to the parties who are entitled to the money, and you will find that a footnote appended to the balance-sheet regarding this amount states that since the date to which the accounts were made up £13,246 has been paid. In addition to that, we have paid off the item on the debit side of the balance-sheet of temporary loan, £6,500. That loan we had to obtain for the simple reason that money due to us was not coming in. It is now, however, as I have just said, paid off; and, in fact, the liabilities are paid off all but the £13,000, which is our usual figure. I mentioned just now, in dealing with the credit side of the balance-sheet, that the outstanding accounts due to us included an item for the repair of the Bilbao cable. I do not deal with the figure, as there is a reason for not doing so. I do not know if you read about it in the papers, but it appears that last November a ship which was trying to get into Bilbao fouled our cable with her anchor, and our cable was broken. It had to be repaired, of course, and that has been done. You may also have noticed from the papers that an action was brought by us against the owners of the ship in question, the "Caloric," for recovering the amount of the damage done. The action has been tried since our report was in type, and has gone against us. That action is very important, not only to us, but to all who are connected with submarine telegraphy, and I hope it will be widely read by everyone interested in telegraphy, because it establishes certain things by authority of law which I think were not laid down before. I will not comment on the case, as I am not prepared to say that the matter has yet been finally settled. If anyone is interested in the case he will find, as far as I know, the fullest report of the proceedings and the evidence in the *Shipping Gazette* and *Lloyd's List* of the 21st of this month. It is worth getting by everyone who is connected with telegraphy. I do not know that there is anything more in these accounts that you would wish to hear any observations upon. I do not know if any shareholder has compared this balance-sheet with the one for 1893. In that case a great difference will have been noticed between the two, because in 1894 we paid off £62,000 of debentures. To do that we made a call of £1 a share on all the Ordinary shares, amounting to £12,931; and the difference we arrived at by taking a certain amount from the reserve fund and by issuing £30,000 of new debentures, bearing the reduced rate of interest of 4½ per cent., the old debentures carrying 6 per cent. If, therefore, you compare the balance-sheet of December 31 last with the balance-sheet of the year previously, you will find that we are in a different position, as the ordinary share capital has been increased by the call, the debenture debt has been reduced by £32,000, and the reserve fund has been reduced by the amount we took off. Otherwise we find nothing in the balance-sheet worth while making any observations on. With these remarks I will move

"*That the report and accounts now presented be, and are hereby received and adopted.*"

Mr. J. DENISON PENDER seconded the motion.

The CHAIRMAN invited discussion, but no shareholder rising to address the meeting, he put the motion, which was carried unanimously. Continuing, he said: The next resolution relates to the dividend. I should have said that we have added to the balance of profit a sum of £1,166, which we have taken from interest on investments. We generally carry all that to the reserve fund, and we have done so on the present occasion; but that portion of the reserve fund which is represented by interest on the investments is available for the equalisation of dividends, as well as for other purposes. Therefore, if we put that interest to the reserve fund in good years, we are entitled, in unfavourable years, to use a portion for equalising our dividends. We have therefore added that £1,166 to our balance. We have transferred £2,500 to the reserve fund, which we do every half-year, and we now propose to declare the dividend of 10 per cent. per annum on the Preference shares, less income tax, and a dividend at the rate of 4 per cent. per annum on the Ordinary shares, free of income tax. He then moved the following resolution:—

"*That the dividend at the rate of 10 per cent. per annum (less income tax) on the Preference shares, and a dividend at the rate of 4 per cent. per annum (free of income tax) on the Ordinary shares, both for the half-year ended December 31, 1894, be and are hereby declared.*"

Mr. PENDER briefly expressed his pleasure in seconding the motion, which was carried unanimously.

The CHAIRMAN: The third resolution refers to the reappointment of the retiring directors, and I have great pleasure in proposing it:—

"*Resolved, that Sir John Pender, G.C.M.G., M.P., and Mr. J. Denison Pender, be and are hereby re-elected Directors of the Company.*"

I need not add anything to that, I feel sure.

Mr. JOHN GLOVER seconded the motion, which was carried unanimously.

Mr. GEORGE DRAPER next proposed—

"*That Messrs. Deloitte, Dever, Griffiths and Co. be, and are hereby re-elected Auditors for the present year with a remuneration of 20 guineas.*"

Mr. HIBBERDINE seconded the resolution, which was unanimously carried.

The CHAIRMAN having intimated that that closed the business of the meeting,

Mr. DRAPER proposed a vote of thanks to the Chairman and Directors. Mr. Etlinger had, he observed, been reluctant to make any promise with respect to the current half-year, but he thought that, with such a Board, and with the present management, they might feel that the prosperity of the Company was assured.

Mr. CROWE seconded the motion, which was unanimously carried.

The CHAIRMAN: I beg to thank you on behalf of my colleagues and on my own part. With reference to the remark of Mr. Draper, I can assure him that nothing is left undone by the Directors and our excellent manager, Mr. Gerhardi, to pick up all the traffic that comes in our way.

The proceedings then terminated.

Altrincham Electric Supply Company (Limited).

The first annual meeting of this Company was held last week at 33, Brazennose street, Manchester. Mr. F. B. Ross presided.

The SECRETARY (Mr. J. E. Sharples) submitted the report of the Directors, which states that the public lighting of Altrincham and Bowdon was commenced on January 1st, and had proved in every way satisfactory.

The CHAIRMAN, in moving the adoption of the report, said that the work of laying the mains was begun in September, 1894, and at Christmas the three feeding centres (Old Market place, St. Margaret's Church, and Old Bowdon Church) had been connected with the Broadheath generating station. The total length of cable laid was upwards of 14,000 yards. A gratifying amount of support had been accorded by the public, and the light had given general satisfaction. At present there was connected an equivalent of 2,552 8-c.p. lamps. They estimated that before the commencement of the next lighting season the number would be at least 5,000. That would be sufficient to pay all the expenses of the undertaking, and then they might begin to think of dividends. Much opposition had been experienced from the gas company. He did not see that the gas company would suffer by this Company's success.

Mr. W. P. J. FAWCUS seconded the resolution, and said he had no doubt that when they got more customers they would be able to reduce the price for current. There was no reason why electricity should not be produced cheaper than gas, and he looked forward in a few years to the price being reduced from 7d. to 4d. per unit. At the latter rate it would be much cheaper than gas. At present the cost of coal was a little over ¾d. a unit, as compared with 1½d. in Manchester; but they expected that when certain appliances were brought into use, they would be able to reduce the cost of coal to about ½d. per unit.

The report was adopted.

Messrs. F. B. Ross and W. P. J. Fawcus were re-elected Directors, and the meeting terminated with a vote of £100 to the Directors as remuneration, and of thanks for the satisfactory working of the Company.

Sheffield Electric Light and Power Company (Limited).

The fourth annual meeting of this Company was held at Sheffield on Wednesday, Alderman G. Franklin presiding.

The CHAIRMAN, in moving the adoption of the report, said they began the year with a balance of £585. To that they added a small balance from the suspense account, and the profit for the year was £1,943. That gave a total profit of £2,675. This amount had been reduced by the payment of interest on debentures by a proportion of the formation expenses written off, £202; and the transfer to the depreciation fund of £1,250. The shareholders would see that these sums, which the Company had to pay out of profits, absorbed £2,143. 11s. 10d. and left only a balance of £531. 17s. The profit for the year 1893 was only £830, whereas last year it was £1,943. In 1893 no provision whatever was made for depreciation, and it came to be a serious question whether they ought not, once and for all, to tackle the question of depreciation of machinery, in order to put the finances of the Company on the soundest possible basis. At the end of 1892 the number of 8-c.p. lamps wired was 7,734, at the end of 1893, 8,419; and at the end of 1894, 15,672. Current sold in 1892 was 122,000 units, in 1893, 131,000 units; and in 1894, 192,000 units. The revenue was in 1892, £2,823; in 1893, £3,555; and in 1894, £4,850. The best test which the shareholders could have with regard to the prosperity of the concern was that the consumers who had taken a few lights were taking more lights. The capital expenditure during the last year amounted to £17,251, as against £19,689 in 1893. A large portion of that money had been spent in the extension of the Company's mains out to the west-end and forward to Ranmoor, and the Directors were now proposing to lay further mains along the Clarkehouse-road, and into the district of Broomhall Park. Notwithstanding the fact that there was to be no dividend paid this year, there was the fact that a dividend had been earned. With regard to the very regrettable interruptions in the supply of current which occurred in December last, as was explained at the time, they were entirely due to the failure of the plant which had been supplied by one of the contractors to do that which it was purchased to do. Since that time the firm of contractors had agreed to make that plant efficient, and as far as they could had done their best to do so. In addition to that, a new set of plant, capable of producing more than the whole of the other machinery put together, was installed in December. Another plant of equal size had been ordered, and it was to be delivered during the summer. In considering the question of electric light, and its great competition with gas, it must be remembered that the electric light in its infancy was competing with gas in its old age.

The adoption of the report was unanimously agreed to, and the remuneration of the Directors, exclusive of the Managing Director, was fixed at £240 per annum. Messrs. George Senior and William Tasker were re-elected as Directors, and Messrs. Shuttleworth as auditors, and the meeting terminated with a vote of thanks to the Chairman.

Willans and Robinson (Limited).

The following report of the Directors of this Company will be submitted at the general meeting, to be held at the Cannon-street Hotel, London, E.C., on Wednesday, the 10th inst., at 3 o'clock:—

The Directors state that the business of the Company continues to increase in a satisfactory manner, as shown by the following figures:—

Indicated horse-power of engines ordered in 1893 (old Company) 18,950
Ditto ditto ditto 1894 26,624

The orders for 1893 greatly exceeded those for any previous year of the old Company's existence.

After writing off £2,870 for depreciation, and providing for interest upon the debentures, the balance to credit of profit and loss for the half-year is £8,520, and the Directors propose that the full interest upon the Six per Cent. Preference shares be paid, and a dividend at the rate of 7 per cent. per annum upon the Ordinary shares (the same as last half-year) be declared, together amounting to £6,006; £1,760 is proposed to be carried to the reserve fund, raising this to £2,646. 9s. 11d. The sum available would be sufficient to pay a dividend upon the Ordinary shares at the rate of about 11 per cent. per annum, but the Directors feel sure of the concurrence of the shareholders in the view that, at this early stage of the new Company's business, the rapid building up of a substantial reserve fund is an object of greater importance than the payment of high dividends.

Owing to unavoidable legal delays, the Company has only recently acquired possession of the site selected at Rugby for the extension works; there is, therefore, little probability that the new works will add to the Company's facilities for producing engines during the present year. Pending the completion of these new works, the business is necessarily carried on under disadvantages which act very unfavourably upon cost and, therefore, upon profits. The restricted space at Thames Ditton, and the limited number of tools available, in proportion to the increasing business, make that increase a matter as much of embarrassment as of gain. It is nevertheless a fact full of encouragement for the future. As a temporary measure, premises have been rented at East Molesey for the storage of patterns, &c. Orders have been taken for some of the Company's water-tube boilers (Niclausse's Patent), which are now in course of manufacture at Thames Ditton; but any large development of this business must be postponed until the works at Rugby are completed.

NEW COMPANIES, STATUTORY RETURNS, &c.

RAND CENTRAL ELECTRIC WORKS (LIMITED).—This Company was registered on March 30th, with a capital of £300,000, in £1 shares, to carry on the business of generators and distributors of electric energy for the purposes of light, heat, motive power, and otherwise, at the Witwatersrand, and elsewhere in South Africa; to supply electric energy to mines and other properties situate in or near the same district, and for that purpose to enter into, and carry into effect, two agreements to be made with Messrs. Siemens and Halske, of Berlin, and to carry on the business of an electric light and power company in all or any of its branches, electricians, electrical and mechanical engineers, suppliers of electricity, and manufacturers of, and dealers in, all apparatus and things required for, or capable of being used in connection with the generation, accumulation, supply, and utilisation of electricity. The subscribers are—

	Shares.
Sir C. Rivers Wilson, G.C.M.G., C.B.	1,000
Max Michaelis	1,000
Maximilian Rapp	1,000
Percy Tarbutt	1,000
August Parsdorf	1,000
Sigmund Neumann	1,000
Alfred H. Marker	1,000

The first Directors are to be appointed as follows: One by Messrs. Siemens and Halske, one by Edward Lippert, of Johannesburg, one by each person who shall have allotted to him £50,000 of the original capital of the Company, and shall subscribe in cash, and the remainder (if any) by the abovenamed subscribers.

SCOTTISH HOUSE-TO-HOUSE ELECTRICITY COMPANY (LIMITED).—An agreement has been made with Angus Macleod, which states that whereas he applied for 1,200 shares of £5 each in the Company, and paid a deposit of 10s. per share on the same, the circumstances under which such application was lodged rendered it just that he should have his name removed from the register of the Company in respect of these shares, and 120 fully-paid-up Ordinary shares have been allotted to him in lieu of thereof.

SUNBEAM LAMP COMPANY (LIMITED). The annual return of this Company, made up to February 14th, has been filed. The nominal capital is £25,000 in £10 shares, and 1,620 of these have been taken up. Of these, 857 have been issued as fully paid, and the full amount has been called on each of the remaining 763, resulting in the payment of £7,600.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—The annual return of this Company, made up to March 12th, has been filed. The nominal capital is £448,200 in £12 shares, and 37,350 have been taken up, allotted, and £448,200 has been received.

UNIVERSAL ARC LAMP SYNDICATE (LIMITED).—The return for 1894, made up to December 31st, and the return for 1895, made up to March 4th, have just been filed. The capital is £3,000, in shares of £1 each, and 2,865 of these were subscribed for and allotted. A call of 2s. has been made on each share, and £277. 10s. has been received.

CITY NOTES.

BRITISH GUIANA.—The report of the Directors of the British Guiana Electric Light Company shows that up to the end of December last the total revenue for the previous half-year was $19,199 against $15,620 for the corresponding period of 1893. Expenditure represented $13,074, leaving a profit balance of $6,124, equal to nearly 11 per cent. on the share capital. The great demand for the electric light in the district supplied by the Company necessitated the putting down of new plant, estimated to cost £4 800.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended March 31st were £932, as against £843 in the corresponding period of 1894, being an increase of £89. The total receipts for the half-year amount to £12,648, against £12,035 for the corresponding period of 1894, an increase of £613.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts for the month of March, 1895, amounted to £2,388, as against £1,800 in the corresponding period of last year.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The Directors of this Company have resolved upon the payment of an interim dividend of 2s. per share, free of income tax, being at the rate of 2 per cent. per annum, for the quarter ended March 31st, the dividend to be payable on and after April 24th.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of March, 1895, amounted to £70,470, against £57,677 in the corresponding period last year.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The accounts of this Company to December 31st last show, subject to audit, a balance of profit of £170,936. 15s. 9d., after payment of three interim dividends. The Directors now propose to distribute on May 2nd prox. the usual dividend of 2s. 6d. per share, making a total dividend for the year 1894 of 5 per cent., together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year. The share register will be closed from the 24th inst. to May 1st prox. The traffic receipts of this Company for the month of March, 1895, amounted to £40,942, and to £38,923 in the corresponding period of last year, being an increase of £2,019.

——— In our advertisement columns will be found a list of the numbers of 389 Five per Cent. Australian Government Subsidy Debentures of £100 each, which were drawn by lot on the 1st inst., and will be paid at par on July 1st next at Messrs. Barclay, Bevan and Co.'s, 54, Lombard-street, London, E.C.

GLOBE TELEGRAPH TRUST COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend of 3s. per share on the Preference, and 2s. 3d. per share on the Ordinary shares.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of March amounted to £23,600. The total receipts from January 1st to March 31, 1895, amounted to £68,000, and to £63,000 and £63,200 in the corresponding months of 1894 and 1893.

HOVE ELECTRIC LIGHTING COMPANY (LIMITED).—A prospectus has appeared this week inviting applications for subscriptions to the balance of 2,851 Ordinary shares of £5 each, and £12,500 First Mortgage Four and a-Half per Cent. Debentures, the balance of the authorised debenture capital of £25,000. The shares are offered at a premium of 5s., and the debentures at a premium of £3 per debenture.

LEIPZIG TRAMWAYS COMPANY.—At an extraordinary general meeting of the shareholders in this Company, held on Tuesday, a proposal was considered for the sale of the undertaking to a German company. It was explained by the Chairman (Mr. W. B. Hawkins) that there was an idea among the authorities at Leipzig that the head offices of the Company should be at that place, and in view of the early possibility of changing the system at present in use, and working the lines by electricity, the Directors recommended that the suggested transfer should be agreed to. The proposal was adopted.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 31st ult. amounted to £1,002. The amount for the corresponding week last year was £841.

MIDDLESBOROUGH TOWN AND LANDS COMPANY (LIMITED).—The Directors of this Company, in their first annual report, just issued, state that the electric lighting branch of the undertaking has recently shown some improvement in revenue, and as there have been further reductions in expenses, the result of the year's working has shown a small profit.

OSWESTRY ELECTRIC LIGHTING COMPANY (LIMITED)—A meeting of the shareholders of this Company was held last week, Mr. A. Wynne Corrie presiding. He gave an interesting resumé of the work done by the Company since its formation in March, 1893. A site had been obtained at Coney Green, which would afford ample room for the present proposed plant, and additions equal to ten times the initial capacity. Since the second general meeting of the shareholders, held in June last, the Directors had gone carefully into every point, and tenders had been accepted for the necessary machinery plant and cables, and arrangements made for erecting the supply station. Mr. Wynne Corrie was re-elected Chairman, and Messrs. G. Perks and R. Lloyd were re-elected Directors. Messrs. Josiah Jones and E. Bremner-Smith were also elected Directors.

RIVAL TELEPHONE COMPANIES IN THE UNITED STATES.—The Elkhart Telephone Company, which will be a keen competitor of the Bell Corporation, has been organised under the laws of Indiana, U.S.A. The Board of Directors includes R. B. Campbell, general manager of the Baltimore and Ohio Railroad Company; H. E. Bucklen, president of the Elkhart and Western Railroad Company; and Charles Selden, superintendent of telegraphs, Baltimore and Ohio Railway. The Company claims to have unlimited capital at its command.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended March 29, 1895, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3.148.

WESTERN UNION TELEGRAPH COMPANY.—The following is the report of this Company for the quarter ended December 31, 1894:—

Surplus October 1, 1894, as per last quarterly report		$7,386,468. 14
Net revenues, quarter ended December 31, 1894		1,580,995. 73
		$8,967,463. 87
From which, deducting for dividend of $1\frac{1}{4}$ per cent. paid January 15, 1895	$1,191,933. 75	
Interest on bonded debt	223,901. 20	
Sinking funds	20,000. 00	
		$1,435,834. 95
Left a surplus January 1, 1895, of		7,531,628. 92
The net revenues of the quarter ended March 31st, based upon nearly completed returns for January, partial returns for February, and estimating the business for March, will be about		1,200,000. 00
		$8,731,628. 92
From which, appropriating for—		
Interest on bonds	$223,400. 00	
Sinking funds	20,000. 00	
		243,400. 00
		$8,488,228. 92
It requires for a dividend of $1\frac{1}{4}$ per cent. on the capital stock issued about		1,192,000. 00
Deducting which leaves a surplus, after paying dividend, of		$7,296,228. 92

In view of the preceding statements, the Committee recommend the payment of a dividend of $1\frac{1}{4}$ per cent. on the capital stock of the Company on 15th April.—The dividend may be collected through any bank on or after the 15th inst.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the half month ended March 31st are £2,810, as compared with £2,827 in the corresponding period of 1894. The November receipts, estimated at £4,000, realised £4,079.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Mar. 27.		Price Wednesday, Apr. 3.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Apr. 3	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	14 0	Anglo-American	41½	42½	41	42	4 15 3	Jan., Apr, July, Oct.	42⅜	41½
£2,993,560	Stock	28 0	Do. Preferred	78½	79½	78	79	5 1 3	„ „	80	78¾
£2,993,560	Stock	5/0	Do. Deferred	6½	6¾	6½	7	..	..	6 13/16	6⅝
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 17 8	January and July	..	..
130,000	£10	3/0	Brazilian Submarine xd	12	12½	12	12½	5 4 0	Mar., June, Oct., Dec.	12¼	12 1/16
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	109	113	109	113	4 9 6	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	148	152	148	152	4 12 1	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	6 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	„ „	..	..
12,931	5	1/8	Direct Spanish (fully paid)	4	4½	4	4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9½	10	9½	10	5 0 0	„ „	..	–
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8½	9	8½	9	6 0 0	Jan., Apr., July, Oct.	8 13/16	
400,000	10	2/6	Eastern	16¼	16¾	16¼	16¾	3 18 9	„ „	16½	16¼
70,000	10	6%	Do. 6 per Cent. Preference	17¼	17¾	17¼	17¾	3 7 7	„ „	17⅜	17¼
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	124	127	124	127	3 3 0	May and November	124½	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	108	105	108	4 13 0	February & August	..	..
250,000	10	2/6	Eastern Extension	17⅜	17⅞	17⅜	17⅞	4 0 8	Jan., Apr., July, Oct.	17⅝	17½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	123	126	123	126	3 3 6	February & August	124	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	107	103	107	4 14 7	January and July	105½	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	103	107	4 14 7	„ „	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106	109	106	109	3 13 11	February & August	..	–
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 8	May and November	..	–
180,227	10	1/6	Globe Telegraph and Trust	9⅝	10⅛	9⅝	10⅛	4 8 1	Jan., Apr., July, Oct.	10 1/16	9 13/16
180,042	10	6%	Do. 6 per Cent. Preference	16⅝	16⅞	16⅝	16⅞	3 11 3	„ „	16¾	16⅝
150,000	10	5/0	Great Northern	21¾	22¼	21¾	22¼	3 16 7	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 13 6	March & September	..	..
17,000	25	12/6	Indo-European	52	54	52	54	4 12 7	May and November	52	–
37,543	10	5/0	London Platino-Brazilian	5	7	5	7	..	„ „	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	105	109	105	109	5 10 7	March & September	103½	–
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	105	108	3 14 0	..	..	–
11,839	8	4/0	Reuter's	4	6	4	5	..	April and October	..	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	119	124	119	121	4 16 9	„ „	120½	..
15,609	10	6/0	West African Telegraph	4	5	4	5	..	January and July	..	–
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	101	104	4 16 7	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	–
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	98	103	7 15 4	June and December	..	..
88,321	10	6d.	West India and Panama	⅞	1⅛	⅞	1⅛	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	6 6 8	May and November	11¼	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	„ „	9½	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 11 1	June and December	..	..
64,242	15	3/0	Western and Brazilian	10	10½	10	10½	5 4 6	May and November	..	..
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	–	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	4	4½	4	4½	..	..	..	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 15 5	February & August	..	–
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 15 6	„ „	..	–
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	116	120	115	120	5 19 8	May and November	..	–
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	101	103	101	103	5 17 1	March & September	..	–
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	–	..	3 5/16	..
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	⅛	–
171,504	£1	..	Oriental Telephone and Electric (fully paid)	9/16	1⅛	9/16	1⅛	..	Yearly	–	..
484,597	5	2/6	National	5½	6½	5⅛	5½	4 10 11	June and December	5 7/16	5¼
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15½	16½	15½	16½	3 12 0	„ „	16¼	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	16½	14½	15½	3 17 5	„ „	..	..
119,234	5	2/6	Do. 6% Non-Cumulative 3rd Pref.	5⅜	5⅞	5⅝	5¾	4 5 1	–	5 13/16	5 9/16
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	104	106	3 6 0	January and July	105½	104
58,000	5	1/0	United River Plate	1	2	1	2	..	„ „	..	–
£146,733	Stock	6%	Do. 6 per Cent. Debenture Stock (red.)	85	90	85	90	5 9 11	„ „	..	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	13	14	13	14	1 15 8	–	..	..
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	14½	15½	14½	15½	3 18 8	..	15 3/16	14⅞
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5	5½	5	5½	3 17 9	–	5 7/16	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	..	–
8,322	£5	..	House-to-House Electric	..		..		–	–	..	–
16,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		–	..	..	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		–	January and July	–	–
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7½	7⅝	7⅜	7⅝	–	–	..	–
111,000	5	..	London Electric Supply	..		..		..	–	..	–
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	10¼	10¾	10¼	10¾	2 6 6	..	10 11/16	10⅝
£150,000	Stock	4½%	* Do. 4½% Debs.	118	120	118	120	3 15 8	June and December	119	–
6,462	£10	2 0	Notting Hill Electric	7¼	7¾	7¼	7¾	..	..	..	..
19,980	£5	4 6	St. James and Pall Mall	7½	8	7½	8	..	–	7¾	–
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8½	9	3 17 9	–	..	..
59,900	5	6%	Westminster Electric Supply (fully paid)	7¾	8	7⅝	7⅞	3 3 6	–	..	–
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2½	2⅝	2½	2⅝	6 6 7	–	2 5/16	2¼
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2⅜	2⅝	4 11 5	–	2½	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	113	116	113	116	3 17 11	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2¾	3¼	2¾	3¼	–	January and July	..	..
12,139	5	–	Edison and Swan United	1⅝	1⅞	1⅝	1⅞	–	..	–	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	–		–		..	..	–	..
120,000	2	..	Electric Construction	¼	½	¼	½	–	..	..	..
12,845	2	2 9¾	Do. 7 per Cent. Cumulative Pref.	1¼	1¾	1¼	1¾	–	..	1 5/16	–
91,105	2	10/0	Elmore's Patent Copper Depositing	1¼	1½	1¼	1½	–	..	1⅜	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	..	..	..
60,000	10	10/0	India Rubber, Gutta Percha, &c., Works	22	23	22	23	4 6 11	February & August	22½	22¼
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	101	103	101	103	4 7 5	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	–	..	..
16,000	£10	..	Do. 8 per Cent. Preference	–		..		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	⅛	—	⅛	.	..	..	..
87,350	12	36/0	Telegraph Construction and Maintenance	39	41	39	41	8 15 7	March and July	39⅝	–
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 11 1	January and July	..	..
37,614	£5	–	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		.		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	.		..		..	..	..	..
£63,870	10	12/6	W. T. Henley's Telegraph Works Ordinary	10	11	9½	10½	5 11 8	..	10½	10¼
£30,000	10	..	Do. Preference	..		..		..	..	..	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1¼%	City and South London Railway	45	47	45	47	2 13 2	May and November	–	..
7,000	10	6%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	..	–
£67,130	Stock	4%	Do. 4% Perpetual Debenture	130	133	130	133	3 0 2	May and November	..	..
87,600	£10	2%	Liverpool Overhead Railway	8¼	8¾	8 1/16	8 9/16	2 5 2	..	..	..
0,295	10	6%	Do. 5% Preference	14	14½	14	14½	3 11 6	..	..	..
125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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NOTES.

Whatever may be the exact *modus operandi* of telegraphy without wires, the fact that telegraphic communication was last week kept up between the island of Mull and the mainland, by means of the system with which Mr. Preece has experimented so much of late, is an interesting event in the somewhat prosaic latter-day annals of telegraphy. The six-mile cable connecting Oban with Auchnacraig having broken down, a gutta-percha insulated wire, 1½ mile long, was run along the ground from Morvern, whilst on the island of Mull the ordinary overhead circuit connecting Craignure with Aros was made use of; the distance intervening between the two parallel circuits was about 3½ miles, the Sound of Mull being here at its narrowest. Using a vibrator as a transmitter and a telephone as a receiver, the usual telegraphic traffic was dealt with until the cable was repaired. Morvern, we may remark, is some 15 miles from Oban as the crow flies.

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The Paper recently read before the Institution of Electrical Engineers by Mr. Langdon is an instance of the way in which a description of plant and a dry relation of experience may give rise to quite as interesting, and certainly more valuable, discussion than the most designedly controversial contribution. The best height and distance apart of arc lamps, the best size of lamp, the best system of distribution, were the practical points which occupied the attention of the various speakers. There was a decided expression of opinion in favour of a three-wire system of distribution at 220 or 110 volts for open-space arc lighting, the lamps being strung in groups of four or eight across the outer mains. On the score of superior safety, greater security against complete breakdown, and general flexibility, some such plan undoubtedly has the advantage, and after the statement which was made with regard to the Albert and West India Docks installation, it must be considered that even from the point of view of cost of copper, this method can be made to pay. We cannot help thinking that electrical engineers are inclined to lay too much stress on low total cost per unit, and even yet do not thoroughly realise that freedom from breakdown is quite as essential, if not more so.

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Mr. Langdon's figures with regard to the comparative cost of electricity and gas are invaluable, coming as they do from a railway engineer without bias, and based as they are on actual experience. Taking the Lawley-street (Birmingham) figures, and reckoning the arcs at 800 c.p. instead of 1,200 c.p., and allowing the regenerative gas burners to be all they are said to be, it will be seen that gas comes out at something like four times the price of electricity, and the more closely we look into the figures the worse they become—for gas.

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We publish this week a short article on "American Electrical Tramway Gearing," from the pen of Mr. J. D. Dallas. As the writer himself remarks, his criticisms and conclusions do not apply to English practice. What is true of an American tramway is by no means true of the type of heavy electric railway to be found here, and it is doubtful if it always applies even to an English tramway. The restrictions which compel an engineer to adopt gearing, when a light car is to be driven at a comparatively low speed, vanish when a heavy coach or train is to be propelled at a higher speed. Again, the light and somewhat rough construction of the permanent way on many American tramways may forbid the heavy motor truck, which has received sanction, and has been found serviceable here and on the Continent, and may compel the engineer to give his motors and gears a flexible suspension. Yet there are some points where American and English experiences meet. It is conceded everywhere now, for example, that where gear must be used it must be of the positive kind. Frictional gears, belts, ropes, and other arrangements which do not give a positive grip, have been tried and found wanting. They invariably fail on the slightest gradient if the load happens to be abnormally heavy; and for all that they are so silent their efficiency has not proved to be high. One of the most notable instances was the use of steel-cord gear on the Berlin-Lichtenfeld tramway, by Messrs. Siemens and Halske.

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Mr. Dallas inclines to favour double-reduction spur gearing, which has certainly been thoroughly tried in America; but we are sorry he has so little to say on behalf of worm gear. There is a curious diversity of opinion in regard to this latter gear. Setting aside the fact that unless it is well made with the best materials it is useless, we have on the one hand engineers who, like the late Mr. Reckenzaun, are able to extract a satisfactory 90 to 95 per cent. efficiency from it, and, on the other hand, engineers who have not a good word to say for it, either on the score of efficiency or life. We are inclined to believe that, other things being equal, much of this difference is due to the distribution of the thrust on the contact surfaces and to the choice of a peripheral velocity for the pinion. Of course, with this gear an oil bath is essential to high efficiency. In the use of spur-gear one of the troubles which is met with is the back-lash caused by the over-running of one tooth against another. This is inevitable where two or more teeth are paired at the same time, and it is only to a certain extent reduced by such devices as that employed by Mr. Sprague. This device, consisting in setting half the width of the teeth half a pitch ahead of the other half-width, is simply one step towards employing helical gear; and it might be more satisfactory to go the entire way. Another plan, which has been recommended by some English engineers, is to adopt teeth of very long pitch and comparatively short length, thus throwing all the driving force upon only one tooth at a time. We do not know if this gear has ever been tried on tramcars, but it has been found very efficient in mill work. It would be necessary to make the teeth sufficiently long to prevent tripping, but the length might even then be very much less than usual.

The letter on "The Foundations of Electrical Science," by M. G. Giorgi, which will be found in our Correspondence columns this week, although inspired by the recent discussion on "Labour-Saving Apparatus," must not be confused with it. The point under debate is not now the best method of teaching electrical science, but the very nature of the foundations of that science. The foundations of any physical science are, of course, matters of thought rather than of fact; since in the actual world of phenomena any one process cannot be said to be more fundamental than any other. Ohm's law may be a foundation idea, but it is not a more primitive phenomenon than, say, cathode rays or luminescence phenomena. The problem raised by M. Giorgi, then, is as to what is the most consistent and logical conception of electrical science. His attack on the suppressed dimensions of electrical quantities is really beside the point, since no one nowadays insists on looking on resistance as a velocity or on electrical things generally as mere matters of L, M and T. M. Giorgi thinks that the electric current is the starting point for an ideal conception of electrical science. Granted that this may be so, *educationally*; but we are not now concerned with the exigencies of education. We are inclined to think that M. Giorgi would find things growing rather complicated before he had got very far, if he adhered to the electric current as the resting-place for the apex of his inverted pyramid. For, when we look at it more closely, what particular function are we to regard as electric current? Or, are we to take all the related functions as the proposed primary foundation? In fact, what in exact language is the definition which M. Giorgi would give to this quantity? It is an interesting and important matter which he has opened, and we hope some of our readers will venture to discuss it.

The plan which has just been adopted at Bristol of telephonically connecting the central station with the engineer's house is no doubt a very excellent one—for the station. As a further precaution, however, we would suggest that it would be worth while to give the engineer the blessing of his own light in his own house. Any failure of the supply would then probably be made immediately manifest to him by an outward and invisible sign, about which there could be no mistake. We once had the pleasure of spending a night at the house of an engineer whose little water-power electric light supply station lay on the other side of a paddock and a narrow stream. We were assured that whenever the lights showed ominous flickering or signs of giving out, it was the engineer's pleasant custom to clear the window, garden paling, paddock, and narrow stream in rapid succession, arriving at his station just in time to rescue the electric light from damning disrepute.

The Postmaster-General, we are glad to notice, is willing to grant an inquiry into the alleged loss on Press telegrams provided the Press will consent to abide by the result. That the offer is declined affords another reason for instituting the inquiry and following it up by action. Mr. Jeans, Chairman of the Press Association, wants all the figures, and then to be allowed to draw from them what conclusions he pleases. In reality he draws the conclusions first, and asks for statistics after. His conclusions are, as we have before stated, that night Press work cannot be blamed for the loss, because the wires would otherwise be comparatively idle. But why Press work only? According to this all night work ought to travel at a cheaper rate, because of its not travelling by day when the wires are full.

We believe we are correct in saying that so heavy is the Press work at night time that the most highly-paid operators and the most costly appliances have to be resorted to in order to cope with it. Night work is always more expensive than day work, and it is probably the fact that even Press messages cost more at night than in the day-time, although transmitted at a cheaper rate. But whether by day or by night, the tariff is preposterously low when compared with that of ordinary messages. Mr. Jeans's contention as to the set-off in the way of newspaper custom to the Post Office may be a reason for amalgamating the accounts of the two services, but it is absurd as an argument for ruinously low rates being imposed on the telegraph service.

The Verband Deutscher Electrotechniker.—The next annual meeting of this society is to be held in Munich from June 27th to 30th next.

The Telautograph.—We hear that Prof. Elisha Gray's two-wire telautograph is now on its way to Europe, and will in all probability be exhibited at the June *soiré* of the Royal Society.

Marriage.—On Saturday, 6th inst., at St. Mary Abbot's, Kensington, Mr. W. B. Esson was married to Mrs. L. V. Fairfax. A reception was afterwards given at the Kensington Palace Hotel, De Vere-gardens.

The Northern Society of Electrical Engineers.—At the ballot for new members and associates on the 8th inst., Messrs. A. F. Ellis, F. W. Page, and J. Sambidge were elected members, and J. A. Ormerod as an associate.

American Association for the Advancement of Science.—The next meeting of the American Association for the Advancement of Science will take place at Springfield, Mass., August 19th to September 4th. Meetings of affiliated societies begin on Monday, August 26th.

Welded Rail Joints.—Welded rail joints, both by the electric process and cast, have, says the *Street Railway Review*, stood the crucial test of an exceptionally severe winter, and have weathered the storm with a record even better than the most sanguine expectations dared to hope.

Cable Interruptions and Repairs :

	Date of Interruption.	Date of Repair.
Cadiz—Teneriffe..................	Feb. 23, 1895.	April 8, 1895.
Latakia—Cyprus	Nov. 27, 1894.	—
St. Louis—Noronha	Mar. 12, 1895.	—
St. Vincent—San Luiago	April 5, 1895.	—

The Westinghouse and General Electric Companies.—The Philadelphia correspondent of *The Times* announces that the committees which are making arrangements between the Westinghouse and General Electric Companies for "pooling" have practically completed their negotiations.

Expiry of a Faure Secondary Battery Patent.—On Tuesday next will expire a patent, No. 1,676, of April 16, 1881, taken out by M. Camille Faure, and relating to the securing of the active material against the face of a secondary battery plate by means of various contrivances such as felt, paper, wicker-work, indiarubber bands, &c.

Institution of Mechanical Engineers.—The general meeting, already announced for Wednesday evening, 24th, and Friday evening, 26th April, at half-past seven p.m., will be held in the Lecture Theatre of the Royal United Service Institution, Whitehall, S.W., by kind permission of the Council of the Royal United Service Institution.

Society of Arts.—The following are the Papers to be read at the first four Wednesday meetings of the Society of Arts after Easter:—"The Use of Electricity for Cooking and Heating," by Mr. R. E. Crompton; "Deviations of the Compass," by Prof. A. W. Reinold, F.R.S.; "The Extraction of the Rarer Metals from their Oxides," by Prof. William Chandler Roberts-Austen, F.R.S.; and "Means for Mitigating the Fading of Pigments," by Capt. W. de W. Abney, F.R.S.

Accumulator Traction in France.—An electric tramway on the accumulator system has recently been completed between Nice and Cimiez. The generating plant comprises two 50 H.P. steam engines, driving two dynamos giving 200 amperes at 200 volts. The accumulators employed are of the Laurent-Cély type, supplied by the Société du Travail Electrique des Metaux. Each car is provided with 90 cells, and two motors connected to the axles by gear wheels.

An Electric Mountain Railway.—A company is being formed to construct an electric rack railway up the Sonnenberg at Lucerne, under an 80-years concession granted in June, 1893. The line will be 3·8 kilometres long, the terminal station being at an altitude of 2,555ft. The necessary electric energy will be supplied from the Rathhausen central station, the current being conveyed along an underground conduit. The line will be of the metre gauge, the speed ranging between 9 and 12 kilometres per hour.

Royal Meteorological Society.—The ordinary meeting of this Society will be held, by kind permission of the Council of the Surveyors' Institution, at 12, Great George-street, Westminster, on Wednesday next, the 17th inst., at 7:30 p.m. The following Papers will be read:—"The Frost of January and February, 1895, over the British Isles," by F. Campbell Bayard and William Marriott, and "Some Hints on Photographing Cloud," by Birt Acres. The above Papers will be illustrated by photographs and lantern slides.

Belts.—The recent very eccentric behaviour of the Eccentric Association of Engineers of New York makes one inclined to wonder whether the Association has any interest in direct-coupled engines and dynamos. "Whereas," says a resolution of this Association, "the mayor of Brooklyn, Charles A. Schieren, has shown by his official acts that he is in sympathy with the Brooklyn trolley corporations in the fight of our brothers for justice and living wages; and whereas, said Charles A. Schieren is a large manufacturer of belting in the city of New York; resolved, therefore, that the members of the Eccentric Association of Engineers will do all in their power to prevent the use of belts manufactured by the Schieren Belting Company."

Municipalisation of the Telephones.—At the meeting of the Edinburgh Town Council last week, Sir James Russell moved the adoption of a report from the Lord Provost's Committee recommending that application be made to the Board of Trade for a licence to establish a system of telephonic communication within the city. He said that the evidence before the Telephone Committee showed that a Town Council could very easily give an efficient twin-wire service for a rate of subscription at about half the present charge. If the National Telephone Company were confirmed in its monopoly by the Postmaster-General, they would do what they had done in the past—namely, bring in a Bill and take their streets. If for nothing else than to bring the Company to its senses they ought to adopt the motion. It was agreed to recommend the matter to the Lord Provost's Committee for further report.

Electrical Expenditure of the London County Council.—At the weekly meeting of the County Council on Tuesday last, the estimate of the receipts and expenses for the year ending March 31, 1896, was submitted. The Highways Committee, under the administration of the Electric Lighting Acts, estimated that the receipts of the Council for electric meter testing fees was £200, this being an increase of £170 over that of last year. The estimate of expenses was—salaries and wages of inspectors, &c., £680; gas and electric current, £80; stores, £200; incidental, £100, and contingencies, £200; total, £1,260. Last year the estimate was £1,205. The same committee further estimated that £550 would be required for expenses under the London Overhead Wires Act, 1891. The Fire Brigade Committee estimated that £8,000 will be required for telephones and fire alarms. This is a decrease of £250 on the estimate of last year.

Institution of Electrical Engineers.—In consequence of the exigencies of their building operations, the Council of the Institution of Civil Engineers have been compelled to place the whole of their premises in the contractor's hands, and no further meetings can, therefore, be held there for some considerable time. The Institution of Electrical Engineers have consequently obtained permission to hold the remaining three meetings of their Session, viz., on April 25th, May 9th and 23rd, at the Society of Arts, John-street, Adelphi.——At the last meeting, the following gentlemen were passed in:—(Member) A. H. Walton; (Associates) A. H. Avery, C. J. Bosanquet, T. W. Broadbent, Cadwallader Morgan van Cuylenburg, R. McGillivray Dawkins, F. A. Glover, J. P. Nelson, L. F. Noakes, S. Richardson, W. Walker, A. J. C. Waterland.——An error occurred on p. 695 of our last issue; the gentlemen stated to have been elected to the Institution of Civil Engineers were passed into the Institution of Electrical Engineers.

Edinburgh.—The Edinburgh municipal electric supply station was formally opened yesterday (Thursday evening), by the wife of the Lord Provost. The station is designed for both continuous and alternating current supply; the former working on the three-wire system for the nearer districts, and the latter, working at high pressure with transformers, for the districts which are more remote. The plant capacity of the station is 40,000 glow lamps and 175 street arc lamps. A battery of the newest type of Crompton-Howell storage cells has been erected. The alternating current is supplied at a frequency of 60 ∼, from two Ferranti alternators direct coupled to Willans engines. Besides supplying the outlying districts, these alternators also drive the street arc lamps through Ferranti rectifiers. The feeders consist of armoured cables for the alternating currents, and bare copper in conduits for the continuous currents. The distributors consist of covered cables in earthenware conduits. The charge for supply will be 6d. per unit in the night, and 3½d. during the daytime; and a system of discounts will be adopted.

Press Telegrams.—In reply to a question put in the House of Commons on Thursday last week, by Mr. Jackson, Mr. A. Morley said: I have read the letter in *The Times* to which the hon. member refers, and I have also seen other communications in the public Press on the same subject. I have already in this House, in reply to questions put to me by the hon. member for Cardiff and other members, explained that it was impossible to separate the cost of dealing with Press telegrams from that of the rest of the service; but I added that the best estimate that could be formed by the officials of the Post Office pointed to the annual loss on Press telegrams being at least £300,000 a year, and probably a still larger sum. I see no reason whatever to depart from this estimate, and I should be quite willing to arrange for an impartial investigation, such as is suggested by the right hon. gentleman, if I were to receive satisfactory assurances that the Press would abide by the result of an inquiry, and would undertake not to oppose the passage of the necessary legislation for a corresponding revision in the charges if it should be shown that they are insufficient to provide for the cost of the service.

A Thermo-Chemical Carbon Cell.—At a recent meeting of the Académie des Sciences, M. Désiré Korda read a Paper on a "Thermo-Chemical Carbon Cell." The author finds that if barium peroxide is heated to redness in contact with a carbon plate, the oxide becomes reduced to baryta, and a difference of potential of about one volt is produced, the carbon plate being negative. A similar result was obtained with cupric oxide as soon as a layer of potassium carbonate was placed between the oxide and the carbon, the difference of potential in this case amounting to 1·1 volts. The experiments were in each case performed by connecting a plate of gas-retort carbon by means of a platinum wire to one terminal of a Richard voltmeter, and placing on the carbon a little of the salt. A platinum wire dipping in the salt served to complete the circuit. On heating the carbon to a dull red heat in a Bunsen flame, a violent effervescence takes place, carbon dioxide being evolved, and the voltmeter shows a deflection corresponding to about one volt. This deflection remains constant as long as any of the higher oxide is left.

A Remarkable Optical Effect.—Writing to the *Electrical Engineer* of New York, Mr. M. Logan describes an optical effect produced in an asbestos-lined switch-box, an explanation of which may possibly occur to some of our readers. The following is a reprint of Mr. Logan's letter :—

> On Eighteenth-street, near the Union Station, this city, there are two different street railway companies using the same track and trolley wire. On a pole, placed near one of the junctions, is a box containing two switches. One of these is a double-throw switch, so connected that either company can "pull" this section ; the other has then nothing to do, directly, with this combination. To render this arrangement fireproof, the box is lined with asbestos. When one power house shuts this section down, it is my duty to go and climb up the pole and throw the double-throw switch over so that the other company will "pull" until the first one may resume operation, when the switch will be thrown back. In throwing this switch back it is sometimes necessary to break a pretty heavy current. At night, when this is done, a very peculiar light effect may be noticed on the asbestos lining of the box. This light is very white, almost uncanny, and seems to undulate slowly back and forth. This lasts only a few seconds, and is noticeable only after a heavy current is broken at the switch. The warmth of summer and cold of winter do not affect it perceptibly. Is this a property of asbestos ? If not, what is it ?

Electric Railways in Connecticut.—Electric railway enterprise in America has developed so fast that it has already reached the local legislatures, where it promises to give plenty of employment to lawyers. The Connecticut Legislature, according to latest advices, is now engaged in hearing the arguments of representatives of the steam railway companies against the further granting of charters to electric railways, which it is proposed to run parallel to, and in competition with, the existing lines. Vice-President Hall, of the New York, Newhaven, and Hartford Railway, opened the indictment with a lengthy speech, in which he said that outsiders were seeking to wreck the steam railways in Connecticut by building parallel electric lines, which would be quite as harmful as the parallel steam lines, which other capitalists had in past years vainly tried to get legislative permission to build. He concluded by producing a map showing that the electric railways now existing or possessing powers or seeking powers, would result in a competitive parallel line running alongside the track of his own company from the New York State line to Springfield. The New York and New England Railway Companies were also represented, and the promoters of the electric railways have now been called upon to make a reply.

Municipalisation of Tramways.—In the House of Commons, on Friday last, Mr. Stuart moved the suspension of Standing Order 171, which prohibits Local Authorities from themselves working the tramways they may acquire. The motion was defeated by a majority of 33 in a House of 319. Sir John Lubbock, in opposing the motion, remarked: "The Progressives wanted to municipalise, or rather monopolise, everything, and they wanted to manage, in addition to the tramways and the water supply, secondary education, the hospitals, the docks, the Port, and even the pawnshops. Now their idea of the millennium appeared to be that the population of London should consist of 118 Councillors, 19 Aldermen, and 4½ million County Council employés."—On Monday last the Select Committee of the House of Commons, presided over by Mr. Roby, resumed the consideration of the Bill promoted by the London County Council to obtain powers to work any tramways which have been or may be purchased by them. After hearing counsel on behalf of the North Metropolitan Tramways Company and of the London Tramways Company, the Chairman asked what evidence was there to show that the Council should not possess the power of working in the interest of the public This question gave rise to a long discussion, in the course of which several important points were raised. Eventually the Committee decided to consult the Board of Trade. Sir Courtenay Boyle having arrived, the Chairman explained the matter to him. Sir Courtenay Boyle replied that the Board of Trade would have no power to make by-laws under the Tramways Act, and if powers were given public opinion alone would be their support. The Committee found the preamble of the Bill proved. They would require a clause giving the Board of Trade power to make by-laws for the Council, and a clause prohibiting the raising of fares on Sundays and holidays.

The Electrical Preparation of Titanium.—Hitherto, says M. Moissan in the *Comptes Rendus*, titanium has been more known in combination than in the free state. It has been previously obtained by Berzelius, Wœhler, Deville, and Kern only in the state of amorphous powders, the appearance and the properties of which varied with each preparation. On heating titanic acid in a crucible in the electric furnace (100 amperes and 50 volts), I regularly obtained a titanium oxide, fused or crystalline, of an indigo-blue colour. With a current of 300 to 350 amperes at 70 volts, I obtained a bronze-yellow mass perfectly fused. This is the titanium nitride of Friedel and Guérin, Ti_2N_2. If I heated in the air in a boat of carbon under the action of an arc of 1,200 amperes and 70 volts, the melted mass obtained was titanium carbide, TiC, absolutely free from nitrogen. For obtaining titanium the author used the rutile of Limoges, carefully selected and containing very little silica and iron, but afterwards substituted titanic acid prepared in the laboratory. It is intimately mixed with carbon, compressed and dried. This mixture was strongly compressed into a crucible of coke of 8cm. in diameter, and placed in the middle of an electric furnace. Some 300 to 400 grammes were operated on. The arc from a current of 1,000 amperes and 60 volts was allowed to play for 10 to 12 minutes. The crucible when cold was found to contain a homogeneous mass which had been melted only to a depth of a few centimetres. Even with a current of 2,200 amperes and 60 volts the fusion was not complete. Beneath the melted titanium was found a layer of yellow nitride, and at the bottom of the crucible a layer of blue titanium oxide. This fused mass may be mixed with titanic acid and, anew, submitted to the action of a current as intense as the former. By this method was obtained a titanium free from nitrogen and silicon, and containing only 2 per cent. of carbon. This titanium forms a mass with fractures of a brilliant white, hard enough to scratch easily steel and rock crystal. Its specific gravity is 4·87. Carbon dissolves in melted titanium, forming a definite carbide. The excess of carbon crystallises out as graphite. In the electric furnace silicon and boron combine with titanium, forming borides or sillicides, melted or crystallised, and having a hardness equal to that of the diamond. Melted titanium is the most refractory substance which has as yet obtained with the electric furnace. It is more infusible than vanadium, and goes far beyond pure chromium, tungsten, molybdenum, and zirconium. Melted titanium has a less affinity for nitrogen than the powders obtained by the action of the alkaline metals upon the fluotitanates. Still, this titanium, if reduced to powder, burns in nitrogen at a temperature of 800deg. In the totality of its properties, titanium distinctly approaches the non-metals, especially silicon.

ELECTROMAGNETIC THEORY.—LXVI.*

BY OLIVER HEAVISIDE.

(Continued from page 670.)

§ 254. Our results, so far, depend upon the fundamental function $q1$, where q is the square root of a differentiator. From it follow various other results, notably the functions $\epsilon^{-qx}1$ and $q\epsilon^{-qx}1$. Since they represent the elementary waves of potential and current due to a steady impressed force, they are of particular importance; and since they form the elements in more advanced problems that the preceding, their meanings should be carefully noted. Thus, collecting some formulæ for reference, let

$$q = (\mathrm{RS}p)^{\frac{1}{2}}, \qquad y = (\mathrm{RS}x^2/4t)^{\frac{1}{2}},$$

for shortness. Then we have

$$\epsilon^{-qx}1 = 1 - \operatorname{erf} y$$
$$= 1 - \frac{2}{\pi^{\frac{1}{2}}}\left\{y - \frac{y^3}{3} + \frac{y^5}{5\,\underline{|2}} - \frac{y^7}{7\,\underline{|3}} + \;.\;\;.\;\;.\right\}, \tag{1}$$

which gives the V/V_0 curves, and

$$\epsilon^{-qx}q1 = \left(\frac{\mathrm{RS}}{\pi t}\right)^{\frac{1}{2}}\epsilon^{-y^2}, \tag{2}$$

which gives the C/V_0 curves, when V_0 is steady, beginning at the moment $t=0$. Equation (1) belongs to Fig. 1, and equation (2) to Fig. 2, § 248.

Most solutions of problems in mathematical physics are in the form of infinite series. Finite solutions are quite exceptional. When of fundamental importance and of a relatively simple nature, the series functions receive special names and have conventional short expressions. Mathematicians get so accustomed to working with the short expressions that when they get solutions in terms of one or a finite number of such functions they sometimes say that they have got the solution in a finite form. But if the functions were such as had not received special names, the case would be substantially the same. The difference is merely conventional. Compare (1) and (2) above, for example. In (2) we have a case of the familiar exponential function; in (1) a relatively unfamiliar function which seems a great deal more transcendental than the other, which is its slope. The name erf y for the deficit of $\epsilon^{-qx}1$ from unity was invented by Glaisher, and by using erf we have a condensed empirical form for the functions we are concerned with.

Now, granting the desirability of having special short ways of representing important functions, we may remark first that $\epsilon^{-qx}1$ and $\epsilon^{-qx}q1$ may be themselves regarded as the special short ways, shorter than the other ways, in fact. This would be an undesirable deviation from common practice were no advantage gained. But in the present case the forms in question are actually indicative of the functions themselves in their structural meaning, through the operators generating them. Moreover, they are the forms which present themselves naturally in the mathematics. Furthermore, they are the proper forms for the easy and immediate performance of operations on the functions far more easily than either the full series or the exp and erf forms. Lastly, when we pass to more complicated cases, we shall see that they are made up of these $\epsilon^{-qx}1$ and $\epsilon^{-qx}q1$ functions, occurring in these particular forms. Considering all these things, we see that there may be great advantages in using these forms in their naked simplicity, serving not merely as empirical abbreviations, but as structural formulæ. Practice confirms this conclusion, as will be evident in the following.

§ 255. When we employ an infinitely long line we do away with reflected waves, and exhibit the essentials in the simplest manner feasible. The conditions prevailing are the same all along, so no change occurs in the behaviour of the V and C waves generated at a source. Now, passing to more practical cases, the easiest are those in which there is only one reflected wave. Let, for example, the impressed force e be situated at the point $x=a$, and the beginning $x=0$ be earthed, whilst the end of the line is at an infinite distance.

The potential V generated by e is

$$\mathrm{V}_1 = +\tfrac{1}{2}\epsilon^{-q(x-a)}e, \text{ on the right,} \tag{3}$$
$$\mathrm{V}_2 = -\tfrac{1}{2}\epsilon^{-q(a-x)}e, \text{ on the left,} \tag{4}$$

because there is a rise of potential to the amount e at the place of e, and the two potentials $+\frac{1}{2}e$ and $-\frac{1}{2}e$ are the sources of elementary V waves, V_1 to the right, and V_2 to the left. The currents, however, are the same at equal distances from e on either side, viz.,

$$\mathrm{RC}_1 = \tfrac{1}{2}q\epsilon^{-q(x-a)}e, \quad \mathrm{RC}_2 = \tfrac{1}{2}q\epsilon^{-q(a-x)}e, \tag{5}$$

which follow from (3) and (4) by space-differentiation, or by using the operator q on the right side of e, and $-q$ on the left, because C is reckoned + from the source e on the right side and to the source on the left side.

The positive V_1 wave to the right suffers no change, except what is involved in its known expression. But with the negative wave V_2 it is different. When it reaches the origin it has gone through the length a, and is, therefore, attenuated to $-\frac{1}{2}\epsilon^{-qa}e$. But the potential is constrained to be zero at the origin. This requires $+\frac{1}{2}\epsilon^{-qa}e$ to be superposed on the negative wave at the origin. Taken by itself, this would mean that the line is raised to potential $+\frac{1}{2}\epsilon^{-qa}e$ at the origin, which, by the previous, means a wave

$$\mathrm{V}_3 = \epsilon^{-qx} \times \tfrac{1}{2}\epsilon^{-qa}e. \tag{6}$$

This is the reflected wave, and is positive, or from left to right. Since it suffers no further reflection, the complete potential is

$$\mathrm{V} = \mathrm{V}_1 + \mathrm{V}_3 = \tfrac{1}{2}\epsilon^{-q(x-a)}e + \tfrac{1}{2}\epsilon^{-q(a+x)}e \tag{7}$$

on the right side of the source, and

$$\mathrm{V} = \mathrm{V}_2 + \mathrm{V}_3 = -\tfrac{1}{2}\epsilon^{-q(a-x)}e + \tfrac{1}{2}\epsilon^{-q(a+x)}e \tag{8}$$

on the left side. These waves are of the former kind precisely, only the constants being different. The e may be any function of the time. If e is steady, we may employ the developed formula (1) above. The final result in this case (by $q=0$ in (7) and (8)) is $\mathrm{V}=e$ on the right side, and $\mathrm{V}=0$ on the left side.

Note that when e is shifted up to the origin (by making $a=0$), the two positive waves are made equal and coincident, whilst the negative vanishes. That is, the case of e at the origin (earthed) previously treated may be regarded as the case of instantaneous generation of a reflected wave of identically the same nature as the primary wave to the right, their co-existence making a single wave of doubled size.

Another easy case is when the line is cut at the origin. This makes $\mathrm{C}=0$ there. The initial waves V_1 and V_2 from e at $x=a$ are the same as before, but the reflected wave differs. It is the negative of the former reflected wave, because it has to cancel the current due to the primary wave V_2. So

$$\mathrm{V} = +\tfrac{1}{2}\epsilon^{-q(x-a)}e - \tfrac{1}{2}\epsilon^{-q(a+x)}e, \qquad \text{(right)} \tag{9}$$
$$\mathrm{V} = -\tfrac{1}{2}\epsilon^{-q(a-x)}e - \tfrac{1}{2}\epsilon^{-q(a+x)}e, \qquad \text{(left)} \tag{10}$$

are the potentials when the line is cut at the origin. The final state when e is steady is $\mathrm{V} = -e$ on the left and $\mathrm{V}=0$ on the right side of the source. The final current is zero. These steady results are obvious.

§ 256. After the above easy cases in which only one reflected wave is generated, pass to a case more nearly allied with practice, in which we have an infinite series of reflected waves all of the same type. Let the line be of length l, and be earthed at both beginning $x=0$ and at the end $x=l$. Call these A and B for descriptive convenience. Have e on at A. We will first build up the result in a physical manner. The initial wave from A is

$$\mathrm{V}_1 = \epsilon^{-qx}e, \tag{11}$$

and there would be no other if the line were infinitely long. But when V_1 reaches the end B, and has attenuated to $\epsilon^{-ql}e$, it would raise the potential there to that value, were it not for the constraint forcing V to be zero. So $\mathrm{V}_2 = -\epsilon^{-ql}e$ has to be superposed to cancel the effect of the first wave. This is the value at B of the reflected wave starting from B, and going towards A. At distance x from A it has traversed the distance $l-x$, and therefore has attenuated to $-\epsilon^{-q(l-x)} \times \epsilon^{-ql}e$; so the second wave is

$$\mathrm{V}_2 = -\epsilon^{-q(2l-x)}e. \tag{12}$$

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When this wave reaches the origin A, it has attenuated to $-\epsilon^{-2ql}e$. It would lower the potential there to that extent. But the potential is kept constant. So we have the same kind of reflection as at B, viz., with reversal of potential. The third wave is therefore $+\epsilon^{-2ql}e$ at A, so that, generally,

$$V_3 = \epsilon^{-q(2l+x)}e \qquad (13)$$

expresses the third wave. It is positive, like V_1. When it reaches B, it becomes $\epsilon^{-3ql}e$, and (in the same way as the first wave) generates a fourth wave with the potential reversed. The fourth wave is therefore $-\epsilon^{-3ql}e$ at B, and becomes

$$V_4 = -\epsilon^{-q(4l-x)}e \qquad (14)$$

at x. It is unnecessary to elaborate further, because the process is the same for all the succeeding waves. The complete potential is therefore

$$\begin{aligned} V &= V_1 + V_2 + V_3 + V_4 + \dots \\ &= \left(\epsilon^{-qx} - \epsilon^{-q(2l-x)} + \epsilon^{-q(2l+x)} - \epsilon^{-q(4l-x)} + \epsilon^{-q(4l+x)}\right. \\ &\qquad \left. - \epsilon^{-q(6l-x)} + \epsilon^{-q(6l+x)} - \epsilon^{-q(8l-x)} + \epsilon^{-q(8l+x)} - \dots\right)e. \qquad (15) \end{aligned}$$

The current to correspond is given by

$$RC = \left(q\epsilon^{-qx} + q\epsilon^{-q(2l-x)} + q\epsilon^{-q(2l+x)} + \dots\right)e, \qquad (16)$$

where it should be noted that all the signs of the waves are +. That is, if the initial wave produces positive V_1, the reflected waves are alternately + and – as regards potential, but the currents to correspond are all the same way.

If e is steady, (15) gives V in a series of elementary waves of the kind (1) above, and (16) gives C in terms of the functions (2) above. The successive waves are smaller and smaller, of course. But the above reasoning is the same whether e be steady or be any function of the time, so the above results are fully expressive of the solutions in general, understanding that the waves will have different meanings quantitatively in different cases.

We may readily transform the above solution to a compact form. The odd terms in (15) make one geometrical series, and the even terms make another. So, summing up, we get

$$V = \frac{\epsilon^{-qx} - \epsilon^{-q(2l-x)}}{1 - \epsilon^{-2ql}}e = \frac{\operatorname{shin} q(l-x)}{\operatorname{shin} ql}e. \qquad (17)$$

This is the condensed and most convenient form of the operational solution.

Putting $q = 0$ in (17), we see that a steady e gives the final steady state

$$V = e\left(1 - \frac{x}{l}\right), \qquad C = \frac{e}{Rl}, \qquad (18)$$

as is obvious by Ohm's law when the cable has become permanently charged. The potential is kept down by the reflections, whilst at the same time they allow the current to rise to a steady value.

The above way is instructive, and should certainly be followed sometimes. But when understood, much of it may be taken for granted, because the operational method gives the waves automatically and easily. Thus, to obtain (17), we have the general solution

$$V = \epsilon^{qx}F + \epsilon^{-qx}G, \qquad (19)$$

where F and G are time functions (constants as regards x) to be determined. We should not call them "indeterminate," as is sometimes done in similar cases, because they *are* determinate, or determinable, and in fact have to be determined. They are determined by the terminal conditions $V = e$ at $x = 0$, and $V = 0$ at $x = l$, which give

$$e = F + G, \qquad 0 = \epsilon^{ql}F + \epsilon^{-ql}G. \qquad (20)$$

Finding F and G from these, and inserting them in (19), we obtain the solution (17) at once.

Expand it by division, and the developed wave solution (15) results. This is the practical way to work in more complicated cases. We arrive easily and speedily at the condensed form, and may then develop it if we like. That the development of the operator in (17) into elementary wave operators by division is legitimate, is obvious from the above.

If the simply periodic solution be got from (15) by the property $p^2 = -n^2$, or $p = ni$, we obtain an infinite series of simply periodic trains of waves. It may be that only the first, or the first two or three, are wanted. If so, this way may be useful. We have

$$\epsilon^{-qx}\sin nt = \epsilon^{-Px}\sin(nt - Px) \qquad (21)$$

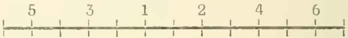
when $p = ni$, the value of P being

$$P = (\tfrac{1}{2}RSn)^{\frac{1}{2}}, \text{ by using } i^{\frac{1}{2}} = \frac{1+i}{2^{\frac{1}{2}}}.$$

Equation (21) shows the wave train in an infinitely long cable. When of finite length, it is the type of the individual members of the infinite series of wave trains, x having to receive the series of values indicated in (15).

We may sum up this infinite series if we please, and obtain a resultant formula in a complicated way. But if this resultant be wanted, it can be got much more easily by making $p = ni$ in the condensed operational solution, because the summation has been already effected in it.

§ 257. There is another way of regarding the matter. It is usual in heat problems involving reflections, to consider the extra terms to be due to images. In our present problem, it would work out thus. Let the straight line represent part of an infinitely long cable without any external connections. Let the dots divide it into equal lengths l. At every second point let impressed forces, each of strength $2e$, act simultaneously and in the same direction, say from left to right. Then the potential at A, due to the pair of forces at 2 and 3, is zero. So is that due to the pair 4 and 5, and so on. The potential at A is therefore that due to the $2e$ there only; that is, e on the right and $-e$ on the left of A. Now consider B. The forces at 1 and 2 produce no potential at B. Nor do the forces at 3 and 4, and so on. The result is that between A and B, the potential is the same as if the line were AB only, but earthed at both A and B, and with an impressed force e inserted at A. This is a mathematical equivalence.



But the way previously followed is, I think, preferable. It is as easy to follow, if not easier. But more importantly, it represents the true physics of the matter. We take the line as it is, and do not leave it, but introduce the reflected waves just as they arise at the terminals. The order of the waves is 1, 2, 3, 4, 5, &c. In the figure these mark the places of the source and its imagined images. But the real sources are at A and B.

It will also be noted that I described these waves as if they came into existence one after the other. The formula (15) or (17), on the other hand, says that they are contemporaneous. This is right enough for the formula, but is only a mathematical fiction in reality. The waves are successive, in the way described. The speed of propagation of disturbances is $v = (\mu c)^{-\frac{1}{2}}$ or $(LS)^{-\frac{1}{2}}$ approximately, where L is the inductance per centimetre. Our ignoration of L makes v be infinite. This accounts for the contemporaneity of the waves in the diffusion formula.

But give L a finite value, no matter how small, and v is finite, and the waves are successive. By taking L small enough, they will differ as little as we please from the above waves in type, whilst being successive. So we are justified in using the above natural way of description.

All diffusion formulæ (as in heat conduction) show instantaneous action to an infinite distance of a source, though only to an infinitesimal extent. It is a general mathematical property; but should be taken with salt in making applications to real physics. To make the theory of heat diffusion be rational as well as practical, some modification of the equations is needed to remove the instantaneity, however little difference it may make quantitatively in general.

Of course, to rationalise the theory in our immediate problem, we have merely to take L into account. We then change the type of the waves as well. The change may be little or great. It is very great in some telephone circuits, and, of course, with Hertzian waves. In the more advanced treatment of the subject, including L (and K the leakance as well), we have just the same kind of wave analysis as above, though q has a different meaning, and the waves are of another kind.

There is only one exception to the rule of an infinite series of waves, and that is in the theory of the distortionless circuit. It is possible to completely absorb an arbitrary wave by means of a suitable terminal resistance. Then there are no reflected waves.

(To be continued.)

AMERICAN ELECTRICAL TRAMWAY GEARING.

BY J. D. DALLAS.

Nearly all American motor cars are worked with gears of one form or another. The great majority, however, are equipped with spur gearing, though the bevel form is employed in some cases and in others axle motors. It may be of interest to give a short account, however, of the many different forms which have been used in the development of gearing to the forms now in general use. They may be roughly divided as follows:—(1) Worm gearing, (2) bevel gearing, (3) sprocket wheels and chains, (4) rope belting friction gears, (5) spur gearing, (6) connecting rods, axle motors, &c.

Worm Gearing.—This has been tried by more than one engineer, though the measure of success has not been great. The fact that such a gear precludes the flexible suspension of the motor from the truck necessitates the pounding of the motor and truck deadweight being directly transmitted to the rails and joints, with the consequent increase of repairs of equipment and track. In addition, the thrust of a worm gear decreases its efficiency when compared with the spur form. So, notwithstanding the employment of it in other engineering work, a worm gear has not been found well adapted for use for traction purposes. Various bronzes, forged steel, &c., have been tried; the results were, however, unsatisfactory. In this case, as in all others not otherwise mentioned, the teeth were of the machined form.

Bevel Gearing.—This has been employed chiefly by Rae and Sperry. A pinion on the armature spindle engaged a spur gear on an intermediate shaft, which, in turn, engaged a bevel gear on each axle. The great objections to bevels are—First, the difficulty of providing gears with sufficiently strong teeth in the restricted space available under a car, and, secondly, if the motor be flexibly suspended from the trucks, the alignment of both axle gears with the pinions is doubtful, and if the motor be rigidly attached, heavy pounding on the rails ensues, as in the case of the worm form. The great object of using a bevel is that one motor only need be employed, with the advantage that both axles are at the same time coupled to the source of power, which increases the tractive effect. Careful experiments, carried out by different manufacturers, tend to show that this form of gear is, moreover, not very efficient.

Sprocket Wheels and Chains.—These have been tried by Vandepoele and others. A tramway with such gearing, devised by Fisher, was running in a suburb of Detroit in 1888. One motor was mounted on the front platform of each car, and the truck springs acted as a cushion. The chains were satisfactory, the loss small, and the noise not excessive. So long as the traffic was not great these cars were very successful. Increased traffic necessitated the use of the space occupied by the motor. The sprockets and chains, however, have not given the same satisfaction since the motors have been placed under the cars. Vandepoele employed sprockets and chains in St. Catherine's, Ontario; the road has been in operation for a number of years.

Belts and Ropes.—Belting and rope-driving with and without gears have been tried from time to time. Many patents exist treating on designs of gear, but none of them seem to have so far proceeded beyond the experimental stage. Belts were used with the object of reducing starting shocks. With the same idea E. H. Johnson and others have proposed the adoption of a spring to allow of a certain movement before the gears become locked.

Spur Gearing.—This form of gearing is now almost universally adopted. It readily allows of flexibly suspending the motors with the rigid alignment of the armature spindle and axle. Machined teeth have always been employed, except in the case of bevel gears, where moulded shrouded teeth have been used so far. The speed met with has been too great to warrant the successful employment of moulded teeth; in fact, the speed exceeds that given by Prof. Unwin as a safe limit for machined ones. In 1888, when street tramways first began to alter their motive power to electricity, the double reduction form of spur gearing was adopted by Sprague, Bentley Knight, Vandepoele, and others.

Two distinct forms were used. One in which both gears and both pinions were on the far side of the motor from the commutator. In the other form the armature pinion and intermediate gear were on the far side, and the intermediate pinion and axle gear on the commutator side of the motor. Fig. 1 gives an example of the former, and Fig. 2 an example of the second form, which was adopted by S rague and others. The axle gears were split, and bolted together by set screws with lock-nuts and split pins; the intermediate gears were in one piece. Fig. 3 is a small motor, which has done excellent work on narrow gauge tracks of 30in. in large factories and yards.

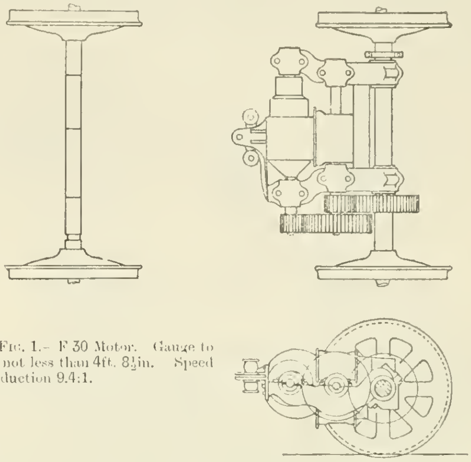


FIG. 1.—F 30 Motor. Gauge to be not less than 4ft. 8½in. Speed Reduction 9.4:1.

This class of spur gearing held the field until the early part of 1891, when all the large manufacturers introduced the single reduction type, including the Thomson-Houston, Edison, Westinghouse, and Short Companies. This step was a very great advance in electric traction, as, in addition to the reduction in the first cost, weight and upkeep of the car equipments, the loss of the gears was reduced from about 15 per cent. to 6 per cent., with an enhanced commercial efficiency of the motors of 9 per cent. It is not probable that gearing will be wholly dispensed with for street tramway work. It would be almost impossible to design an efficient axle motor of approximately the same weight as those now in use—viz., 1,450lb. The weight of a double-reduction motor of the same output (15 B.H.P.) was about 1,980lb., or a gain of some 500lb. The Thomson-Houston Company designed a gear with 67 teeth, and a pinion with 14, which is now the standard of the General Electric Company; several hundreds of motors

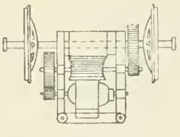


FIG. 2. — Westinghouse Double Reduction Geared Motor.

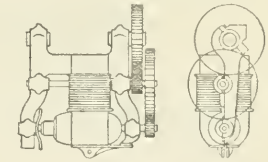


FIG. 3.—F 6 Railroad Motor. Gauge to be not less than 2ft. 6in Speed Reduction 18.9:1. Weight 600lbs.

are working with this gear (Fig. 4). The Westinghouse Company used a reduction of 3·3 : 1, the Edison Company 4·4 : 1, the Baxter Company 3·47 : 1, with the same type of gear.

With the object of reducing the backlash, Sprague employed in many cases staggered gears; their introduction, however, has not been general, on account chiefly of cost; the same advantages can also be obtained by a carefully designed form of tooth. The staggered gears were made in two pieces, the gear being split circumferentially after the teeth had been cut. One-half of the gear was then moved one half-tooth interval in advance of the other, and the two portions rivetted together. Gears have always, or nearly always, so far been of cast iron, with carefully cut teeth. They have given every satisfaction. Mortice gears have been employed with the object of diminishing noise, but it was found to produce the opposite effect. Wood is unsuitable for use with such high and varying speeds as are met with in this class of work. White maple, oak, &c., have been tried; the shape and number of teeth have been altered, but with the same result. For pinions many different metals have been used, bronze or forged steel are now very generally adopted. An aluminium bronze pinion will be found to possess the advantages of reducing the noise, of a prolonged life, and of wearing uniformly. Pinions of this alloy after working over 20,000 miles were found to have worn but inappreciably. Gun-metal, brass, and a variety of bronzes have been tried, all of which gave satisfactory results, though the wear was greater than in the case of the bronze mentioned above. Raw hide pinions reduce the noise to a minimum, but they have the fatal objection of rapidly going to pieces. A lamination of raw hide and sheet steel or iron diminishes the noise until such time as the edge of the raw hide wears; the sheets of metal then act as saws, and rapidly destroy the gears. Sheet steel or iron pinions have been tried with excellent effect, but the cost is unfavourable to their introduction.

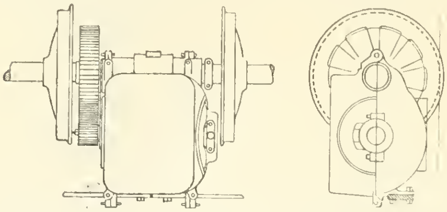


FIG. 4.—W. P_{30} Motor. Teeth in Pinion, 14. Teeth in Gear, 67. Reduction =4.78:1. Gauge to be not less than 3ft.

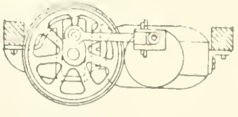


FIG. 5.—Eickmeyer Motor coupled by means of a Rod to Wheel of Car. Motor mounted flexibly on Car axle-box.

Motors coupled by rods have been exploited by Eickmeyer and others. The former adopted coupling rods with and without gears. Fig. 5 gives an example of the latter. The coupling rod permits of a readier means of cushioning the motor than could be obtained if it were directly mounted on the axle; of course, in each case the axle and the armature revolve at the same speed. Coupling rods have also been employed connecting both axles, with a view to increase the tractive effect.

Westinghouse, Short, and others have designed axle or gearless motors, and a considerable number of these were at one time in use. The Westinghouse Company's armature was rigidly mounted, and made to take the place of a part of the axle, to the two portions of which it was bolted by flanged couplings. The Short Company wound the armature on a bronze sleeve; at each end of this sleeve three arms engaged three corresponding projections at either end of the axle by flexible rubber connections. The following is one of the principle reasons why axle motors have not been generally adopted. Suppose that the wheels be 30in. in diameter, and that the tramcars average six miles per hour in crowded streets, which is perhaps not an unfair assumption, the armatures at this speed would be making only some 70 turns per minute. The design of an efficient axle motor to weigh, say, 1,500lb., and able to develop 15 B.H.P., at, say, 80 revolutions per minute, is the problem which must be solved before the present geared motors will be generally superseded. The conditions in England are widely different, and these remarks are not intended to necessarily apply to electrical tramway work here. The form of tooth adopted in bevel and spur gearing has been universally the involute, which possesses the advantages (1) that wear in the armature and axle boxes does not affect the working of the gears, and (2) that the involute spreads at the base, which is the weakest part of a tooth.

THE GOVERNING OF STEAM ENGINES.

BY G. L. ADDENBROOKE.

Since I last* wrote on this subject, much attention has been devoted to the governing of engines, and lately, in especial, two very valuable Papers have appeared. One by Capt. Sankey, of Messrs. Willans, deals exhaustively with the respective merits of governing by a throttle valve or by altering the cut-off of the admission valves. The other, by Mr. Richardson, relates more particularly to the relative merits of different designs of governors, and the two together do much to clear up many points of uncertainty. It is not my intention to go into these communications—those who have not read them already should make a point of doing so in the original; my object has been to point out what sort of governing we want for engines driving electric lighting or power plant, and to show that the conditions in a central station, particularly, are different to a mill or factory.

The first of these articles was devoted to showing that, until the advent of electric lighting, the attentions of engineers were directed to designing a governor which would keep the speed of the engine constant at all loads, which is the requirement for factory work. It was then pointed out that, more or less generally up to the present, electrical engineers have accepted an engine governed in this way, and have provided by the use of resistances for the extra speed and higher voltage which are required in electric lighting plant at full load.

In the last article it was shown that in a low-tension station the speed must be increased 6 to 8 per cent. to secure the increased voltage needed in the omnibus bars at full load, and in an alternating station somewhat less, as there is less loss of pressure in the mains at full load. These differences can be compensated for by the use of resistances in the exciting circuits, but then a dual control is established in the station, and extra labour is required and extra watchfulness, which it is desirable to get rid of.

In some low-pressure central stations where ring mains are in use, it is the practice to regulate very much from the engines, and my object was to urge the desirability of extending this and doing the same in alternating stations.

The question, then, arises as to the adaptability of existing governors to such a purpose, and how far their sensibility could be relied on, that is, whether sufficiently fine regulation could be secured to alter the adjustment of the voltage with certainty within ½ per cent. while running, and that over a range of about 10 per cent. in the speed of the engine.

The Papers mentioned above do a good deal, from the mechanical standpoint, to answer this question in the affirmative; and there is in my mind no doubt that when engine builders understand clearly what is required of them, and when electrical engineers are willing to arrange for the regulation of the voltage to be done from the engine and not from the switchboard, then the right governors will be forthcoming.

As a practical illustration of what can be done, I will describe some experiments which I made a few weeks since.

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* See *The Electrician*, Vol. XXXIII. pp. 571, 745.

I was acting as consulting engineer for the lighting of some mills in India. The plant ordered by my clients consisted of three 40 kilowatt dynamos, coupled direct to Belliss compound engines; the boiler pressure was 120lb., and the speed was to be under 525 revolutions full load; the dynamos were fully compounded. The compounding having been adjusted on the first set, and trials of this and the second set having established the characteristics and working of the plant, I took advantage of the trial run of the third set to make the experiments on the governing and control of the engine, after the plant had run for about four hours at full load, viz., 100 volts, 100 amperes, and 500 revolutions.

The experiments were as follows:—

1. The whole current was suddenly switched off, leaving no load on the engine. The speed at once went up to something over 600 (the tachometer was not calibrated further), but within a second it was reduced to 575, and after two more ooscillations of rapidly-decreasing amplitude, and taking only a few seconds, the engine settled down to run steadily at a speed of not more than 1 per cent. difference from the full-load rate. This was repeated, and the current then switched on.

2. The governor (of the throttle-valve type) was kept full open, and the speed run up to 575 revolutions, when the dynamo gave 403 amperes at 118 volts. The engine was then doing 18 per cent. more than its proper load, or about 80·1 H P. It still ran quietly, and the governor seemed to have proper control over it.

3. An attempt was now made to ascertain the sensitiveness of the governor to slight differences of adjustment, which are obtained by means of a small hand-wheel working on a screw, this alters the tension of a spring, the latter balancing the thrust of the governors, the action of which opens or closes a sensitive throttle-valve arranged in the main steampipe.

In the first place, the load was reduced to a quarter, and when everything was running steadily, a complete turn of the governor adjusting wheel was made. The result was to reduce the revolutions about 12, and to bring down the voltage 3 per cent. Under the same circumstances, a half turn made about five revolutions difference in speed. The difference made by $\frac{1}{8}$in. of a turn was not sufficiently decided to be observed, but $\frac{1}{4}$in. turn was; and it was clear that the voltage could easily be regulated within less than 1 per cent., or $\frac{1}{3}$in. turn, by means of the governor.

In the next place, the full load, was put on, and the above experiments repeated, to see if the governor was as sensitive at full as at one-quarter load. Under these circumstances a whole turn of the governor adjustment wheel reduced the revolutions by 14, and the voltage in two trials, both up and down, was increased and decreased by 3 per cent., in accordance with the direction in which the turn was taken.

4. The plant running full load, by rotating the adjusting wheel the speed was lowered between 20 and 30 per cent. while the engine was running, and afterwards brought up again to the normal.

Of course, in trials like these, involving small differences, slight alterations of pressure in the boiler, the cooling and heating of resistances, and other matters a very high degree of percentage accuracy is only attainable by extreme care and careful preparation. But the above results are sufficiently accurate for all practical purposes, and my observations left me with the impression that, if possible, even better could have been done after the engine had had two or three weeks' constant work, and all the working parts had become properly polished.

It is worthy of note that the engine, which indicated some 65 H.P. during the trials, was placed on a platform, and was not bolted down—simply standing on its own extended bed-plate.

Messrs. Belliss and Co. have certainly used great care and skill in working out their engine, with the most excellent results. My account of these trials is not, however, to eulogise their engine beyond expressing a high opinion of it, nor do I suppose that they are unique in their method of governing. But my object has been to show that engines can be made to govern, and with provision for altering the adjustment of the governor or the speed of the engine, over the full range required for central station or similar electric work; and that the governor can also be made sensitive enough to enable sufficiently accurate increments or decrements of voltage to be provided for by adjustment of the governor, and thus that it is thoroughly practical to provide the voltage required in the omnibus bars and in the circuits by adjustment of the engine, leaving the switchboard attendant to his proper duty of observing the voltage in the feeders and at the feeding points or transformer stations, which he is then in a better position to keep at the requisite pressure than if he had to look after the adjustment of exciting resistances also.

AN ELECTRIC HEATING TABLE.

The accompanying table, showing the relation between electric power and energy expended and the radiation and amount of heating produced, has been calculated by Mr. H. Ward Leonard, and was recently published in the *Electrical Engineer* of New York. As it comprises a number of constants which should prove useful to engineers engaged in electrical heating work, we reprint it for our readers:—

Unit.	Equivalent value in other units.
1 k.w. hour. =	1,000 watt hours. 1·34 h.p. hours. 2,656,400 ft. lb. 3,600,000 joules. 3,440 heat units. 366,848 k.g.m. 229lb. coal oxidised with perfect efficiency. 3lb. water evaporated at 212°F. 22·9lb. of water raised from 62°F. to 212°F. 8 cents at usual rates for electric heating.
1 h.p. hour =	0·746 k.w. hours. 1,980,000 ft. lb. 2,580 heat units. 273,740 k.g.m. 0·172lb. coal oxidised with perfect efficiency 2·25lb. water evaporated at 212°F. 17·2lb. water raised from 62°F. to 212°F. 6 cents at usual rates for electric heating.
1 k.w. =	1,000 watts. 1·34 h.p. 2,656,400 ft. lb. pr. hour 4,424 ft. lb. per minute. 73·73 ft. lb. per second. 3.440 heat units pr. hour 573 heat units per min. 9·55 heat units per sec. 0·229lb. coal oxidised per hour. 3lb. water evaporated per hour at 212°F.
1 h.p. =	746 watts. 0·746 k.w. 33,000 ft. lb. pr. minute 550 ft. lb. per second. 2,580 heat units pr. hour 43 heat units per min. 0·71 heat units per sec. 172lb. coal oxidised per hour. 2·25lb. water evaporated pr. hr. at 212°F.
1 joule =	1 watt second. 0·00000278 k.w. hour. 102 k.g.m. 0·00094 heat units. 73 ft. lb.
1 ft. lb. =	1·36 joules. 1,383 k.g.m. 0·00000377 k.w. hours. 0·000291 heat units. 0·0000005 h.p. hour.
1 watt =	1 joule per second. 0·00134 h.p. 0·001 k.w. 3·44 heat units per hour. 73 ft. lb. per second. 0·003lb. of water evaporated per hour. 44·24 ft. lb. per minute.
1 watt per sq. in. =	8·26 thermal units per sq. ft. per minute. 120°F. above surrounding air (Japanned cast iron surface). 66°C. above surrounding air (Japanned cast iron surface).
1 heat unit =	1,048 watt seconds. 772 ft. lb. 0·252 calorie (kg.-d.) 108 k.g.m. 0·000291 k.w. hour. 0·000388 h.p. hour. 0·0000667lb. coal oxidised. 0·00087lb. water evaporated at 212°F.
1 heat unit per sq. ft. per min. =	0·121 watts per sq. in. 0·0174 k.w. 0·0232 h.p.
1 kilogram metre =	7·23 ft. lb. 0·00000366 h.p. hour. 0·00000272 k.w. hour. 0·0092 heat units.
1lb. bituminous coal oxidised with perf'ct efficiency =	15,000 heat units. 0·98lb. anthracite coal oxidised. 2·1lb. dry wood oxidised. 15 cubic ft. illuminating gas. 4·37 k.w. hours (theoretical value). 5·81 h.p. hours (theoretical value). 11,590,000 ft. lb. (theoretical value). 13·1lb. of water evaporated at 212°F.
1lb. water evaporated 212°F. =	0·33 k.w. hour. 0·44 h.p. hour. 1,148 heat units. 124,200 k.g.m. 1,219,000 joules. 887,800 ft. lb. 0·076lb. of coal oxidised.

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Owing to the growth of the electrical and allied industries the demands for space in "THE ELECTRICIAN" are, for the greater part of the year, so pressing that a permanent increase in the size of the journal has become necessary. To meet the increased cost involved by this step, and by other improvements, such as heavier paper and more numerous illustrations, the price of "THE ELECTRICIAN" will be advanced to 6d. on and after May 3rd next. Hitherto this sum has been charged when the number has contained a Supplement, and, as the industries grow, these may be more frequently necessary; but the practice of charging extra for Supplement numbers when issued will be discontinued.

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ELECTRIC CULVERT EXPLOSIONS.

It takes two to make an explosion—an explosive mixture and something to ignite it. Both are evidently frequently present in electric supply culverts, and the question is how they get there, and how they are to be prevented from coming there in future. As to the explosive mixture, or "bang gas" as German natural philosophers call one kind, it is not difficult to see how it gets there; it would be much more difficult to see how it did not. Though a large proportion of what the gas manager, after comparing his station meter with the consumers' meters, puts down to leakage is due really to the gas falling in temperature after passing the station meter, the genuine leakage is very considerable; and anybody whose nose happens to be in the neighbourhood of an opened street in town, knows that the ground is saturated and reeking with the output of gas works. A culvert thus naturally gets fouled with enough gas to form an explosive mixture. It may contain enough to be inexplosive, and to turn gas into a culvert might be a possible means of making it safe. We once heard of a works where they used a great deal of gas, and had a great many pipes and many leaks. Finally, the leaks were so numerous that the atmosphere was not even explosive, and burners were fed with air, the flames burning inside out in an atmosphere of gas. Anyone coming in with a light left a curtain of flame in the doorway, while his light was extinguished. We do not ourselves believe this. There may be real "bang-gas" formed by electrolysis, or there may be electrolytic hydrogen available also. We will try to show presently that there may be even large quantities, though the electrolysis is due to a film of moisture on a piece of porcelain. It is clear, at least, that the explosive mixture can be provided by the gas companies, or by electrolysis. Other sources have been suggested, but there is no lack of possible ways of getting the explosive mixture, only of keeping it away.

The match or exploder is a little more difficult to account for. The report of the Committee appointed to confer with the Electrical Adviser to the Board of Trade is before us, but does not go into much detail. Given a negative main, a porcelain insulator, and a piece of damp wood in contact with the soil, the question is, How can a film of moisture, of a total weight of a milligramme or two, provide pieces of sodium as big as peas, and an incrustation? It has been suggested by us that possibly the porcelain, or rather earthenware, may have been decomposed. But the evidence now before us would appear to completely dispose of this explanation. A very large bulk of earthenware or porcelain would have to be used up to provide a piece of sodium the size of a pea, with a suitable crust of caustic to keep it dry. The bare fact of the glaze having been attacked, does not show that the sodium comes from it. The sodium, once present, might easily attack glaze. Those who have worked at the electrical winning of sodium know that it attacks such things readily if it has a chance. If the whole electrolyte available is only a fraction of a drop, the question is, How does all the sodium get there? and How does enough electrolyte to carry the salt electrolysed get there?

We will hazard an explanation, though circumstances do not allow us to study the matter with the deliberation it deserves. Nearly a century ago von Reuss discovered what he called "Motus Stoechiagogus." This is a more learned name than "bang gas"; it means what is now called electric osmose. If electrodes are separated by a porous partition, the fluid as a whole moves into the cathode compartment, especially if the electrolyte be a poor conductor. Various experiments have been made, and the subject has been very thoroughly investigated. One experiment, recently prominent, though really made by him long ago, was Lord Armstrong's, with two glasses of distilled water connected by a thread. On connecting to an electric machine, the water went to the cathode, and the thread to the anode. The explanation of the movement of the thread in the opposite direction has not been very clearly given, as far as we know. It might have been foretold in the following way, but was not:—If the glasses had been mounted on wheels with little friction, and if the thread had remained still, the friction of the water past it would have afforded a force with no reacting force, and the whole system would have moved without any external force, which is impossible; so there must be an equal and opposite force on the thread. An experiment by Gernez approaches our conditions more nearly. He separated the anode and cathode chambers by a glass partition, and applied some thousands of volts. The water climbed round by the movement of the imperceptible film of moisture. A mark of stearine stopped the action.

In a culvert we are concerned with the cathode only for the moment. We do not know where the anode really is; we only know that something is eaten somewhere. We have a cathode separated by a film of electrolyte from a larger supply in damp wood, connected with an extensive vat in the form of the earth. There is then a continuous flow of dilute solution of salt to the cathode. Soda is formed, and as the water is scarce, sodium. This process, going on by the month or year, can accumulate considerable quantities of soda and sodium, and of course carbonates are also formed. As to how the sodium can light the gas, the catastrophe can happen in many ways. If you have 100 volts or more on a circuit, which, owing to the gradual accumulation of caustic, has a fairly low resistance, you may easily have a high enough temperature to fire a piece of sodium suddenly exposed to the air by a flake of protecting hydrate or oxide falling off. That the sodium is in lumps shows it must have been hot at least once, as it would not otherwise be run together unless it aggregates in some mysterious way like flints in chalk. Again, a piece falling off into a wet culvert might easily fire. In many cases potassium was also present. Potassium fires more easily than sodium. The metals also alloy and form a liquid which will light even without being thrown into water. This alloy being liquid, a coating cannot adhere to and protect it. When a drop is spilled on the table, if it does not catch fire at the time, it will if a duster is used to wipe it away.

If our hypothesis prove correct, the Board of Trade Committee's suggestion as to increasing the insulation may not be permanently effective. One might suggest laying the porcelain with a sheet of metal, preferably lead, under it. This would cut off the continuous supply of electrolyte, making a local cell with a lead anode, and no supply of electrolyte beyond that originally on the porcelain. We are encouraged to make this suggestion by the comparative absence of incrustation in the cases where iron brackets were used. If the explanation given is correct, it also leads to a curious conclusion corroborated by practical experience, namely, that though the anodes or positive mains are corroded, they have a tendency to insulate themselves as far as moisture is concerned, while the negatives are always tending to earth themselves as thoroughly as possible by accumulating conducting material by electrolytic creeping. It is also instructive to reflect that researches on such things as electric endosmose, made by scientific men out of pure wantonness, now throw valuable light on the causes of things so baneful to man as culvert explosions.

OBITUARY.

JOHN HENRY GREENER.

The death is announced, at the age of 66, of Mr. John Henry Greener, once a well-known figure in telegraphic circles. Mr. Greener died on Sunday at Herne Hill.

Born at Etherly, Durham, in 1829, Mr. Greener began his career in London on the Blackwall Railway, and was there first connected with the electric telegraph. In 1847 he entered the service of the old Electric Telegraph Company. In 1853, Mr. Edwin Clark being then engineer, Mr. Greener was appointed by the Company to proceed to Norway to construct the telegraph on the Norwegian Trunk Railway, which was at that time being made. This was the first line of telegraph erected in Norway. In 1855 he went to Denmark to construct the telegraph on the Royal Danish Railways. Shortly after his return from Denmark, Mr. Greener was ordered by the Company to proceed to Ireland, to report on the state of the telegraph lines between Dublin and Galway, for the purpose of establishing direct communication with the Atlantic cable. He was afterwards appointed by the Telegraph Company as outdoor assistant to Mr. Latimer Clark (then engineer to the Company), which position Mr. Greener held until the end of 1860. At this time he was selected by the Secretary of State for India as telegraph engineer to accompany the British Resident at Baghdad, to examine and report upon the condition of the Turkish telegraph lines from Constantinople, through Asia Minor and Turkish Arabia, down to the Persian Gulf, with the view of establishing overland telegraph communication to India, after the failure of the Red Sea cable. In 1862 Mr. Greener returned to England, and reported personally to the India Office as to the condition of the above lines, and the possibility of their extension through Mesopotamia to the head of the Persian Gulf. In the same year he proceeded to Bombay, to accompany, as telegraph engineer, the expedition for taking soundings and selecting suitable stations as landing places for the proposed cable from Karachi to Fao. Mr. Greener constructed the land lines from Baghdad through Mesopotamia down to Fao, at the head of the Persian Gulf. The cable was laid successfully to Karachi, and communication between England and India completed in January, 1864. In 1865 Mr. Greener returned to England and became connected with the India Office as Inspecting Engineer for Telegraph Stores. Mr. Greener was also Inspecting Engineer for Telegraph Stores for the Crown Agents for the Colonies, and for the Agent-General for the Cape of Good Hope.

THE ST. PANCRAS CONDUITS.

The following is the report presented to the Board of Trade by the Committee of Members of the Royal Society and the Institution of Electrical Engineers appointed to confer with Major Cardew with regard to the circumstances connected with the formation in large quantity of an alkaline deposit on the mains of the St. Pancras Electric Light Supply, and the presence in this deposit in some cases of the alkaline metals in an unoxidised condition :—

The Committee have held three meetings, and a *précis* of the proceedings at these meetings is attached to this report. After taking evidence as to the present condition of the mains of the St. Pancras electric lighting system, and after receiving from Prof. Thorpe reports of analyses, made under his direction, of the chemical composition of the incrustation found on the insulators of these mains, and of the salts contained in the bearers of these insulators, the mortar and concrete of the conduits, and the adjacent soil, the Committee are of opinion that the explosions which have occurred were caused by the firing of an explosive mixture of coal-gas and air by sparks caused by means of the above-mentioned incrustation. It has been proved that sparks may be caused either by the incrustation itself acting as an imperfect electrical conductor, or by moisture coming into contact with metallic sodium or potassium, both of which metals have been found to exist within the incrustation.

These metals have been produced by the electrolytic decomposition of alkaline salts chiefly derived from the soil, and conveyed by moisture along the fibres of the wooden bearers towards the negative conductor.

To avoid a repetition of these accidents, the bearers of the insulators at present in use should be replaced by other devices, through which moisture is prevented from travelling, and it is recommended that the pattern of insulator in use should be changed, and a pattern adopted in which a longer insulating surface is interposed between the conductors and the bearer.

The Committee is also of opinion that it is desirable that means should be provided by which the conduits can be inspected throughout their length, so far as is necessary to detect incrustations on the insulators. The Committee have not thought it within their province to investigate the causes of the presence of coal-gas within the electric lighting conduits, but it is obvious that this is the primary source of danger.—(Signed) P. Cardew, Rayleigh, T. E. Thorpe, William Crookes, R. E. Crompton, Alexander Siemens, Alexander B. W. Kennedy, March 22, 1895.

Précis of Proceedings of Committee.

Meetings of the Committee have been held on March 4th, 8th, and 22nd.

At the first meeting, Mr. Baron, chief engineer of St. Pancras Electric Light Works, gave detailed evidence as to the deposit or incrustation on the insulators on the St. Pancras mains, from which it appears that it was first noticed about 18 months ago, and found to be alkaline—that 60 to 70 per cent. of the whole number of insulators which can be examined, *i.e.*, those in or near the street boxes, are affected by it, and that in some cases when scraped off it forms again within 24 hours. That the insulators which are supported on wood bearers at the various street boxes are those generally affected, and only in two or three cases has any incrustation been found in the intermediate insulators within the culverts, which are supported on iron brackets. These wood bearers have become thoroughly saturated with saline moisture. They are supported at each end by being let into the brick sides of the culvert, and in some cases the end fibres of the wood may be in contact with the soil. Mr. Baron has seen the deposit flame with a yellow sodium flame in several instances when water was dropped on to it, or when it was dropped upon wet ground. He has also seen sparking from the negative main over the insulator to the wood bearer, and has produced the same by experiment with a solution of the material deposited. The insulator in this test was moistened on the surface with clean water, and the wood-bearer was standing in the solution. The sparks occurred in about five minutes. The glaze on the insulator has been attacked in some cases. He does not think that the process of salting the streets in order to melt snow has any connection with the formation of the deposit.

Mr. Miller, of the Kensington and Knightsbridge Electric Lighting Company, also gave evidence as to leakage from the negative main always attracting moisture, and stated that a negatively-charged cable belonging to his Company laid in the subway at Kensington Court had a small fault of insulation, which apparently gave rise to a moist efflorescence on the adjacent brickwork, which if brushed with the hand emitted a sort of phosphorescent light in the dark. His Company had experienced no trouble from incrustation on the insulators, but very high quality insulators of hardened glass or porcelain and of the "double shed" pattern were used. In their system every insulator used can be easily examined.

On March 6th Lord Rayleigh, Prof. Crookes, and Prof. Thorpe visited the St. Pancras mains. At a street box near the Chester Gate, Regent's Park, a piece of incrustation in a moderately hard and friable condition about the size of a hazel nut was taken from the negative main. This was placed on the cover of the street box and some water put on it, when it broke into flame. There appeared to be several nodules of metal, one about the size of a pea. This metal was solid. Some flashes of sodium flame were also seen along the wood bearer as if the metal had been deposited there. The wood was saturated with moisture, especially under the negative. This wood bearer was subsequently sent to Prof. Thorpe for examination. At the places corresponding to the position of the negative mains the wood was much blackened and carbonised, and very wet. On cutting it into six pieces it was found that the wood was saturated with alkaline salts, which were strongly caustic near the negative main, and chiefly carbonates of potash and soda at the ends. The soil, mortar, and concrete at this point have also been tested by Prof. Thorpe, and his analysis appears below.

At the second meeting of the Committee, Mr. Crompton produced three specimens of deposits taken from the insulators of the Southampton electric light mains. These have also been analysed by Prof. Thorpe (*see* below). Prof. Thorpe produced an analysis (*see* below) of three samples of the deposit obtained from the St. Pancras mains. Considerable discussion took place as to the exact process by which the incrustation and the free metal were produced, and it was finally decided to have another meeting before reporting. At the third meeting, on March 22nd, further specimens from the St. Pancras mains were examined and Prof. Thorpe's analyses were considered. A glass insulator from the Southampton mains, showing a considerable amount of deposit, was also submitted. The report was then discussed and adopted.

Analysis of Deposits obtained from Electrical Mains.

Sample from St. Pancras mains received March 2nd.

The substance had the composition

Caustic soda	7·69	per cent.	
Caustic potash	4·88	,,	
Sodium carbonate ...	34·40	,,	
Potassium carbonate...	52·77	,,	
	99·74	,,	(+ traces of silica, alumina, and lime.)

Three Samples from Southampton received March 9, 1895).

All are practically-pure sodium carbonate, with a very small admixture of potassium carbonate. The sample taken from the earthenware insulator is amorphous, and contains appreciable traces of calcium carbonate ; the other two (from glass insulator and distributor) are crystalline, and free from all except adherent impurities. None of the samples contains free alkali.

Soil, Mortar, and Concrete from St. Pancras.

The aqueous extract obtained from each of these by slow percolation had an alkaline reaction (alkalinity from 0·12 to 0·23 gram NaHO per 250 cubic centimetres of extract), and contained in each case compounds of sodium and potassium, the latter being present in moderately large proportion.

(Signed) T. E. THORPE, March 21. 1895.

Electric Light in Quarantine.—The New York health officer has arranged to use the electric light in passing vessels through quarantine at night.

ON THE QUESTION OF DIELECTRIC HYSTERESIS.*

BY ALFRED W. PORTER, B.SC., AND DAVID K. MORRIS.

The condenser on which the following experiments were made is the one referred to in a Paper by one of us read before the Royal Society on June 1, 1893 (Roy. Soc. *Proc.*, Vol. LIV., p. 7). It is a 5-microfarad condenser of tinfoil and paraffined paper, made by Messrs. Muirhead. In the Paper referred to it was shown that when it is allowed to discharge itself through a coil containing induction, the rate of dissipation of energy (calculated from the damping of the oscillations that occur) is greater than that due to the resistance of the outside circuit, the additional dissipation being equal to what would have taken place if about 59 ohms had been added to the circuit resistance.

The following experiments were made with the idea of ascertaining whether this additional dissipation is the result simply of viscosity in the dielectric of the condenser, or to true hysteresis of the charge with respect to the potential difference between the condenser plates. A sharp distinction is not always made between the two phenomena; it cannot be too clearly borne in mind that, on the one hand, viscosity is a "time" effect—*i.e.*, it depends on the rate of change of the variables; while, on the other hand, the phenomenon of hysteresis does not in any way involve the rate at which the changes in the quantities are made.

Rapidly performed series of cycles, such as occur during an oscillatory discharge, are hence unsuited for discriminating between the two causes: to test whether true hysteresis exists it is essential to so arrange the experiment that all viscous effects shall have had time to subside before any measurement of charge is made. Hence the interesting experiments made during the last three years by Riccardo Arnò,† in which a dielectric cylinder begins to rotate when placed in a rotating electrostatic field, as well as the experiments made by P. Janet‡, and by one of us using oscillatory discharges do not serve as test, experiments on this question. The arrangement which we adopted to test for hysteresis is as follows:—A battery (E.M.F. = 11 volts) is connected permanently in simple circuit with the ends of a rheostat of 850 ohms resistance. The condenser terminals can be put in contact by means of a two-way switch, with one end A, and an intermediate point B of the rheostat. The position of the point B is capable of continuous adjustment, and hence also is the difference of potential between the condenser terminals. The charge that the condenser possesses at any time can be ascertained by discharging it (by means of the switch) through a ballistic galvanometer.

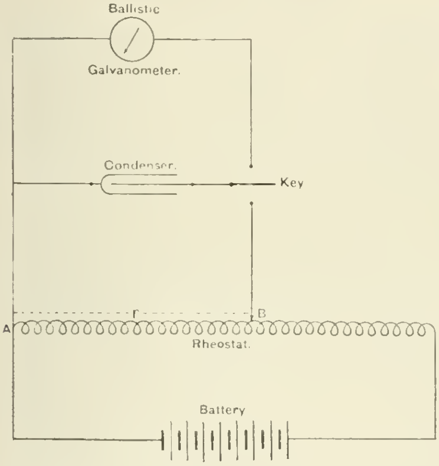

FIG. 1.

Since the methods for testing for hysteresis consist in putting the thing tested through cyclic series of states, it is essential that any change of state involved in the measuring operations should itself form part of a cycle. This was accomplished by making the cycles in the manner indicated in Fig. 2, which has been drawn as it might appear if considerable hysteresis were present.

Commencing at the point R in the cycle (*i.e.*, with no difference of potential between the terminals), the potential difference is gradually increased until the point P on the curve is reached: the condenser is then discharged; the portion of the curve P U is traced during the "instantaneous" discharge, and the galvanometer indicates the loss of charge P T, which includes whatever viscous flow takes place during the time of throw of needle ($2\frac{1}{2}$sec.). While the galvanometer is still in connection with the condenser a further viscous flow takes place, until, if the cyclic state has been set up, the starting point R is arrived at. Before allowing the switch to again connect the condenser to B (Fig. 1) the rheostat is unwound so as to bring B back to A; there is then no potential difference between B and A, and the condenser receives no charge when the switch completes connection. After this connection has been made the potential difference is again gradually increased, but to a higher value than before—to S (say); it is gradually diminished till it has the same value as at P; we thus arrive at a point Q; the condenser is then discharged through the galvanometer; the throw of the needle measures the loss of charge Q T, which includes the same viscous effect as before; the point U is reached during the throw of needle: after which a further viscous flow takes place, until (if the cyclic state be set up) the point R is returned to once more. The contact B is moved back to A while the condenser is still detached from it; and this series of operations is then many times repeated.

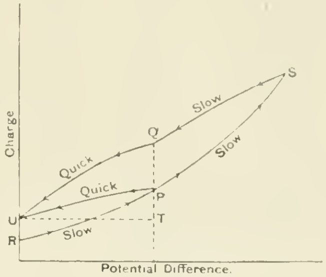

FIG. 2.

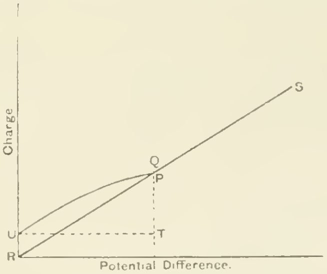

FIG. 3.

If the dissipation of energy in the condenser is due to hysteresis, then, as in the magnetic analogue, we know that the cyclic curve will embrace an area, and the point Q will not coincide with the point P; and the converse of this is also true if time has been given for viscous effects to subside. If, on the other hand, experiment shows no difference in the charge when at Q from what it is at P, there can be no hysteresis, unless of an amount so small as to elude this method of detecting it. The following figure (Fig. 3) shows the kind of curve that will be traced if hysteresis be absent.

The experimental results are given in Table I. The point P was so chosen that the charge was then almost exactly half of the maximum charge. The duration of a cycle of operations was never less than five minutes. The galvanometer throws were read by a telescope and scale, and are expressed in centimetres. As both galvanometer mirror and telescope are of fine quality there is no difficulty in detecting a tenth of a millimetre on the scale.

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* Paper read before the Royal Society.

† Published in the "Rendiconti della R. Accademia dei Lincei," October 16, 1892, p. 284, April 30, 1893, p. 341, November 12, 1893. p. 260, March 18, 1894. p. 272, June 17. 1894. p. 585, November 18, 1894. p. 294. For translations *vide The Electrician*, March 3, June 23, December 29, 1893, and January 18, 1895.

‡ "Sur les Oscillations Electriques de Période Moyenne," *Journ. de Phys.*. August, 1893. For other recent literature on the subject *vide* A. Hess, "Sur les Diélectriques Hétérogènes," *Journ. de Phys.*, April, 1893; Steinmetz, *The Electrician*, April 8. 1892 (from the *Electrical Engineer* of New York).

Table I.

Discharge at P.		Value of $q - p$.	Discharge at Q.	
Time of discharge.	Galvanometer throw (p).		Time of discharge.	Galvanometer throw (q).
HRS. M.			HRS. M.	
11 27	52·61	−0·11	11 33	52·50
11 37	52·72	+0·06	11 44	52·78
11 48	52·77	−0·01	11 52	52·76
11 56	52·71	−0·01	12 4	52·70
12 6	52·63	+0·02	12 10	52·65
12 12	52·61	+0·03	12 17	52·64
12 21	52·53	+0·06	12 25	52·59
12 28	52·45	+0·06	12 32	52·51
12 36	52·49	+0·05	12 44	52·54
12 46	52·53	−0·03	12 50	52·50
12 53	52·48	−0·03	12 58	52·45
12 60	52·43	−0·02	1 4	52·41
2 39	52·04	+0·02	2 45	52·06
2 54	52·00	−0·02	2 58	51·98
3 4	51·98	−0·03	3 11	51·95
3 14	51·95	−0·06	3 18	51·89
3 21	51·92	+0·04	3 25	51·96
3 27	51·83	−0·05	3 31	51·78
4 32	51·70	−0·07	4 36	51·63
4 39	51·55	+0·04	4 42	51·59
4 44	51·56	+0·02	4 48	51·58
4 55	51·55	+0·02	5 00	51·57
5 4	51·53	+0·03	5 8	51·56
5 11	51·53	+0·00	5 16	51·53

—	At P.	At Q.
Mean of first 12 throws	52·580	52·586
Mean of second 12 throws	51·762	51·757
Mean of all 24 throws	52·1710	52·1715

It will be observed that the throws fall off gradually throughout the experiment in consequence of gradual failure of the battery power; but as this affects both series to the same extent, it has no influence on the ratios. Individual values of the ratio

$$\frac{\text{Throw at Q}}{\text{Throw at P}}$$

differ amongst themselves by small amounts, being below unity in 11 cases, above in 12, and equal to unity in one case. The ratio derived from the first 12 values is $1+\frac{1}{8750}$, that derived from the second 12 values is $1-\frac{1}{10350}$. The best values of the ratio derived from all 24 values approximates still more closely to unity.

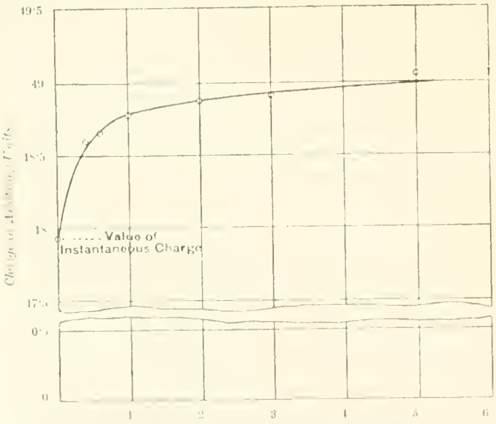


Fig. 4. Relation between Charge of Condenser and the Duration of Application of Charging Electromotive Force.

Hence the position of the point Q in the diagram is indistinguishable from the position of the point P; and we may conclude that when time has been given for viscous effects to subside the charge of the condenser is the same for a given value of the potential difference, whether that value has been arrived at from higher or from lower values than itself.

Since, until further experiments be made, this conclusion can only be taken as applying to the condenser when under the conditions of this experiment, it is necessary to form an idea as to the highest value of the electromotive intensity which was produced in the dielectric. Only a very rough estimate of its value can be made without dismounting the condenser. If we assume that the thickness of the paraffined paper is about 0·01cm., then, with 11 volts potential difference between the plates, the electromotive intensity equals 1,100 volts per centimetre, or about 3·7 electrostatic units. If we take the dielectric constant of paraffined paper as 2, the corresponding electrostatic induction is 7·4 electrostatic units. It may be mentioned that in the experiments of Signor Arnò the induction ranged from 0·03 to 14·58 electrostatic units.

In order to give an idea of the viscous effects which come into play in the same condenser, we have ascertained the variation of the charge which it takes up on the application of an unvaried E.M.F. to its terminals for different intervals of time. The results are plotted in Fig. 4. The time constant of the rise of charge, calculated from the capacity of the condenser and the resistance of the circuit through which it was charged, was less than $\frac{1}{20000}$ of a second; hence in seven times $\frac{1}{20000}$ of a second the charge would have risen to within $\frac{1}{10}$ per cent. of its final value if dissipation of energy had taken place only in the outside circuit.

Thus, while the condenser here experimented upon exhibits marked viscous effects, yet we can detect no hysteresis.

The foregoing experiments were conducted in the Physical Laboratory of University College, London, and our thanks are due in many respects to Prof. G. Carey Foster in connection with them.

ELECTRIC LIGHTING FOR RAILWAY PURPOSES.

The following is an abstract of the discussion which took place at the Institution of Electrical Engineers on Thursday, the 28th ult., and Thursday the 4th inst., on the Paper read by Mr. Langdon. Speakers who have returned their proofs revised have their names prefaced by an asterisk:—

The PRESIDENT (Mr. Crompton) said that before the discussion opened he would like to say that the Paper bristled with interesting points. He might just point out a few of the questions that he hoped would be dealt with adequately in the discussion. There was the question of series *versus* parallel systems of arc lighting, the question of the proper height of posts, and the very beautiful device of the light-bridge at Leeds. It was astonishing to find that the first unbiased accounts of the respective costs of electric lighting and gas came before them from a railway engineer. Electric light men would not have dared to put them in such a straightforward manner. He (the President) had been much interested in the remarks of Mr. Langdon upon the question of steam *versus* gas for generating purposes and also in his remarks on direct driving.

Mr. FLETCHER said Mr. Langdon had told them a good deal about steam plant, but very little about gas plant. The installation to which he was going to refer was entirely town gas at 3s. per thousand. The plant had been running since the beginning of October last, and they had there three 55 H.P. tandem gas engines, driving three 36-unit dynamos, one a stand-by, the other two running. The three-wire system was employed. At the outset the question was gone into thoroughly whether they would run on the ordinary parallel system or on the three-wire system. They found that the three-wire system lent itself the more readily to the conditions, and in calculating it out they found it would be very much cheaper. The method of distributing was really from the distributing board in the engine room itself. They had, therefore, fourteen outside conductors going, each of these going through the recording instrument. These were divided up, the arc circuits were kept by themselves, and the incandescent circuits by themselves, so they were able to get at reliable figures to a certain extent with regard to each. Mr. Langdon had told them that his records were taken hourly; their meters were read every quarter of an hour, so that they got a little nearer to absolute accuracy than Mr. Langdon did. During the week they produced somewhere between 2,000 and 2,500 units, and they were able to do that, taking the arc and incandescent together, at 2¼d. per unit, including, as Mr. Langdon did, all station charges, carbons for arc lamps, renewals of incandescent lamps and other charges which might crop up. They could very safely say they were producing the current at 2½d. per unit, including all charges. He might mention that they had there 720 incandescent lamps and 36 double-carbon 32-hour arc lamps. They found a very great economy in using double-carbon lamps. It might interest them to know something of the gas engine. It was a gas engine which they were practically the first people to use; the engine was built on the tandem principle without any stuffing boxes.

*Dr. DU RICHE PRELLER said that from his own experience he ventured to say that when they got town gas at 2s. or 2s. 3d. per thousand cubic feet, it was preferable to Dowson gas if only for this reason: that they saved the first cost of installation of a gas plant. The second point he should like to refer to was the distance between the arc lamps in station yards and the height above the rails. If he took Mr. Langdon's maximum figures, which were 90ft. or 100ft. apart and the height 20ft., that would be equal to about three arc lamps of 2,000 C.P. per acre. That certainly seemed a great deal; but, of course, the density of the atmosphere had to be taken into consideration. What he should like to ask Mr. Langdon in this connection was, whether he has ever tried to raise the height from

20ft. to 40ft. ! He had had occasion to inspect a good many of these installations on the Continent, in Germany, France, Italy and Switzerland, and there the universal rule was to place the focus at a height of from 50ft. to 60ft. above the rails. The distance between the lamps was about the same, 80ft. to 90ft. or 100ft.; the globes were opalescent. He was speaking, of course, of 2,000 c.p. lamps of 12 to 16 amperes. The third point he should like to refer to was the question which Mr. Langdon had raised with regard to direct or alternating current for light and motive power in railway stations. He should have no hesitation in answering that, by saying that it should be an alternating current – single, two or three phase – according to the proportion of light and power. In this connection he might mention an interesting instance of that kind which he saw in the initial stage last year at Dresden, in Saxony. The installation was by Siemens and Halske, and was a three-phase installation. There there were three central railway stations, and all the three were supplied from one central electric-lighting station erected for the purpose. The total power was 1,300 H.P. The original voltage was 100 transformed up to 3,000 volts and then down to 200 volts at the points of consumption. The transmission circuit was five or six miles in length.

THURSDAY, APRIL 4TH.

*Mr. LANGDON said on the occasion of the last meeting reference was made to the question of interest and depreciation. He had always regarded the question of depreciation as rather a bugbear, for the reason that electrical machinery, if any machinery at all, must be kept in the most perfect order. There was no possibility of allowing that to depreciate. Hence it was a question whether any amount at all should be allowed for depreciation. But there was just this to be said, that the time might come, although they kept everything in perfect order, when it would be necessary to replace existing machinery by that of an improved character, and so, perhaps, it would be right to make some allowance for depreciation. That allowance, however, ought to be very small in his opinion. He had, as an extreme measure, and purely for the purpose of comparison with the cost of gas, taken 5 per cent. for depreciation or renewal of plant. Interest he put at 3½ per cent. That would be 8½ per cent. on the capital required, and based upon that he had drawn out a statement in continuation of that comparison he made in the Paper between the cost of gas and the cost of electric light, in three sheds on the Midland Railway. The result was that, instead of making a saving of £1,050, they made a saving of £615. He wished to emphasise this, that this was taking into account all charges for electric light. There were the renewals, repairs, cleaning, and other expenses, which they had to call to account; but with regard to gas, they took only the cost of the gas itself.

*Mr. J. S. RAWORTH, after complimenting the Midland Railway Company on the work they had carried out and upon the general excellence of their arrangements, said he had himself had some experience of railway lighting. He was disappointed to find no reference in the Paper to the electric lighting of trains. He took it, however, that Mr Langdon's opinion was that the use of electricity for lighting trains was not yet quite practicable. He had already discussed this matter with two or three other gentlemen, and they did not agree with this opinion. They said it was practicable, and that it had worked well on the Brighton line and elsewhere. He quite admitted that it had worked well on the Brighton line, but it must be remembered that in that case there were some remarkable circumstances. The locomotive superintendent commenced the operation by taking out a fundamental patent in the way of train lighting. He knew Mr. Langdon had tried a scheme for lighting on the Midland Railway, and while it lasted that was very successful. The light was very good, and if it failed he was sure it failed on its demerits. He thought they would have no opportunity of seeing electric lighting of trains thoroughly and practically tested until somebody put two towns at a certain distance apart, and ran trains between those two towns. Under such circumstances, he had not the slightest doubt electric light would beat gas and oil by two or three to one. Coming to the question of arc lamps, he saw Mr. Langdon had a little device which he believed he (the speaker) had the honour of inventing. That was of fixing the arc lamp on its foot, although it appeared to him that Mr. Langdon had not taken quite a full advantage of it, for he saw he had hooks above, which he supposed was for the purpose of sustaining the weight, thus preventing the easy unshipment of the lamp from below, which is the chief merit of the arrangement. He wanted to say one word on Mr. Langdon's costs. If they came to add up the total output of the electric lighting stations under his care, they would find it did not amount to very much. He thought Mr. Langdon was to be congratulated on the excellent results he had obtained from these numerous small isolated stations. The highest figure of total cost given was 4d., and the smallest 2·7d. Those figures were very good, and compared on the average very favourably with the cost of lighting stations constituted under far more favourable circumstances. He thought, however, this was an example of a business well conducted by people who understood that business.

*Mr. W. LEONARD said Mr. Langdon, in his preliminary remarks, referred to several railways which had adopted the electric light in its early stages, but he omitted to mention the South-Eastern Railway. He thought it was due to Sir Myles Fenton to mention that he was one of the first to recognise the advantages of the arc system of electric lighting in its application to railway stations and the lighting of busy centres. The President would probably recollect that in 1881 he introduced a small plant at Bricklayers' Arms Goods Station. He thought that might be called the President's preliminary encampment, for it was practically a small tent, with a temporary lighting plant consisting of a portable engine and about four Gramme machines to light four arc lamps, and that, he believed, was in use for some considerable time. In 1882 the Brush Company started the lighting of the Charing Cross Station and in the same year the British Electric Light Company took up the lighting of the Cannon-street Station, and the three stations had been lighted continuously from those dates up to the present moment. At Bricklayers' Arms they had now 25 10-ampere lamps of the Brush type and the Brockie-Pell, 12 outside and 11 in the sheds. The circuit extended three-quarters of a mile, and they had a Brush dynamo capable of lighting 40 or 50 lights. The lamps were switched on independently, first the inside lamps, 14 in number, and then the outside lamps, and in the morning they were switched out in the reverse order. The cost of running those lamps for last year was just under 1¼d. per lamp-hour. At Charing Cross Station, after the Brush Company had given them notice that they wished to give up the lighting, they made arrangements with the Charing Cross and Strand Company. Those lamps were supplied and maintained throughout at 5d. per unit, including the carbons. At Cannon-street, following the same example, they had made arrangements with the City of London Company to light the station, and their lamps had been running now for about six months. Mr. Langdon mentioned that clear globes were not a success on the Midland. He might state that so far as they were concerned their lamps were placed higher and further apart than Mr. Langdon's, and they found that people very much preferred the clear globes when that was the case. He had no doubt that if a uniform generator could be applied for arc and incandescent lighting, there would be a good scope for contractors because one of the difficulties at railway stations was that a very small plant was required, and to have duplicate machines of different types was a very great disadvantage.

Mr. E. MANVILLE said that a point which had struck him was that for all the extensive lighting undertaken by the Midland Railway the current was kept down to 10 amperes, many lamps apparently being only of 7½ amperes. He thought it was apparent to most of them who had had to do with lamps of high candle-power that even a comparatively small increase in the current taken by an arc lamp was productive of great extra efficiency in the light. For lighting the streets of Portsmouth, he believed for the first time, lamps of 12½ amperes had been used. He felt from his experience there that an increase of current of from 10 to 12½ amperes had been of very great benefit to the general lighting of the streets. Mr. Langdon laid considerable stress upon the adoption of plants in which both arc and incandescent lighting, both extending over considerable areas, were supplied from the same plant. That was exactly what they had carried into effect at Portsmouth. The incandescent lighting was effected on the transformer distribution system with a low-tension network, and from the omnibus bars of the station the arc lighting was also effected by means of transformers and rectifiers. These rectifiers, which he believed to be the first introduced for practical use in the kingdom, had proved themselves eminently satisfactory in meeting the conditions of series arc lighting, and they certainly had achieved great economy.

Mr. ALBRIGHT said a good many of them knew the facts Mr. Langdon had stated in regard to cost and so on, but coming from them those facts would never have produced the effect they had from the mouth of the author. In his opinion, the great improvement in arc lamps, with which they were all acquainted, led the way to an immensely extended adoption of electric lighting for goods yards and so on; but it was a mistake to over estimate the advantages and to talk about a 10-ampere lamp as of 2,000 c.p. Most of them knew that the actual candle-power of such a lamp, when placed in a globe or lantern, was not much in excess of 1,000 or 1,200 c.p. He believed the best system for large railway stations, stores, offices, &c., was the direct-current system, whether they called it the three-wire system or parallel system with middle wire, at 220 or 440 volt pressure. Whatever merits alternating currents might yet be proved to have in small towns with extended areas, he thought very few impartial engineers equally concerned, like himself, in making alternating and direct-current machinery, would advocate its adoption for railway-station work. He was also inclined, on somewhat similar grounds—those of safety—to condemn high-tension direct-current series arc lighting, and also because all the lamps on that system, without considerable complication at any rate, had to be of practically the same size; whereas, in inside warehouses under low-roofed stations, and in many other places, small arc lamps might be advisable. In other places he entirely agreed with Mr. Manville—large arc lamps were probably much the best. He did not know whether Mr. Manville meant to say that 12½-ampere lamps were first used at Portsmouth or whether *he* first used them there. As a matter of fact, his firm had been in the habit of using 12½, 15, and even 20-ampere arc lamps under similar conditions with favourable results. He believed 15 to 20-ampere lamps, 50ft. to 60ft. above the ground, were the best to adopt in goods yards and similar places. Returning to the system to be adopted. With series arc lighting, supposing a waggon were derailed, or any similar accident occurred, under many circumstances they would extinguish at one blow 50 arc lamps, whereas by the three-wire system four to eight lamps would be the maximum extinguished by such an accident. The very fact that they could now rely upon 220-volt incandescent lamps tended to make that system simplicity itself. It also enabled the requirements of the author, to which Mr. Manville also alluded, namely, to have the whole of the operations of incandescent lighting and arc lighting and the use of motors to be performed from one machine, to be easily fulfilled. At the same time, he did not agree with the author if he meant that one single machine and one single engine should be employed for such a piece of work as that. Another advantage of adopting such a system as he was advocating was that arc lamps of any size could be used as required, in some places 5, in others 10, 15, or 20 amperes. He thought it was extremely probable that, depending on the particular requirements of every case, accumulators would be a very great improvement and benefit as an addition to such a system. He believed generally that it would pay to introduce them.

especially with the greatly reduced first cost of accumulators now established. His idea of how passenger stations, goods yards, store sheds, &c., should be worked was that a low tension network should be laid throughout. In addition to the permanent lamps and motors, there should be a number of points at which plugs might be inserted for running portable arc lamps, incandescents or motors according to requirements. This was not merely an idea on his part, for at the present time it was actually carried out in the Albert and West India Docks over a total distance of five miles. He was informed that the cost of the conductors in this case was most carefully considered before the system was adopted, and in being worked out it was found on the question of the conductors alone this three-wire system was cheaper than the high-tension system. In regard to cost of production, he believed now that cranes, capstans, winches, pumps, travellers, hoists, &c., could be and were being worked electrically, they would be able to obtain a very fair day load in such situations as Mr. Langdon had drawn attention to, and that gentleman's figures, good as they were, would soon be able to be cut down from 25 to 50 per cent. He thought this state of things would be realised before they were much older in several of the chief railway stations and yards.

Mr. R. W. WEEKES said in reference to Table II. in Mr. Langdon's Paper they got the fuel exceedingly cheaply on the railways, and at the same time the machinery was well looked after, which kept the cost down; but when they looked at the labour item in the cost of production, he thought they found it was considerably higher than in any ordinary direct-current station of an output almost in a line with that in the railway stations referred to.

*Capt. SANKEY called attention to the last column in Table II. It would be observed that in every case the cost of coal per unit was less for the half-year ending December than for the half year ending June, the evident cause being the better load factor. Mr. Langdon had given two load curves for the Derby Station, one for December 21st and the other for June 24th. He (the speaker) had worked out what the cost of coal consumption ought to be for those two load curves, that was to say, if the engines were working absolutely in the best conditions having regard to the load. He was able to say this, because he knew the consumption of these particular engines at every point of the load curve. The result came out thus: for the load curve for December the coal was 0·23d. per unit, and for June it was 0·84d. per unit. It was evident from that that an enormous difference was made by the load curve. The average of those two figures was 0·53; the average of the figures given by Mr. Langdon for Derby was 0·59. It was very remarkable, he thought, that those figures should agree so nearly, that there should be so little difference in the actual working figures and those obtained by calculation. He thought the reason was that the station at Derby was looked after in a most exemplary manner. The way in which those calculations were made was described for the first time in some remarks he made on Mr. Crompton's Paper on the cost of electric lighting read before the Institution of Civil Engineers. Mr. Langdon had favoured him with two load curves for the Lawley-street Station, Birmingham, from which he had calculated the cost of coal per unit; the average was only 0·32d. per unit, owing to the better load factor, notwithstanding, that the engines were simple. The actual average cost as per Table II. was however, 0·52d. per unit, from which it was evident that this station was probably for some local reason not worked to the same advantage as Derby.

*Mr. A. P. TROTTER said Mr. Langdon had given them a very lucid description of a plant for producing a certain result. But the result was not putting down so much plant, that was the result to the contractor, but the result to the company was the production of a certain amount of useful illumination, and on that point Mr. Langdon had not given them much information. He had worked out from Mr. Langdon's figures what that gentleman had really been doing, that was to say, what Mr. Langdon had obtained in the way of useful illumination. It was very important that they should know what was the illumination which was found suitable for such work in order that future contractors might be guided by it. In goods yards there were two purposes for which illumination was wanted: one for reading the labels in transhipping packages and so on, and another was for shunting. A comparatively small amount of illumination would do for shunting, so long as it was uniformly even and the lights were not dazzling; but a better illumination was needed for reading labels, for the coefficient of the man's handwriting came in. Mr. Langdon gave a little information about the size of the lamps so far as amperes were concerned, but did not say what the watts were. Even the candle power was hardly worth while talking about. What was wanted was the result in illumination. The candle-power of an arc lamp varied in different directions, and for this purpose they must really consider that the candle-power of an arc lamp was different in different directions. It was a matter of simple calculation, and just to refresh their memory he had placed a diagram, Fig. 1 [reproduced], on the board, and from this he had deduced what Mr. Langdon was doing. They might remember that in a Paper he read some time ago he showed that, taking a polar curve, a semi-circular curve fitted the light of an arc lamp to 60deg., and then fell off. Below that it went off, depending rather on the length of the arc. He had shown, in a Paper before the Civil Engineers, that the illumination from 90deg., with the vertical down to 60 deg., varied as the fourth power of the cosine of the angle of inclination. The question was, in some of these cases, whether you wanted a high maximum or a high minimum. For a goods yard he should say the minimum illumination was the important thing to observe. Mr. Llewellyn Preece, who was on Mr. Langdon's staff, communicated some calculations in an article in one of the journals in September, 1893, in which he calculated out the cosine of these curves, and gave a table from which it was easy to deduce the illumination of arc lamps from the distances apart. He (the speaker) had recalculated that diagram (Fig. 2) and extended it to greater heights. The dots showed lamps of 20ft., 30ft., and 40ft. high; the illuminations were plotted vertically, and distances horizontally. They would see that with lamps on posts 50ft. high, the minimum was better than in any of the other cases. He had also worked out some figures from Mr. Langdon's data, and he would just put them down. He had taken the candle-power of the 6·8 ampere lamps at 900, and the 10 ampere lamps at 1,500 c.p. This was not a laboratory measurement, but, for a lamp in a dirty glass, it was about as near as they could get it.

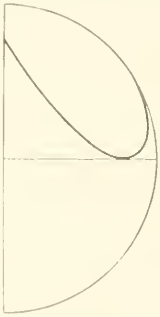


Fig. 1.

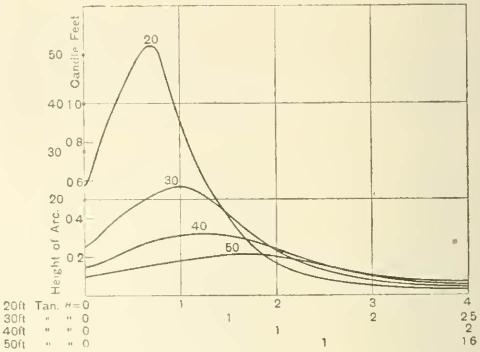


Fig. 2.

C.P.	Height of post (feet).	Distance apart (feet).	Illumination.	
			Max.	Min.
900	20	90	1·1	0·206
1,500	20	120	1·85	0·12
1,500	25	120	1·17	0·153
1,500	40	120	0·5	0·28
900	40	120	0·3	0·168

The maximum illumination, due to the 900-c.p. lamp on a 20ft. post, was about 1·1. About half a candle-foot was the best he had found got in the City; at least, it was so at the time of his observations. If the 1,500-c.p. lamp were raised to 25ft., the maximum was about the same, 1·17, and the minimum was increased to 0·153. For the lighting of goods yards and the like they should attend to the minimum, and leave the maximum to take care of itself. With 40ft. posts 120ft. apart, the minimum was increased to more than a quarter of a candle-foot. But, taking the smaller lamp, 900 c.p., and putting that on a 40ft. post, they got a *better* minimum than with the 1,500-c.p. lamp on a 20ft. post, when they got 120ft. away from it. Dr. Preller had mentioned that a 40ft. post was a good thing, and said that even 50ft. and 60ft. posts were used on the Continent 80ft. or 90ft. apart. There was no need to go so far as the Continent for such lighting. At Nine Elms the posts were 50ft. high, and 80yds. to 90yds. apart. The ratio of distance apart to the height was the really important thing in such lighting as this. Taking Mr. Langdon's own figures, and running out the ratio, one ratio was 4·5, then at St. Pancras 4·3, and far end of platform 6·4, and so on. That was to say, the lamps were six times as far apart as they were high. It was pretty much the same with street lighting; it gave you a fair distribution and a fair chance of getting a good minimum of lighting. The minimums in the City lighting, as he had measured them, were considerably lower than might be expected. In the City lighting about half the whole area of the street was less than 0·1 candle-foot. That was when the lamps were at their best. The observations were taken in the winter of 1891 2. The lighting of Whitehall by gas was about the same; outside, in Great George-street, it never got up to 0·1 anywhere; it varied from 0·03 to 0·005 candle foot. That would not do for a shunting yard. One point which was very important for such work was to have fairly high lamps, to get rid of dazzling.

Mr. **ALEXANDER SIEMENS** said as they were on the point of height of lamps and distance apart, he might say that in 1879 they lighted the Royal Albert Docks with lamps of 28 amperes with an average of 80ft. high and 270 yards apart. The question of what height a lamp should be was an extremely simple one; it was a question of differential calculus of the maximum and minimum. The height ought to be about two-thirds of the distance between the lampposts to get the maximum illumination in the centre of the space between the two posts.

*Mr. **CHAMEN** said on the question of lighting warehouses he would like to mention an arrangement of inverted arc lamps which was put into some of the sheds at Southampton Docks at the suggestion of Mr. Aldridge. The shed first experimented upon was one through which the whole of the American Line passengers had to pass on embarking or disembarking, and a very great portion of the cargo was also handled in the same shed. It was first lighted with incandescent lamps; the light was complained of, lamps of higher candle-power were put in; the light was still complained of, and still more lamps were put in. No satisfactory result, however, could be obtained. The roof of the shed was then whitewashed throughout, and 12 10-ampere inverted arc lamps were put up in place of the whole of the previous incandescent arrangement. The result was a considerable economy in current, the arc lamps using, if he recollected rightly, about half the amount of energy taken by the incandescents; the lighting, on the other hand, was everything that could be desired, the smallest writing on any of the labels on packing cases could be read with ease in any part of the shed. The shed measured approximately 350ft. long by 120ft. wide, and the height from floor to principals was about 8ft. on the side where the trains came in, and he believed about 12ft. on the other side. It had since been decided to light some of the other sheds in the same way. On the question as to the system which should be employed to meet the conditions of general railway lighting, he certainly thought that a three-wire system at either 220 volts or 440 volts, or possibly even higher still, would be found to answer every requirement which Mr. Langdon could find, except perhaps, that of lighting a long line of suburban railway stations, a thing which, however, he believed had not yet been done by any railway company. For such work as this he thought an arrangement of high-pressure alternators and transformers, and possibly rectifiers also, if any arc lamps were required, would be found the most economical arrangement. Mr. Langdon did not seem to have tried using larger lamps placed higher and using fewer of them, 45ft. up, 15 amperes, 100yds. to 110yds. At the Crystal Palace there was a plant consisting of a Galloway engine capable of indicating somewhere about 130 H.P., and a Lancashire boiler. The engine drove three 550-volt compound dynamos by means of countershaft and belting. Each dynamo supplied 33 arc lamps, arranged in three circuits of 11 each. The lamps were suspended by means of hoisting gear from the 60ft. gallery, and were generally kept at a height of about 17ft. 6in. from the ground. They were spaced about 56ft. apart in two straight lines. The hours of lighting varied considerably, the longest run being seven hours and the shortest 30min., so that in summer more coal was wasted in getting up steam than was used in running the lights. The results of the year's working, from October, 1893, to October, 1894, which had been given to him by Mr. Carr, chief engineer of the Crystal Palace, were as follows:—Total units generated, 45,584; total lamp-hours, 82,880; cost of coal, 19s. 6d. per ton; total cost per unit generated, including coal, oil waste and petty stores, carbons and all wages, 3·2d.; total cost per lamp-hour, 1·77d. Taking into account depreciation, or rather redemption reckoned on the original cost of the whole plant, some items at 10 per cent. and some at 5 per cent., but most at 10 per cent., the total cost per unit came to 5·21d., and the total cost per lamp-hour 2·87d. Of course, the efficiency of this plant was not so high as would be obtained with modern type direct-driven sets. The I.H.P. required to drive the 99 lamps was slightly under 100; whilst running the engine, countershafting belts and dynamos light, that was to say, with the brushes lifted, indicator diagrams showed 22·5 H.P.

Mr. **A. H. PREECE** said Mr. Langdon had referred in his Paper to the installation of the Great Northern Railway Company. He thought a brief description of what they had done there might be interesting to members. They had practically installed there 1,317 I.H.P., the plant being capable of lighting, including spares, 500 10-ampere arc lamps and 20,000 8-c.p. glow lamps. The engines, five in number, were Fowler's slow-speed engines, each driving two 50-light Brush dynamos. The glow-lighting dynamos were of 300 and 250 kilowatts. The circuits were arranged over a length of five miles. They had to deal with the problem of lighting a long narrow expanse of goods yard, seven miles in length, and it was utterly impossible to do anything but use the alternating-current system. In this length they started from King's Cross, and lighted the station and the goods yard; and they also lighted the goods yards at Holloway and Finsbury Park, and showed the light right down to Hornsey; before long all the suburban stations in that direction would be lighted. At present there were 300 arc lamps installed, and 7,000 glow lamps. The principal point of interest to members would be that of cost. They had had a fair load on since July last, and their generating costs came out at an average of 2·67d. per unit, exclusive of carbons and cleaning arcs: the total came to 3·37d. The interest and depreciation came to about 1d. a unit, which must be added to the other figures. From December to March—which was, of course a heavy time—the load increasing every month, the costs had gone down to under 3d. per unit. The coal was about 0·9d. per unit, and the wages, another big item, 0·97d. per unit. As regards the wages they were in rather a difficulty because the station was under two heads, the locomotive department taking the engines and boilers, and the telegraph department the electrical part, the result being that there were two complete staffs in the station, which was not conducive to economical working. As regards height of lampposts and the distances apart, they really could not, in putting light in a goods yard, go into small figures such as Mr. Trotter had dealt with; they wanted light at certain points where the lines branched, and they had to put the lamps there, so that the lamps were scattered about all over the yard without much regard to uniformity, the brilliant light being at the places where the crossing-over took place. In the sheds they wanted as much light as possible. In the Great Northern sheds the lights were 16ft. high and 14ft. apart; in the goods yards they were on 20ft. posts 80ft. to 100ft. apart.

Mr. **W. M. MORDEY** said Mr. Langdon asked in the latter part of his Paper what the future means was going to be for the distribution of electricity for the general purposes of railway working, and he imagined that Mr. Preece had just given them the information which Mr. Langdon expected when he said it was not possible to carry out the broad scheme of lighting and distribution they had in view at King's Cross by any other than the high-tension system. He supposed, as Bismarck said the other day, they must either fight or fossilise; so, at the risk of reopening a question most of them thought had closed, he must ask those interested in railway working to consider whether the future development would not take some such direction as Mr. Preece had indicated. It was not possible, he thought, by any two or three-wire system to carry out work on a scale of the King's Cross sort in any satisfactory way. The arc lighting at the Great Northern Station, and the arc lighting Mr. Langdon had carried out, had been nearly all done on the series high-tension system, and there was no doubt that system had many advantages. It did not require any arguments from him, because there was no other system where they had to deal with arc lighting and arc lighting alone. He was an advocate of direct currents for arcs where they did not want a large amount of other work which could be done better in other ways. If the arc lighting was a comparatively small portion of a large scheme, then he thought arc lighting should also be done by alternating currents or rectified alternators. Mr. Ferranti, as they knew, was trying to introduce rectifiers for that work. He (the speaker) wished him success, not only for his own sake, but because it would enable them to combine the advantages of two systems. It gave them what some of them thought was an advantage in arcs—the downward light. He was, however, getting a little shaky on this point. They always used to be taught that the downward light was an advantage. Another argument against alternating current arc lamps was that they did not give as much light, but he thought that was exploded. A really large system, where they had to supply all parts of a station from a distance, motors as well as lighting, and where they wanted to be able to turn out different circuits, could, he thought, be most satisfactorily carried out by alternating currents.

*Mr. **J. N. SHOOLBRED** said there was one point he was surprised none of the speakers had yet referred to, and which to his mind formed a very serious blot on the very fine work Mr. Langdon had carried out. That was the utter absence of any guarantee or safeguard against breakdown. This was not merely a source of inconvenience, but of positive danger, and he thought some attention ought to be paid to it.

The **PRESIDENT** (Mr. R. E. Crompton) said he wished there was time for him to speak on the subject of the Paper, as it related to the kind of thing with which he commenced his career. He supplied lamps to St. Enoch's station in the very early days, when very few people dreamt of electric lighting. Mr. Siemens, Mr. Raworth, and himself were connected with the lighting of St. Enoch's, King's Cross, and Bricklayers' Arms in 1881, so that railway lighting had now reached a very respectable age. One point not touched upon was the enormous benefit railway men had derived from the electric light. A very great saving of life had resulted from its adoption. He was not going to be tempted, even by Mr. Mordey, to go into the subject of alternating currents. Mr. Mordey knew he was talking nonsense when he talked about the one system or the other being dead. Mr. Mordey could not have chosen a worse example than to put an alternating current in a goods yard. Mr. Trotter had communicated one of the most important and useful contributions to the subject. One of the most important things to know was what should be the proper height, and what the proper power of the lamp. He was quite in agreement with Mr. Siemens on that point; that gentleman's firm in the very early days hit upon what had been the best practice, and which had been mainly followed by his (the President's) firm. Mr. Manville ought to know that 15 and 13-ampere lamps had been the rule, and 10-ampere lamps the exception. Mr. Langdon used 10 amperes and smaller because the plant came over from America equipped for that size. It was American practice to use 10 amperes, but it was English practice long anterior to that to use 15 to 20-ampere lamps 40ft. to 45ft. high. Nothing was so easy to do as an electric light installation for a railway station. It was extremely easily carried out on a simple system with 400 to 500 volts, and easiest of all for transmission of power and lighting. The simplest form of plant and the simplest form of network could be used, and there was nothing dangerous to human life.

Mr. **LANGDON** said the discussion had taken so wide a range that he questioned very much whether it was in his power to give a full reply to all that had been said. The Paper which he had laid before them was one of a very unpretentious character in itself. It was merely a statement of what had been done by one of the larger railways in the kingdom with the object of applying electric light to its traffic purposes. He thought they would join with him in saying that the results achieved showed how far-seeing and judicious had been the action of the Midland Board in calling to their aid electric light. The object of the Paper had been to lay before not only the members of the Institution, but others who might be interested in the question, what had been done, and also to ask assistance and advice of gentlemen who were advocates of various systems. The time no doubt was approaching when railway companies would have to make use of the electric light and electricity for other purposes besides lighting to a very much greater extent than had been the case hitherto. The installation at Liverpool-street and Holloway might perhaps be taken as something of a type of that which they would probably have to bring into use at other places. He would like to thank Mr. Raworth for the kind and complimentary manner in which he had referred to the Midland Railway Company. He could not sufficiently express his thanks to Mr. Trotter for the admirable exposition he had given them as to the arrangement of the light. He fancied, however, that the lighting of railway yards was somewhat different to that of lighting large areas generally. They wanted, as Mr. Preece had mentioned, to place the light in such a position that the men might have the full benefit of that light at every point, and he thought for that purpose the height they had chosen was about the best they could attain, and gave them about the best results for their purposes. Mr. Siemens had given them data upon which they might go in these matters, and Mr. Chamen had advocated the use of a three or a five-wire system. He scarcely felt himself confident at the present moment to offer any opinion upon those different systems. He would answer the points raised more fully in writing.

PARLIAMENTARY INTELLIGENCE.

THE SELECT COMMITTEE ON THE TELEPHONE SERVICE.

The Select Committee, appointed to "consider and report whether the provision now made in the telephone service in local areas is adequate, and whether it is expedient to supplement or improve this provision either by the granting of licences to local authorities or otherwise," reassembled on Friday last, under the presidency of Mr. Arnold Morley, Postmaster-General. The Committee deliberated for some time in private, and then proceeded to hear further evidence.

Mr. H. E. CLARE, Deputy Town Clerk of Liverpool, replying to questions addressed to him by the Chairman, said that he was a member of the Council and Secretary to the Association of Municipal Corporations. He had been asked to give evidence before the Committee on behalf of that Association. The view of the Association with regard to the telephone system was that it was now an absolute commercial necessity, as well as a great private and domestic convenience. Looking at it as a trade necessity, it seemed to the Association most important that intercommunication between large centres of commerce should be made as easy and as cheap as possible, and that it was far more important to develop intercommunication between trading centres than to develop intercommunication within any given exchange area.

The CHAIRMAN: You refer to the trunk wire system of communication between one town and another town?

WITNESS: I mean that in the case of a town like Liverpool it is far more important that we should have an easy and efficient means of communication with Manchester, London, Glasgow, Leeds, Birmingham, and other important centres with which in matters of business we have to deal, than that we should have a little cheapening of the charges in the local area for the communication of messages between one office and another. We can always send a clerk from one office to another in the same town, but we cannot communicate with other towns conveniently in the same way.

In reply to further questions, WITNESS said he believed the greater proportion of the Stock Exchange business between Liverpool and London was done through the telephone. That was also the case as between Manchester and London. From that point of view his Association considered that the whole system should be treated as a national undertaking and not as a local matter.

The CHAIRMAN: If that is your opinion, I suppose you think that the Government have done right in taking over the trunk wire system of the telephone service?

WITNESS replied that their view was that the Government ought to take over the whole of the telephone system. It had been legally laid down that the telephones were part of the Postmaster-General's monopoly under the Telegraphs Act. If the Postmaster-General and the Treasury, with their great knowledge of the details, came to the conclusion that, in the interest of the country, it was not desirable to take over the whole system, but only a portion, of course they must accept such a decision as being based on better information than was available to outsiders. The expectation of his Association was that if the Government took over the whole of the system there would eventually be some considerable reduction in the charges, and that in the public interest the telephone would be developed even in localities which could not be expected to return an immediate profit.

The CHAIRMAN asked if he correctly understood witness to say that he regarded the trunk wires as the most important part of the telephone service?

WITNESS replied in the affirmative. So far as he could see, however, the immediate effect of the Government taking over the trunk lines would be to cause a certain amount of delay in giving the necessary intercommunication.

The CHAIRMAN: Do you express any strong opinion against the municipalisation of the telephone?

WITNESS thought he was only expressing the view of the whole of the corporations he represented when he said that the idea of the municipalisation of the local exchanges was impracticable and wrong.

The CHAIRMAN: Some witnesses from Scotland have, I will not say expressed a desire for competition, but have suggested that it might be desirable there should be competition within some area. Have you any views on that question?

WITNESS could not see how competition in telephone could do any good. It seemed to him that it could only result in increased expense to the general public. In any town where there was sufficient custom to be worth catering for, the National Telephone Company would have practically met the demand. If there were competing companies they would have to buy one another out.

The CHAIRMAN: Would the same answer apply to the competition of a municipality?

WITNESS thought the same circumstances would prevail in view of the competition they had to meet. It was perfectly obvious that the municipal telephones would not pay their working expenses, and consequently they would become a charge upon the rates. He did not think Parliament would sanction such an arrangement, as the telephone was more for the benefit of capitalists and the more wealthy classes than of the public as a whole. It was not like the supply of gas and water, which was a necessity to everyone. It was the decided opinion of his Association that the municipalisation of the telephones would be a great mistake. The Association represented practically the whole of the municipal corporations of England. London, however, was not represented on it, nor were the Scottish burghs. As the telephone system was for the public benefit, he thought Parliament would be justified in endowing the National Telephone Company with the necessary powers to maintain their undertaking in a proper way. On the other hand, the Company, in view of the privileges they would thus obtain, ought to be put under severe restrictions as to the utilisation of streets and other matters. He would suggest that where the Company desired to lay their lines under the public streets, the local authorities should have the option of doing the work themselves at the expense of the Company, or of compelling the latter to carry the wires overhead. He further thought that a maximum dividend and a maximum charge to the user ought to be fixed. Arrangements ought also to be made to prevent the Company interfering unfairly in favour of one exchange area at the expense of another, or of one subscriber over another.

By Mr. FLETCHER MOULTON: To his mind, to have competition in regard to the telephones would be as impracticable as it would be to have competition between companies for the supply of water to a particular town. There would be a sounder argument for municipalising the shops of butchers or bakers in a given district.

Mr. JOHN HARRISON, Town Clerk of Leeds, was next examined. He said he appeared before the Committee in pursuance of a resolution of the Association of Municipal Corporations, and he supported generally the views set forth by the previous witness. The view of the Association was that the best course to adopt would be for the Government to take over the lines, or, failing that, that the lines should be in the hands of a strong company. He scarcely agreed, however, with the suggestion that the Corporations were not in favour of competition, and he would be opposed to any arrangement which would put difficulty in the way of the State acquiring the telephones. He attributed great importance to the trunk lines, and one of the advantages of the Agreement which had been under discussion was that the system of trunk wires would be extended under the management of the Postmaster-General.

Mr. W. H. DICKENSON, Deputy-Chairman of the London County Council, was the next witness. He was entering into a detailed account of the action of the Council with regard to telephonic communication, when, the Chairman having ruled it outside the scope of the inquiry to discuss the question of the policy of the Agreement between the Post Office and the National Telephone Company, points of order were raised by Mr. Moulton and Mr. Benn.

The room having been cleared, the Committee deliberated for some time in private, and, on the readmission of the public, it was announced that the Committee would re-assemble on April 26th to continue the examination of Mr. Dickenson.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March 22, 1895.*

The Destruction of Mr. Nikola Tesla's Laboratory.—The complete destruction by fire last week of the laboratory of Nikola Tesla was a severe blow to the inventor, not only on account of the interruption of his work which it entails, which he most regrets, but also through the total loss of all his earlier models. Mr. Tesla was prostrated physically for several days after the fire, but he is now busily engaged in preparations for the continuance of his researches, which he says will be conducted with more vigour than ever.

The Telephone Situation.—The recent decision in the Bate Refrigerator case has not had the accelerating effect on the telephone industry which it was at one time thought would result from the favourable action. This is due to the uncertainty existing as to the scope of the switchboard and exchange patents controlled by the Bell Company, which are said to number no less than 1,500. Owing to the complete monopoly of the telephone field for so many years, no attention was paid by anyone outside of the Bell Company to the question of detail telephone patents, so that there is little or no knowledge now concerning their scope and status. A number of suits have been entered by the monopoly on various detail devices, and, as a consequence, much timidity will be encountered in inducing the public to invest money in the establishment of exchanges. Full advantage of this state of affairs is being taken by the Bell Company, which seems to be provided with the most remarkable patents for such a purpose, as, for example, those on the combination of a telephone and plug connection, on the use of magnetos in connection with telephone lines, and, in fact, patents on every manner of obvious device in combination with a telephone. The Courts, it is needless to say, will make short work of these when brought before them, but that they should have been granted at all cannot be considered otherwise than discreditable to our patent system.

A Method of Preventing Armature Reactions. On Wednesday of this week Prof. H. J. Ryan, of Cornell University, read a Paper before the American Institute of Electrical Engineers, in which he discussed some practical applications of his principle for the neutralisation of armature reaction, published several years ago. The principle consists in embedding conductors in the face of the pole-pieces, through which the main current is passed in such a direction that its action will oppose and neutralise the armature reaction. Diagrams were exhibited of tests on several machines of this type which have been built, showing that the effects of armature action were entirely absent. In these machines, it was stated, there was absolutely no sparking from no load to 50 per cent. overload, with fixed metallic brushes, and the compounding could be varied without sparking from 10 per cent. drop to 10 per cent. over compound by simply shifting the brushes. Owing to the neutralisation of armature reaction, it is claimed that the output of a machine of a given size and weight may be largely increased, and the expenditure of energy in the field greatly reduced by the lesser *entre-fer* that may be used. In the discussion which followed, several speakers doubted the necessity of such a device, claiming that sparking can be obviated in the usual types of machine by proper design, and that the output of a machine is determined by the heating limit of the armature, which is arrived at before serious sparking is usually likely to occur.

CORRESPONDENCE.

THE FOUNDATIONS OF ELECTRICAL SCIENCE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The valuable communication by which, in a recent issue of your journal, Prof. A. Cornu has joined the discussion on "Labour-saving Apparatus," deals occasionally with another question of a great importance for the study of electrical science. Kindly permit me to draw the attention of your readers to some of Prof. Cornu's statements, which appear to me to be open to a little discussion.

It is the opinion of the learned French professor that no scientific knowledge about electricity can ever be attained to, unless by following the long path usually laid down in theoretical text-books. The definitions of electrical quantities are derived step by step from the fundamental conceptions of geometry and dynamics. Otherwise, "words are offered in place of things." The practical engineer "has long ago lost sight of all the scaffolding upon which rests the measurement of a potential in C.G.S. units; he does not, therefore, dwell long on the preliminary notions, but puts as soon as possible a direct-reading voltmeter . . . in the hands of his students, and these will end by persuading themselves that the volt is an irreducible unit of electric pressure, in the same way as the pound or the kilogramme is an irreducible unit of force, and the foot or the metre of length. In the same way as the volt becomes an irreducible unit so does the ampere, namely, that of electric flow. Then we have the typical compressed system of instruction; proofs are replaced by the manipulation of, and familiarity with, apparatus."

Prof. Cornu thus clearly states his own ideas concerning the scientific establishment of electrical theory. Should we accept without discussion the first principle he starts from? I do not think it advisable.

There was a time when the discovery of the inverse square law for the mutual interactions between electrified bodies afforded to the physicists a basis for the mechanical deduction of electrical units. The consequent establishment of dimensional formulæ in the electrostatic system was regarded as a considerable advance made in the knowledge of physical phenomena. A resistance remained no more an unknown quantity of its own, but was explained to be simply the inverse of a speed. The true, the rational units of measurement were thus found out. The same deductions applied, of course, to the measurement of magnetic quantities. But, when the researches of Oersted and Ampère demonstrated the fundamental equivalence of a current circuit with a magnetic shell, the connecting link between electric and magnetic phenomena was brought into evidence; thence arose for scientists the possibility of getting a new proof of their dimensional formulæ by deducing them through an independent way. This essay ended in a failure; the true and natural units of the electromagnetic system differed from the equally true units of the electrostatic one. Electrical resistance, indeed, was no longer the inverse of a speed, but a speed itself!

It is known how the study of such question has thrown an entirely new light on the field of electrical science, by showing the impossibility of retaining some fundamental assumptions formerly regarded as axiomatic truths. From this study it became evident that the factor appearing in the inverse square law was not at all a purely mathematical coefficient, but expressed a true physical property of the medium, either the inductivity or the permittivity. But for wholly disregarding such a fundamental fact, it had been possible to establish the electrostatic and electromagnetic systems, according to which the one or the other of these quantities was made arbitrarily equal to a dimensionless unit, deprived of physical signification. Thus, any supposed demonstration of the identity of a resistance with a speed, or anything else—a self-induction with a length—was entirely deceptive, by not taking into account the nature of a fundamental quantity. We cannot identify a force with the square of a current, although they are found to bear in some cases a constant ratio; for this ratio is nothing else than the inductivity of a medium, and only the existence of an inductive medium enables us to obtain a force by the interaction of two currents. To bring into agreement the two systems of measurement, we must rationalise them by introducing the explicit consideration of inductivity and permittivity as physical magnitudes. As these are connected by a well-known relation, one of them may be dispensed with, as being a dependent quantity; but the other cannot be dropped out in a scientific dimensional system. It must be maintained as a fundamental conception, such as are the mass, the length, and the time.

No relation whatever has yet been discovered, explaining electrical phenomena by purely mathematical considerations. Electromagnetism brings us into a new world, which, although related with the world of material dynamics, cannot at present be conceived as a part of the same. Science has shown us that the scaffolding by which electromagnetic definitions were based on purely mechanical theories cannot be relied upon.

And is it not now about time that old-fashioned theories should be left out for more scientific ones? Since it is recognised as necessary to add in the electromagnetic system an independent unit, let us accustom ourselves to define it by itself, and to regard it as unrelated with any previously-known one. I think more scientific ideas will arise from a certain empirical familiarity with the fundamental electric quantities, than by having them explained on the ground of any concealed arbitrary assumption. Of course, the independent conception admitted as fundamental in electromagnetic science need not necessarily be the inductivity, or permittivity, or a similar one; perhaps the idea of electric current would do better it is, so to speak, a more tangible conception, such as everyone may be most easily familiarised with.

If physical dimensions are to be regarded as expressing the true nature of quantities, old theories bring us to an undesirable misconception, by representing the current as the square root of a mechanical force. It is certain, however, that if electric current is a mechanical phenomenon at all, we do not know what it consists of. And I see no good reason for trying to forget our ignorance by the aid of an hypothesis, more or less based on a vacuum. He who is familiarised with the effects of electric current knows indeed everything that is to be known about it; such empirical knowledge appears to be the most scientific one we may attain to.

It is evident that by assuming the current as a fundamental conception, the definition of any other electromagnetic quantity easily follows. Electromotive force may be defined, for instance, as the coefficient of current in the expression of power, that is, the power per unit current. From this very simple definition many electromagnetic laws may be deduced as a consequence of the conservation of energy.

I think such a method may be at present regarded as the most rational one for the establishment of electrical science. The practical engineer, as well as the science student, would perhaps take advantage by following it, instead of being troubled with complicated and unnecessary deductions; for anything but a simple and natural explanation of the fundamental conceptions always results in more or less obscuring of the knowledge aimed at. It would be therefore interesting to see a text-book exclusively conceived on these lines. The knowledge of electromagnetism based on empirical familiarity is not so unscientific as it might appear, for the practical engineer who conceives the current as a current, and nothing else, was, in some respects, a little ahead of those mathematicians who regarded the current as what it was not—the square root of a mechanical force. It is not the first time in the history of electricity that practice comes in to aid theory by showing the right track, which an unsound speculation may lead it to lose sight of.

If some of the ideas I have endeavoured to defend in this letter may be regarded as not quite unworthy of a little consideration, I hope I shall on that account find some excuse for having taken up so much of the space of *The Electrician*, for I think every electrician is no less interested than I am myself in the progress of electrical science.—Yours, &c.,

Rome, March 28, 1895. G. GIORGI.

CHARGING FOR ELECTRIC SUPPLY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with much interest Mr. Wright's article on "The Varying Cost of Electric Supply," and your Leader on "Increasing the Load Factor."

I can, however, take back my interest in the question to a date far before 1892. In the autumn of 1882 I was interested in many Provisional Orders, and, against some opposition, I succeeded in having the following clause introduced in the "Conditions as to Price." "5. By a charge which is calculated partly by the quantity of energy contained in the supply, and partly by a yearly or other rental, depending upon the maximum strength of the current required to be supplied." This, of course, is precisely the method which I have subsequently introduced at Manchester and Whitehaven.

I think, however, that Mr. Wright's method of applying the principle is a decided improvement upon mine. He charges a high price until the maximum strength of the current has been used for a certain number of hours, and subsequently charges a lower rate. This avoids the necessity of asking the consumer by which system he will be charged.—Yours, &c.,

April 5, 1895. J. HOPKINSON.

INSULATORS IN CONDUITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We have read with interest the report by the Special Committee formed to investigate the cause of the alkaline deposit found on the St. Pancras electric light mains. Several articles have appeared in the electrical journals attributing this deposit to the decomposition of the stoneware insulators. We fear that the tendency of such articles, unfortunately, may have been to create a want of confidence in a material very reliable and suitable for insulating purposes. We think it, therefore, of great importance that attention should be called to the finding of the Committee of Investigation, which proves conclusively that the deposit (which has been found on glass and brickwork as well as on stoneware) is not derived from the insulators, and which entirely confirms the view taken in our letter to *The Electrician* of March 8th, in which we asked that "before the presence of the unwelcome sodium is attributed to 'decomposition of stoneware,' those interested in the result should wait to see whether the investigation may not prove that the source is to be found not in the insulators, but in the cement, the brickwork, or the surrounding soil."—Yours, &c., DOULTON AND CO.

Lambeth Pottery, London, S.E.

LEGAL INTELLIGENCE.

Muirhead v. Commercial Cable Company.

The case of Muirhead v. The Commercial Cable Company on Tuesday came before the Court of Appeal, composed of Lords Justices Lindley and A. L. Smith, it being the appeal of the defendants from an order of Mr. Justice Wright, dated March 12th last, refusing to interfere with the refusal of Master Walton, in Chambers, to tax the costs in the action.

Mr. WALTERS, who appeared for the appellants (the defendants), said that the action was tried before Mr. Justice Kennedy and eventually came to the Court of Appeal, when the majority of that Court reversed Mr. Justice Kennedy's decision and ordered judgment to be entered for the defendants. The judgment was dated December 18, 1894, and by that judgment it was ordered "that the appeal of the defendants should be allowed, and the judgment of Mr. Justice Kennedy set aside and judgment entered for the defendants with costs, together with the costs of the appeal, such costs to be paid to the defendants' solicitors on their personal undertaking to return the same should the plaintiff's appeal to the House of Lords be successful." The learned counsel stated that on March 7th an appointment was taken before Mr. Walton to tax, and on an objection being taken by Mr. Pollard, on behalf of the plaintiff, that the appeal to the House of Lords would probably come on before Easter, the Master made the following endorsement on the bill: "I think that this taxation ought to be adjourned for six weeks, when I am told the House of Lords will hear the appeal." Mr. Walters stated that the plaintiff had delivered his case, but the defendants' case was not yet filed. He did not think it probable that the case would come on before June, and under those circumstances the defendants appealed from the Master to Mr. Justice Wright, who simply made the following order: "No order; no costs; leave to appeal."

Mr. POLLARD, who appeared for the respondent (the plaintiff), said that notwithstanding that the order for costs was given on December 18th of last year, the defendants did not deliver their bill of costs until March 7th last, when they got an appointment to tax for that day, and a further appointment for March 11th. At the time the defendants delivered their bill of costs, on March 7th, both parties were under order to lodge their case in the House of Lords by April 1st, and the Master was informed by the official who attended to those matters in the House of Lords that if the cases were lodged on April 1st the appeal would be heard within three days, because there were no arrears in the Lords. The Bill would have taken several days to tax, and the Master, thinking that objections to the taxation would be certain to arise, which would necessitate a review and probably an application to the Judge or to the Divisional Court, and taking into consideration the costs of taxation which he thought might be incurred uselessly, he, after consulting with two of the Senior Masters, decided that he would not tax them.

At the conclusion of the arguments of counsel, Lord Justice LINDLEY, in giving judgment, said that he was not prepared to go to the length of saying that the Master had no discretion in the matter. He thought that the Master had a discretion where there was no peremptory order that the costs should be taxed forthwith. He thought that the Master had in the circumstances done what was right and kind, and in his opinion the appeal ought to be dismissed.

Lord Justice A. L. SMITH concurred, and the appeal was accordingly dismissed with costs.

Shelfer v. City of London Electric Lighting Company (Limited) and Meux's Brewery Company (Limited) v. City of London Electric Lighting Company.

In the Court of Appeal on Monday these cases came before Lords Justices Lindley and A. L. Smith, on motion by the defendants for a stay of proceedings pending appeals to the House of Lords in both cases.

Mr. RENSHAW, Q.C., on behalf of the appellants, said that the petition to the House of Lords was lodged on Saturday, and he was instructed to ask their lordships to suspend the operation of the injunction until the hearing of the appeals had been disposed of.

Lord Justice LINDLEY: When are they likely to be disposed of?

Mr. RENSHAW: I suppose, my lord, before the long vacation, but I cannot say.

Lord Justice LINDLEY: Is there any reasonable probability of the appeals being heard this side of the vacation?

Mr. RENSHAW: Yes, I think so, my lord.

Mr. WARMINGTON, Q.C., who appeared for Meux's Brewery Company, said that he should ask that the applicants should give an undertaking to expedite the appeal, as he wanted to secure being on before the long vacation. The notice of motion was to stay all proceedings, but the proper notice was simply to suspend the injunction. The learned counsel stated that nothing had been done with a view to obeying the injunction.

Lord Justice A. L. SMITH asked if the applicants had given up the steam.

Mr. WARMINGTON replied that they had not.

Lord Justice A. L. SMITH replied that it was too bad.

Mr. WARMINGTON said that his clients were suffering worse since the judgment than before.

Mr. RENSHAW said that his learned friend could hardly say that because his clients were asking for an injunction to restrain the applicants from doing what they were advised would very materially remedy the vibration, viz., in pulling down the archway which connected his clients' premises with Sir William Rhodes's premises next door.

Lord Justice LINDLEY said that the applicants agreed to give up the steam a long time ago.

Mr. RENSHAW said that his clients did not say, and never had said, that there was no injury.

Lord Justice LINDLEY: I suppose they cannot stop the vibration without stopping the work.

Mr. WAGGETT, who appeared for Mr. Shelfer, said that the applicants had done nothing. He was told by his client, who was in Court, that the steam was much worse than it was before. He came there prepared to resist the motion to stay proceedings altogether. He suggested that the fair way, if their lordships thought of suspending the operation of the injunction, would be not only to put the applicants on terms to expedite the appeal to the House of Lords, but to suspend the operation of the injunction till May 15th, when they could see what the applicants had done.

Mr. RENSHAW said that he did not think there would be any difficulty in lodging the case by May 15th, because it was not a very lengthy case to draw.

After some further discussion, their LORDSHIPS said that they would suspend the operation of the injunction until June 12th on the applicants undertaking to appeal to the House of Lords.

Mr. RENSHAW said that his clients would undertake to expedite the appeal. He did not want to be bound down to a day, but he did not see why they could not deliver their case by May 15th.

Lord Justice LINDLEY: Very well; we shall not suspend this again easily, you know. The defendants must pay the costs of this application.

Cassel Gold Extracting Company (Limited) v. the Cyanide Gold Recovery Syndicate (Limited).

In the Court of Appeal, on Tuesday, Lord Justice Smith delivered the judgment of the Court in this matter. The original action was brought before Mr. Justice Romer for the infringement of patent rights for a process for treating gold in crushed ore, and for recovering gold from tailings by the process known as the cyanide process. The defendants did not at the trial deny infringement if the patent was good; but they attacked the plaintiffs' patent, and Mr. Justice Romer held that it had been anticipated, and was consequently invalid. Against that decision the plaintiff Company appealed, and a brief report of the case appeared in *The Electrician* during February. The chief point of interest to our readers were the claims made by the defendants that the plaintiffs' patents had been anticipated by, amongst others, Rae, who, they urged, effected equally good results with those made by the plaintiffs' process by means of electricity. This part of the defence was, however, abandoned early in the action. After minutely describing these patented processes, his lordship said the defendants failed to prove that they were able to treat gold in crushed ore and in tailings so as to give any good commercial results. As to the state of knowledge prior to the date of the plaintiffs' patent, the evidence showed that it was not known to Prof. Dewar, Prof. Crookes, Sir Henry Roscoe, Lord Kelvin, or other experts that a diluted cyanide of potassium had a selective action, and would treat gold before touching the baser metals, whilst a strong solution treated the gold and silver and baser metals at one and the same time. There was novelty and utility in the plaintiffs' invention, and in this respect their Lordships differed from Mr. Justice Romer. But on the specifications—the provisional and final—their Lordships came to the conclusion that there was disconformity between them, and that the two specifications could not be read as having the same meaning. There must, therefore, be judgment for the defendants.

Strauss v. Yeaton.

In the City of London Court, Mr. Gustav Strauss, electrical agent, of 130, Queen Victoria-street, E.C., recently sought to recover £25 on a bill of exchange against the defendant, Mr. C. Yeaton, of 139, Cannon-street. The drawer of the bill was a Mr. Jensen, a customer of the plaintiff's, who had had goods which were not then paid for. The consideration which he gave for the bill was the full value, except that Jenson paid two guineas for getting the bill discounted.—The defendant stated that Jenson wanted him to lend him £25, and instead of doing that he signed the bill in question, on condition that he would never be asked to meet it.—Jenson was called, and said he did not tell the plaintiff under what circumstances he had had the bill from the defendant.—The plaintiff said he believed the bill to be a *bonâ fide* bill, and took it.—The Deputy-Judge said there was no answer to the action, and there must be judgment for the plaintiff, with costs.

In re the New Zealand Electrical Syndicate (Limited).

On Tuesday Mr. Justice Kekewich ordered an application by Mr. C. F. Kemp, the liquidator of the Gulcher Company, to have certain shares registered in the books of the Company, so as to vest those shares in him, to stand over till the 23rd inst., in order that the notice of motion might be amended.

South Staffordshire Tramway Company.

Lord Halsbury and Lords Justices Lindley and Smith have dismissed the appeal against the decision of Mr. Justice Kekewich, who held that the plaintiff in this action, and the mortgage-holders whom he represented, were not entitled to an order for sale or to the appointment of a manager, although the Company was in default. It was held that the Tramway Company was substantially a railway company, which is by statute exempt from the operation, in case of default, of the provisions of the Companies Act (1862).

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NOW READY.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Although about 100 pages are added to the book, no addition is made to the price, which is 7s. 6d., post free 8s. 3d., abroad 9s.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices:—*

Laboratory Notes and Forms.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A Large-Sheet Table, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s.—each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"Electro-Chemistry."—This useful work, by Dr. G. Gore, is still on sale, the price being 2s., post free.

"The Work of Hertz."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. net., is now ready.

"Electrical Engineering Formulæ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"Drum Armatures and Commutators."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d (abroad 8s.). Prospectus on application.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and Wilkinson, price 6s. 6d., post free.

"The Electrician."—A special notice concerning certain changes in the price, &c., of this journal (commencing with the new volume on May 3rd) will be found on page 732.

Tenders Invited.—The Corporation of Birkenhead invite tenders for the erection of a brick chimney for their electric station. Tenders must be in by the 22nd inst.

——— The Brighton Town Council invite tenders for the extension of their electricity generating station. Tenders, addressed to the Town Clerk (Mr. F. J. Tillstone), must be in by the 26th inst.

Tenders Accepted.—The Town Council of South Shields have accepted the tender of Mr. W. H. Brown for erecting the buildings in connection with the electric supply station for the sum of £3,124. 15s. The buildings were designed and the specifications prepared by Mr. Jeckell, the borough electrical engineer, whose original estimate for the work was £3,100.

——— The Electricity Supply Committee of the Bradford Corporation have accepted the tender of Messrs. Siemens Bros.

and Co. for the supply and erection at the electricity works of two 300-H.P. Willans engines, each coupled with a Siemens dynamo, for the sum of £3,980.

Tenders Accepted.—The Brighton Town Council have accepted the tender of Messrs. Crompton and Co. for the supply of two new armatures for the sum of £426.

Appointment.—The Electric Lighting Committee of the Walsall Town Council have appointed Mr. Alexander Wyllie, of Oxford, resident engineer at their electricity supply station. Mr. Wyllie has been for some time past assistant engineer to the Oxford Electric Company.

Vacant Appointment.—The Governors of the South-West London Polytechnic, Manresa-road, S.W., invite applications for the appointment of Head Master of the department of Mechanical Engineering, at a salary of £250 per annum. Some further information is given in our advertisement columns, and applications must be made not later than the 29th inst.

Removal.—Messrs. H. M. Salmony and Co. have removed from their temporary premises at 66, Basinghall-street, E.C., to 61, Charing Cross-road, W.C., in which neighbourhood extensive warehouses have been taken to enable the firm to keep large stocks of electrical accessories, &c. The works remain at Notting Hill.

Personal.—Mr. R. A. Chattock, who has for some time acted as electrical engineer to the Hampstead Vestry, has been appointed to the engineering staff of the City of London Electric Lighting Company, and will therefore resign his position at Hampstead.

Bankruptcies.—A receiving order was on April 3rd made against W. J. Kelly, whose address is given at 50, Bread-street, E.C., and 43, King's-road, N.W. The debtor is described as a manufacturer of electric light fittings. He was appointed some time back as Receiver for the debenture holders in Poole and White (Limited).

Liquidations.—A meeting is to be held at 17, Holborn-viaduct, London, E.C., on May 6th, at 3 o'clock, to receive an account of the winding-up of the Kent Patent Arc Lamp Company (Limited).

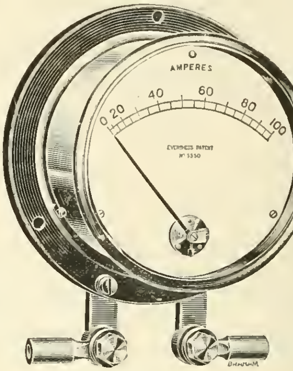
——— A meeting is to be held at 53, New Broad-street, London, E.C., on May 3rd, at 12:30 o'clock, to receive the liquidator's report and accounts in the voluntary winding-up of the Telephone Company of Austria (Limited).

Presentation.—A handsome trophy and centrepiece was recently presented to Mr. F. C. C. Nielsen, the general manager in this country of the Great Northern Telegraph Company, by the members of the British staffs, to celebrate the completion of his 25 years' service with the Company. The presentation was accompanied by a congratulatory address.

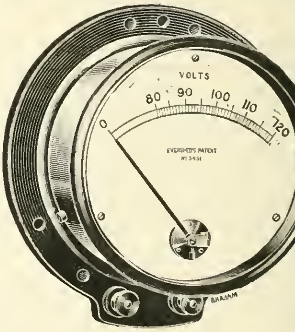
Telephones and Fire Alarms.—We have received from the Single Wire Multiple Telephone Signal Company copies of pamphlets, in English and French, describing the loud-speaking telephones and fire-alarm posts and apparatus manufactured by the Company under the Saunders and Brown patents. Included in the printed matter are illustrations showing the form of post adopted for the fire alarms and a diagram of connections. The system is a very simple one, the principal apparatus consisting of a call point, or post, for the street and an indicator and reply key for the fire station. The Company has recently worked out to the requirements of high officials engaged in the working of electric fire-alarm systems a new method of giving an alarm in the fire station by means of an electric "hooter," in place of the ordinary electric bell. By this means the alarm is given by simply breaking the glass or opening the door of the post, but cannot be given either by the earthing of the wire (for testing or otherwise) or by contact with other wires. The new arrangement will minimise the possibility of false calls, and does not add to the cost. The Company have also recently patented and applied an entirely new system which places fire stations in permanent telephonic communication with the men in charge of fire escapes at fixed street points on the single wire. The call to the man in charge of the escape is sufficiently loud to wake him if asleep, and can be heard a considerable distance from his box. Another patent recently completed is a loud-speaking telephone in a form suitable for telephone lines and exchanges, which, it is claimed, greatly facilitates conversation and obviates the necessity of holding a receiver to the ear. In large houses of business, warehouses, &c., where secrecy is not essential, these telephones can be connected up to a single continuous wire, and call bells and speaking tubes be dispensed with. Telephonic communication is certainly by this means reduced to its simplest form. The Company's single wire system is used by the Post Office, and between 600 and 700 fire-alarm call points have been established in London alone.

——— We have also received an illustrated catalogue from the Private Wire and Telephone Installation Company, giving descriptions of their telephones, electric bells, and fire alarms. The illustrations show a variety of patterns of telephone instruments and pedestal, portable, and other sets.

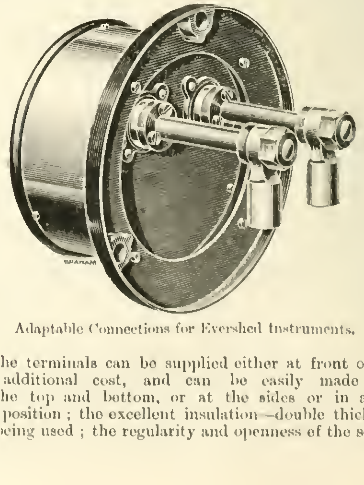
New Evershed Instruments.—Mr. Sydney Evershed, whose experience in the manufacture of electrical measuring instruments on a commercial scale is very extensive, has recently entirely remodelled his pattern of ammeters and voltmeters, with the view of embodying in one type all the improvements suggested by the work of the past 10 years, and has adopted as a standard pattern the form shown in our illustrations. In this instrument perfection of mechanical design has been one of the chief points aimed at, and in its solidity of construction and excellence of workmanship the present pattern fully maintains the high level attained by Messrs. Goolden and Co. and their successors. Among the advantages claimed for these instruments we may mention the facility with which the pattern can be adapted to suit various requirements—the terminals can be supplied either at front or at back without additional cost, and can be easily made to come out at the top and bottom, or at the sides or in any other ordinary position; the excellent insulation—double thicknesses of ebonite being used; the regularity and openness of the scales, and



The Evershed Ampere-meter.



The Evershed Voltmeter.



Adaptable Connections for Evershed Instruments.

the uniformity with which they can be reproduced. The latter is often an important point for central stations, where many similar instruments are required. For alternate-current working these instruments are indispensable. All ammeters are made independent of frequency, and voltmeters can be so made where required; and instruments can be supplied which read the same on both alternating and direct currents. The demand for a high-class measuring instrument of this kind has proved so large, that Messrs. Easton, Anderson, and Goolden have been obliged to double the size of their shop, and make arrangements for manufacturing on the interchangeable system in large quantities. The parts of instruments are all kept in stock, and can be put together and calibrated at a moment's notice, while the more ordinary sizes are stocked ready for delivery. The instruments are made with 6in. and 9in. dials, and the demand for the larger type has proved exceedingly satisfactory. Messrs. Easton, Anderson and Goolden report that they are very busy in their instrument department, and have a large amount of other work in hand. A new price list of instruments has lately been issued, and can be obtained on application to Woodfield Works, Harrow-road, London, W.

Oil Filters.—Messrs. O. Berend and Co., of Dunedin House, Basinghall-avenue, E.C., have secured the control in this country of Koellner's patent oil filter, which, under the title of the "Diamond," was for some years handled by Messrs. Woodhouse and Rawson. It is claimed that over 15,000 of these filters (which are made in eight sizes) are in use in all parts of the world.

"E.P.S." Batteries.—The Electrical Power Storage Company have sent us an advanced copy of a handy list of prices and particulars of the well-known "E.P.S." batteries. Special attention is drawn to the fact that the prices of the larger type of cells have been reduced about 15 per cent. Many other alterations, in all cases cheapening the batteries, have been made. Special attention may be called to the new "Q" type of cell, which has been designed for hand work on board ship and elsewhere. The important feature of this new type of cell is its small weight, which renders it suitable for portable work. In addition to the illustrations of the various types of cells, tabulated prices and other particulars, instructions are given for erecting and working. The list is very complete, and has the additional advantage of a comprehensive foredge index.

Rosin-Cored Solder.—We have received from Mr. C. Herbert Torrey, of Berlin, some samples of solder containing a core of rosin. This material has a large Continental sale, and has already been supplied to several large users of wire in this country. It is turned out in coils of any length, and wires of it are made as fine as one millimetre, external diameter. We have made some rough tests of this material for the purpose of soldering comparatively light wires, and have found it answer very well.

Accumulator Contracts.—We are informed that the contracts for the central station batteries for the Kensington and Knightsbridge Electric Lighting Company at Kensington Court, and for the National Electric Supply Company at Preston, have been secured by the Epstein Company.

Short-Series Arc Lamps.—Messrs. Johnson and Phillips are introducing a new short-series arc lamp designed for use on low-potential circuits, more particularly those supplied with current from central stations. They are designed to work in parallel, or two in series on 100 volts, or a greater number in series on mains of higher pressure. The arrangement of two in series on 100 volts should be especially useful.

The Britannia Company.—This Company are opening an electrical department at their London branch at 100, Houndsditch, E.C., where plant for electric lighting and transmission of power, manufactured at the Company's Colchester works, will be on sale. A number of new lists have recently been issued by the Britannia Company, dealing with their various manufactures, and including lathes, chucks, slide rests, oil engines, &c.

Messrs. Green and Treacher.—Owing to increased demand for their manufactures, this firm are enlarging their premises at 77, Cannon-street, London, E.C., and will in future hold a more varied stock of materials for electric bell and telephone work, and for general fittings for electric lighting.

Electric Cooking and Heating.—An interesting up-to-date article, by the Comtesse de Bremont, on the subject of cooking and heating by electricity, appears in *St. Paul's* for April.

"The Engineering Magazine."—The April number of this magazine is up to the usual high standard, both as regards matter and illustrations. Its contents include: "The Commercial Value of Weather Forecasts"; "Economy in Railway Operation"; "Water Powers of the Western States"; "Practical Hints for City Officials"; "Reducing the Cost of Electric Light"; "Economic Possibilities of the Milling Machine"; "Recent Architecture in France"; "Lessons of the 'Elbe' Disaster"; "Increased Gold Production in Colorado"; "The Burning of Tesla's Laboratory"; and the increasingly useful Review of the Industrial Press. The new number, and nearly all back issues, may be obtained at the office of the European Edition, 1, 2, and 3, Salisbury-court, Fleet-street, London, E.C.

Acton.—An acrimonious discussion on a proposal made by Mr. T. Baker, offering to assist the Council by drawing up gratuitously a report on the probable cost of an installation of the electric light, and the probable revenue from the same, took place at the last meeting of the District Council, and, apparently as a result, it was decided not to agree to the proposal made by Messrs. New and Mayne, fixing a minimum price for street lamps at £2. 10s. per lamp. It was decided to ask the firm whether they were prepared to accept the Council's terms in their entirety.

Ayr.—A committee has been appointed to consider the question of introducing the electric light into the Town Hall and municipal buildings. Satisfactory progress is being made with the electric lighting works and laying of the mains.

Bradford.—At the meeting of the Corporation, on Tuesday, a discussion arose on the tenders which had been received for the supply of the additional engines and dynamos for the electricity works. Mr. Dixon, Chairman of the Electricity Supply Committee, said that 22 tenders had been received, 19 of which specified Willans engines. The highest tender received was £5,900, but the contact was let for about £3,900. After some discussion the Committee's report was adopted, and the acceptance of Messrs. Siemens Bros. tender approved.

Brighton.—The Town Council have resolved to offer the receiver and liquidator of Messrs. Latimer Clark, Muirhead and Co. £1,000 in settlement of all claims under the Corporation's contract with that firm.

Bristol —The Electrical Committee of the Corporation, in consequence of the favourable replies received respecting the extension of the electric lighting mains in several districts, have resolved to recommend the Council to authorise the borrowing of £10,000, £8,000 of which is for mains in new districts, and £2,000 for connecting up customers with existing mains.——At the meeting of the Council on Tuesday the Electrical Committee presented a report which recommended an extension of the private electric lighting. The capital expenditure embarked in the undertaking already amounts to £90,000. The Committee have provided machinery and plant capable of supplying 34,000 lamps. The number of lamps now supplied is 17,425, and the Committee recommend the Council to make further extensions at an estimated cost of £10,000, as above mentioned, bringing up the total capital expenditure to £100,000. Councillor Pearson, in moving the adoption of the report, said that, at a cost of £3,000, the plant could be made equal to 40,000 lamps. The cost of generating the extra current for the area now proposed to be added would be comparatively nominal. His experience had confirmed his belief that they had acted wisely in taking the lighting into their own hands. Mr. Levey said the streets of the town were never better lighted than at the present time. Mr. Pearson, in reply to remarks from Mr. Alderman Dix, who is Chairman of the local gas company, and who alone opposed the adoption of the Committee's recommendation, said the income of the installation was £3,632 from private lighting and £2,820 from public lighting. Light for light, electricity was infinitely cheaper than gas. They obtained ten times the light they had before. The report was adopted almost unanimously.

Burnley.—At the last meeting the Town Council discussed a resolution to the effect that all differential rates in reference to the price of electric current be abolished, and that one uniform charge be made. The mover of the resolution (Mr. Holmes) pointed out that persons using the electric current for lighting purposes paid 5d. per unit, while those using it for motors only paid 3d., and the ratepayers had set their faces in the past against differential rates. Mr. Alderman Collinge (Chairman of the Gas and Electric Lighting Committee) said he believed it was only by charging a reasonable price for electric current that they could encourage the use of motors and help to keep their engines continually running, and in making these differential rates the Council only adopted a policy that had been agreed to in many other places. The Committee's action was approved.

Burton.—At the last meeting of the Town Council a recommendation by the Gas and Electric Lighting Committee, that the electric lighting mains should be extended to Ashby-road and Alexandra-road was agreed to.

Colwyn Bay.—At the last meeting of the Urban Council, Messrs. Clirehugh and Duce, engineer and local agent respectively for the proposed electric tramway between Llandudno, Conway, and Colwyn Bay, attended, and explained the nature of the project, and the Council eventually approved the principle of the scheme.

Church Lighting.—At a meeting of the congregation of Ormskirk parish church it was stated that an offer had been received from Messrs. Robinson, electrical engineers, to provide and erect the necessary plant for lighting the church by electricity for the sum of £289. The vicar is a strong supporter of substituting electricity for gas. It was decided that the subject should be considered by the vicar and churchwardens to report.

Coseley (Staffs.).—At a meeting of the Coseley District Council, on Tuesday, it was decided that the district surveyor obtain the cost of lighting by gas, electricity, oil, and incandescent gas light respectively.

Croydon.—At the County Council meeting on Monday, Mr. Alderman Miller, Chairman of the General Purposes Committee, said that the Electric Lighting Sub-committee had invited 12 companies and firms to establish the electric light for the compulsory area at such a contract price as the consulting engineer of the Corporation might approve—the Council to find the necessary capital for the purpose. It was intended that the Com pany should work the undertaking for a term of years, and maintain the plant, the Company taking the revenue and guaranteeing to the Corporation interest and sinking fund upon the capital expenditure involved. A purchase clause is included in the terms of the contract. Tenders had been received from these firms, and Prof. A. B. W. Kennedy, who had advised the Council, had selected the offer of the British Thomson-Houston (Limited) for the sum of £15,986. It was, however, calculated that £21,000 would be ultimately required to provide a complete system. This sum would include the necessary professional charges. The British Thomson-Houston (Ltd.) undertook to work the scheme for five years, and to guarantee 3 per cent. on the capital, and a sinking fund not to exceed 3 per cent. At the end of the period the plant and undertaking to become the property of the Corporation. The Committee considered that provision must be made for considerable extensions, and they proposed to apply to the Local Government Board for powers to borrow £27,500 for electric lighting purposes. An amendment by Mr. Martin making the term 10 years, but giving the Council the option of taking over the concern at the end of five years, was ultimately approved, as it was understood this amendment would be accepted by the Company. The recommendations of the Committee were, with this modification, approved.

Dover.—It was announced at the last meeting of the Town Council that a notice had been received from the Dover Electricity Supply Company, stating that the Directors proposed to commence the supply of the electric light on the 8th inst. Current was not, however, turned on on that day, but will probably be inaugurated this day (Thursday).

Electrical Advertising Devices.—The word-groups of incandescent lamps, which have recently proved a bold advertisement in London, have now found their way to the provinces, and the mains of the Liverpool Electric Supply Company have been connected up to several of these devices, which are attracting the attention of foot passengers in several of the leading thoroughfares of the town.

Electric Railways Extension.—The Bill introduced into the House of Commons by the City and South London Railway Company has been read a third time, and has reached the House of Lords.

Electric Traction in Italy.—The municipal authorities of Leghorn are at present engaged in the consideration of a proposal for the construction of a network of electric tramways in the town.

The Falls of Foyers.—Those of our readers who are interested in the discussion now taking place with regard to the proposal by the British Aluminium Company, to utilise the waters of the Falls of Foyers for motive power for new works for their aluminium process, will find an interesting article on the subject in the *Daily Chronicle* of the 9th inst.

Folkestone.—The Lighting Committee of the Corporation have recently had before them the question of the improved lighting of the borough. Both electricity and incandescent gas lights have been discussed, and the matter is to be further dealt with at a special meeting of the Committee.

Geneva Exhibition.—It is announced that an exhibition, international as regards the electrical section, will be held in this city next year, from May 1st to October 15th. A very large sum has been contributed by the Federal Government, the Canton of Geneva, and the leading merchants and manufacturers. Special prominence is to be given to the exhibits of electric power transmission plants and apparatus, and to all the latest developments of electricity. It is stated that the motive power derived from the waters of the Rhone will, in the course of a few months, reach a total of 28,000 horse-power.

Glasgow.—The report of the Town Council Sub-Committee on Galleries and Museums, just issued, states that during 1893-1894 gas was used for lighting the Corporation galleries, and during 1894-1895 electricity had been used, and the cost of the latter had proved to be £55 for the year less than the former. This statement appears to have caused some agreeable surprise to many members of the Council.——The Bazaar Committee stated that they had been in communication with Prof. Becker as to a scheme for electrically-controlled timepieces, and he had submitted one showing various electric circuits, and latterly he explained two systems of electrically-controlled clocks and timepieces, and reported the probable capital and annual cost of a system comprehending 140 street clocks controlled by electricity from the Observatory. The committee resolved to recommend that as an experiment one circuit, consisting of one main clock, three relays, and 10 street timepieces should be fitted up in a portion of the city, provided that Prof. Becker obtained satisfactory results from a two months' experimental working at the Observatory. The cost for clock, relays, and timepieces (but exclusive of wiring) would probably amount to about £75 per clock. The proposal was approved.

Halifax.—At the last meeting of the County Borough Council, Alderman Brook proposed that application should be made to the Local Government Board for sanction to borrow £5,000 for the purpose of completing the Council's original electric lighting scheme, and a further £5,000 for additional plant for extensions. £34,800 had already been spent on the scheme, which was £4,800 in excess of the amount granted by the Council for the electricity works. With regard to the extensions, the additional sum asked for would enable them to provide for all emergencies, and to double their output. The sum of £5,000, required to complete their original scheme, was an excess over the estimate.

Killarney.—The contract for lighting part of this town by electricity expired last week ; but the local electric lighting company have been requested to continue the lighting until the decision of the action between the gas company and the Town Commissioners, or until further notice.

Lecture.—A lecture on "Electric Traction," with special reference to traction on common roads, was delivered at the Croydon County Polytechnic on the 8th inst. by Mr. C. H. Yeaman.——Mr. W. R. Bower recently lectured at the Higher Grade Girls' Art Room, York-place, Brighton, on "The Electric Current," the chair being taken by Mr. Councillor Stafford, Chairman of the Brighton Corporation Electric Lighting Committee.

Liverpool.—At a meeting of the Special Lighting Committee of the Corporation on Monday a discussion arose regarding the terms to be offered for the purchase of the undertaking of the Liverpool Electric Supply Company. The sum of £400,000 was mentioned, we learn, as the price offered by the Corporation.

Llanrwst (Denbighshire).—At a meeting of the Llanrwst Board of Guardians, the question of laying down an electric tramway from Trefriw to Llanrwst station was discussed. The chairman said that the committee appointed to meet the promoters had seen them, but the Local Government Board inspector (Mr. Bircham), who had made an examination of the proposed route, had given the committee to understand that he was opposed to the project, and the matter was therefore allowed to drop.

Middlesborough.—In answer to a circular of the Gas Committee to probable consumers, asking whether they would be prepared to use the electric light in the event of the Corporation supplying it, 801 affirmative replies have been received, 3,192 negative, and 2,181 were not returned. Those answering in the affirmative (being mainly resident or carrying on business in the principal thoroughfares) estimated their total requirements at 10,000 lights. The North-Eastern Railway Company have written with regard to the station that the matter was not one which the Directors had yet considered, but the probability was that if they decided to adopt the electric light they would provide their own installation.

The New Code Vocabulary.—In the House of Commons, on Monday, the Postmaster-General was asked whether he was aware that the new code vocabulary, which has been prepared by the Berne Bureau, had been almost unanimously objected to by code users on various crucial grounds, amongst others that many of the words were identical in signals, had only one signal difference from other words, only one letter difference in other cases, and many other objections which would prove fatal to the despatch of business. It was suggested that British experts, in combination with Committees of the Associated Chambers of Commerce, should prepare amendments, and that these amendments should have the support of the British Post Office Department. Mr. Arnold Morley, in reply, said that he was aware that serious objections had been made to the new code, but he reminded the House that the vocabulary does not come into force until January 1, 1898, and that "there was ample time for consideration in the interval, and the matter was receiving careful attention." There can be no manner of doubt that a committee of experts would be able in a short time to effect a wonderful improvement in the proposed official code which, as it stands, is a source of grave concern to code users, who, long previous to the Berne vocabulary coming into enforced use, must see that their codes are in acccordance with official regulations.

Newington (London, S.E.).—A proposal of the General Purposes and Lighting Committee of the Newington Vestry, that the Provisional Order, promoted by the County of London Company, should be opposed, and that the Vestry should give an undertaking to the Board of Trade to promote an Order in the next session of Parliament for establishing a competitive supply in the parish to that now undertaken by the London Electric Supply Corporation, was unanimously adopted.

Oldham.—The plant at the Corporation's electric lighting works is now fully employed, and considerable extensions are immediately necessary. It is found that ample accommodation for additional generating plant has been provided at the works, and, owing to the number of applications now being received, it was decided to communicate with Prof. Kennedy as to the extensions to be made.

Oystermouth (Glamorgan).—The District Council is about to consider a project for the lighting of the village by electricity in lieu of gas, which is obtained from a neighbouring town, some miles distant. The price of gas is of course high, a fact which enhances the popularity of the new scheme. The gas company receives nearly £300 annually for public lighting alone.

Patents in Portugal.—A new Portuguese Patent Law has just been passed, which reduces the cost of obtaining patents in Portugal to about one-half of what the cost was under the old Act. The cost of Portuguese patents has hitherto been very heavy.

Persia.—It is stated that concessions have been granted to an American for the introduction throughout Persia of electricity for various purposes outside telegraphy, but that sufficient capital had not been secured to complete the enterprise.

Plymouth.—An exhaustive report by a Sub-committee of the Works Committee, which was recently appointed to consider the question of the introduction of the electric light to Plymouth, has been circulated this week. The report states that there is no instance on record in this country of an electric supply undertaking in the hands of a municipal corporation having involved any charge upon the rates. The Sub-committee are unanimously of opinion that the Council should themselves exercise the powers they have obtained. It is recommended that the generating station should be erected on the shores of the Cattewater, where it could be built more cheaply than elsewhere in the borough, and plant and machinery, fuel, &c., could be brought either by rail or water. Here whatever steam could be produced from the utilisation of refuse could be employed in generating electric current. The Works Committee recommended the adoption of this report, and the appointment of a sub-committee to visit some of the electric stations in London and the provinces. Mr. Debnam said that Plymouth, like all other towns, would sooner or later adopt the electric light. In looking at the cost of such an undertaking as the electric light, they should also look at the probable return. He had a Board of Trade return which showed that of the 26 companies and 13 corporations which supplied the electric light, every one of those undertakings had returned a profit, and a very substantial profit too. In addition to the value of the improved light which electricity would supply, it would be for them to consider whether the motive power for their trams could not be supplied from the same source. He hoped the Tramway Committee would look ahead, and see whether some great improvements might not be effected in this direction. Prof. Anthony said the feeling in the town was strongly in favour of the introduction of the electric light into the borough. It was finally unanimously agreed that the matter be referred back to the Committee, with instructions to employ an expert and obtain information as to the best method of proceeding and probable cost.

Portsmouth.—It has been decided by a Sub-committee of the Portsmouth Lunatic Asylum Committee to recommend the substitution of the electric light for gas at the Borough Asylum buildings.

Queenstown.—At the last meeting of the Town Commissioners a resolution was adopted informing the local gas company that only half the number of public lamps would be required after May 1st next. It would appear that certain demands made by the Commissioners have been rejected by the Company. Mr. Hammond's report on the question of lighting the town by electricity is expected shortly, and when this is received an electric lighting scheme will, it is stated, be formulated.

The Telephone in Italy.—From a letter received by a correspondent on the subject of the use of the telephone in Rome, it would appear that the telephone does not pay in Italy, and that the companies are dragging on a feeble existence in the hope of Government purchase. This must ultimately come about in order to get rid of what is becoming a public nuisance, for upon the first fall of snow down come all the wires, and the companies are too poor to provide the necessary funds for repairs. The telephone is much discredited in Italy. With regard to electric fire alarms, it is remarked that the stone-built houses of Italy seldom catch fire, and even if the fire alarm service were perfect, the engines are seldom ready when wanted, and generally reach the spot when the fire is out; in fact, the inhabitants dread the visit of the fireman, as, however slight a fire may be, by the time this gentleman has completed his operations the hose has effected ten times more damage than a fairly considerable outbreak of fire could ever be expected to produce. It should also be mentioned that insurance rates are very low in Italy.

Worcester.—An attempt to interfere with the Electricity Committee in its choice of the staff necessary for working the electric lighting station was, at the last meeting of the City Council, almost unanimously disapproved, and a number of appointments suggested by the committee were agreed to.

Yarmouth.—Applications for 300 lamps have been made during the past month, bringing the total number of lamps up to 3,400 for private customers. It is estimated that by the end of the year 6,000 lamps will be connected, which will render extensions absolutely necessary. The surveyor has been instructed to confer with Mr. Preece on the subject.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

March 22, 1895.

5,984. H. J. Bentley. Manchester. Improvements in or relating to signalling and communicating by telephony, and in apparatus used therewith.

5,998. R. W. Braham. London. An improved cup-and-ball joint for electrically connecting and disconnecting electric light fittings.

5,999. J. Peel. London. Improvements in the method of and in apparatus for electrically lighting miners' safety and other lamps.

6,000. J. Peel. London. Improvements in the method of and in apparatus for electrically lighting miners' safety lamps.

6,004. W. P. Thompson. Liverpool. Improvements in telephones. (E. Kirschke, Germany.)

6,006. P. F. C. B. Pretzsch. London. Improvements in electric railways.

6,007. Siemens Bros. and Co. (Limited). London. Controlling apparatus for electrically-propelled railway trains. (Siemens and Halske, Germany.)*

6,010. B. M. Drake, J. M. Gorham, and H. C. L. Holden. London Improved form of magnetic clutch.

March 23, 1895.

6,035. J. A. Rossiter. Dublin. Non-resisting electric conductors.

6,048. C. Bollé. Manchester. Improvements in the manufacture of flexible sheets for electrical insulation. (C. W. Jefferson, United States.)

6,075. W. J. Davy. London. Improvements in electric switches.

6,084. J. E. Florea, V. Takács, and E. Rittinger. London. Improvements in electrical railway signalling and apparatus therefor.*

March 25, 1895.

6,114. F. W. E. Jones. Leamington. An improved filament for incandescent electric lamps.

6,127. R. J. Jones. Liverpool. Improvements in feeding nailing and other machines of that class by means of electricity, and in apparatus used in connection with such machinery.

6,163. W. A. B. Buckland. London. Plate for secondary voltaic battery.*

6,164. J. Schäfer and P. Steffers. London. Automatic cut-out for suspended electrical conducting wires.

6,171. F. Stock. London. Improvements in multiple switches for use with double telephonic leads.*

6,177. W. B. Esson. London. Improvements in alternating-current dynamos.

6,180. H. A. V. Wirth. London. An improved process for the electroplating or metallisation of wood.

March 26, 1895.

6,256. J. W. Gilbert and S. Jevons. Birmingham. Improved construction and arrangement of commutators for dynamos.

6,258. M. Stein and A. Wolf. London. Improvements in apparatus for the electrolytic decomposition or purification of liquids.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

4,647. Burrell and Fowkes. Electric lighting.

4,800. Harris. Semaphore and Morse-signal apparatus.

4,911. Mordey. Electric supply apparatus.

5,003. Aldridge. Regulating electric motors.

5,375. Statter. Electromotors.

COMPANIES' MEETINGS AND REPORTS.

Willans and Robinson (Limited).

The ordinary general meeting of this Company took place yesterday (Thursday) at the Cannon-street Hotel, London, Mr. Mark Robinson, M.Inst.C.E., presiding.

The notice convening the meeting having been read,

The CHAIRMAN, after alluding with regret to the absence of the Secretary (Mr. C. S. Essex) through a sudden and severe attack of influenza, proceeded to move the adoption of the report and accounts. He said: I have to express pleasure at the increased number of shareholders present on this occasion—no doubt the result of the meeting being held in London instead of Thames Ditton. The Directors on previous occasions have tried to ascertain the feeling of the shareholders generally on this point, but without success; we think the result of to-day's experience justifies it. I think I can honestly congratulate you on the past year's work, now completed, and on the Company's prospects for the future. The year 1894 brought us a great increase of orders, and though we can hardly expect to repeat such an advance in 1895, you will be glad to learn that the orders from January 1st to the present date, April 10th, amount to 8,100 horse-power against about 5,800 between the same dates in 1894, so that up to the present we are actually better than last year to the extent of about 40 per cent. I wish that all the profit of this increased work, either for this year or the last, came to us, but it does not. Needless to say we can only keep pace with our work, if we can keep pace with it, by getting much of it done by others, and of course they do not work for us without profit. The new works are the great desideratum, and we will deal with them presently. Dealing with points in the report as they occur, I think you will agree that depreciation is handsomely provided for, so that we are not falling into the mistake of overvaluing our assets. Depreciation, indeed, stands for more than appears, for a further considerable sum has been written off stock, which appears only as a diminution of the gross profit. This formerly appeared as depreciation, but the auditors, no doubt rightly, preferred to deal with it differently. Considering that we are overtasked at Ditton, and that we have much capital paid up which cannot yet be utilised, you will probably agree that earnings large enough, if divided, to pay nearly 11 per cent. on the Ordinary shares, are an earnest of very good things to come. It is true that if we average the two half-years, the first year of the new Company shows an *earned* profit for the Ordinary shareholders of about 9½ per cent., but even these figures are not to be despised. But if, under all the circumstances, you are well content with the earnings, we hope you will be not less content with the dividend—a steady 7 per cent., as we hope to keep it, until we can with complete safety do better. If there is one matter of policy upon which the Directors feel strongly, it is the advantage—nay, the necessity—of building up a really substantial reserve fund; and if there is one part of the report in which the Directors feel a real pride, and on which they expect—because they know they deserve—your approval, it is that part which shows how a reserve fund of over £2.600 will have been created within the first twelve months of the new Company's business. That fund the Directors hope rapidly to augment, nor will they be contented—even if this be the dream of a somewhat distant future—until the reserve fund at least equals the valuation of the goodwill. There are sound business reasons against writing down the goodwill: one is that the accounts show a profit which amply justifies the figure it stands at, and if it does not yearly increase in value instead of diminishing, your Directors, at least, will be grievously disappointed in their estimate of the capacity of the business. But to provide for its extinction by building up a reserve fund—a real fund, invested elsewhere, not merely used in the business—is another matter, and there is no shareholder who will desire it more strongly than the Directors. Gentlemen, I hope that our recommendation of a dividend at the rate of 7 per cent. per annum will equally meet the views of those who rightly value prudence before all things, and of those who, also rightly, argue that an industrial business ought to pay a fairly high rate of interest. I am glad to say that the nature of our business, equally with the extent of the orders, is quite satisfactory. It is, of course, undesirable to publish the accounts in great detail, but the orders yield, generally speaking, the same profits as they always did. The primacy of the Willans engine for electric lighting purposes is, perhaps, more fully acknowledged than even a year ago. We have lately had orders from old customers who, in the search for novelty, or, as one frankly told me, for the sake of having two strings to his bow, have worshipped strange idols; but they have come back to us. The order I value most from a customer is his third order. We obtain his first order; then he wants to make comparisons, and places his second order with someone else. Where will his third order go? I know a good many such cases, and always, so far, the third order has come to us. Perhaps of even more importance than these signs of confidence from old customers who have known and used the Willans engine for years, are orders of a class which has been increasingly frequent of late—that is from lighting stations whose engineers started with a prejudice against high-speed engines, or who, from whatever reason, preferred the ordinary slow-speed, mill-driving type of engine. One company, which had always championed this system, and which operates one of the few London stations in which the Willans engine is not used, ordered an engine from us a few weeks back; this morning they ordered another. The Corporation of a Lancashire town, the very headquarters of mill-engine making, have just decided to adopt the Willans engine, and this morning also, as if to cheer us for this meeting, came an order of really great importance for four engines for a large city in France, whose lighting has hitherto been of the competing, but now, apparently, disappearing type. I think the credit of the engine, and of the Company which makes it, never stood so high. But, gentlemen, gross profits do not alone make a dividend; there is another side to the account, which no doubt offers—and always must offer—many points for criticism. A gentleman, who could not attend, kindly wrote his objections, and as they may well be typical of the views of others, I will refer to them. He considers the charges are high under stationery, printing, law, and travelling &c. So do I, and there are many other charges besides these which the Directors hope to make a substantial impression upon. If they fail it will not be for want of trying. Having given the details of the items in question, he continued: There may be many other matters in the accounts upon which you will desire explanation; if so, I will do my best to explain them, and fortunately the auditors, Messrs. Cooper Brothers and Co., are represented. But, on the whole, we feel that we can put the accounts in your hands with confidence in your verdict upon them. Now, gentlemen, with regard to what occupies our thoughts so largely—the Rugby site—and the new works to arise there. If we were long in selecting it, it was because of the thoroughness of the search, and we believe we have almost an ideal site, as regards central position, as regards railway communication, and as regards economy of production. It is not in a manufacturing town, and we had no wish to go to one, though we desired, and have obtained, easy access to most of the great centres. It adjoins the main line of the North-Western Railway, and buildings upon it will be very much in evidence to those travelling by it. Its position is open and healthy, and we have land enough to be able to keep it so. It lies over 300ft. above sea level, and perhaps its only fault is that it is not very flat. It is a curious fact that, in the course of a year's search through the Midlands, it is doubtful if we found one single site, of adequate size, which, if really flat, was not also subjected to floods. We fear no floods at Rugby, and the necessary levelling will not cost a great deal. We have prepared plans for the immediate erection of a machine shop and erecting shop, approximately equal in capacity to those at Thames Ditton, and of a foundry of considerable size, large enough to make us independent of outside purchases of castings. The plans have been prepared for other shops besides these, but we leave it for circumstances to decide when these shall be commenced. At our next meeting we hope both to show plans and also to report that the works are far on towards completion, and towards helping the congested works at Thames Ditton. Gentlemen, I thank you sincerely for the attention with which you have listened to our statement, and I now beg to move the adoption of the report and accounts.

Mr. G. B. CLIFTON (a shareholder) seconded the motion.

A brief discussion followed.

The CHAIRMAN, in reply, said he supposed that the Company's "centre of gravity" would ultimately be Rugby, but what would happen then he thought it would be advantageous not to discuss. He thought they had amply provided for insurance. He believed that when the balance of the authorised issue of shares was made—and they would be offered later in the season to the existing shareholders—they would get a quotation on the Stock Exchange. There had been a few transfers of shares, mostly at par. As regarded the new work, he thought they ought to get the tools round about Christmas; that, too, was the earnest desire of the works manager. They took their patents at a very small amount, and the question of their expiration was not one which practically affected the prosperity of the Company. He might have mentioned before that their debenture debt, which fell due at the end of last month, was paid off; but they had decided to keep alive the system of debentures they offered to their workmen, who received 5 per cent. on them, and, by arrangement, additional interest, raising it to what the shareholders received. The arrangement only applied while the holder remained in the Company's service. He then put the motion, and that was carried unanimously.

Resolutions were afterwards passed declaring the dividends recommended on the Preference and Ordinary shares, and re-electing the auditors.

Mr. D. STOCK proposed a cordial vote of thanks to the Chairman and Directors for their conduct of the business during the past year. He thought their report was perfectly satisfactory.

Mr. YOUNG seconded the motion, which was unanimously carried.

The CHAIRMAN briefly acknowleged the vote, and the proceedings then terminated.

Southampton Electric Light and Power Company (Limited).

The annual meeting of this Company was held at Southampton on Monday.

The CHAIRMAN (Mr. Harper) said he considered the Directors' report showed that they were now on the way to dividend-earning success. The progress reported at the last meeting had been more than maintained, and the Directors recommended a dividend of 6 per cent. on the Preference shares and 2½ on the Ordinary shares. The year was started with a debit balance of £184, but that had been wiped off, and after allowing for depreciation they had been able to pay the dividend announced. They only wanted to make the Company a success. The cost of production of electric current at their station was below the average of companies having even larger outputs. They would have to apply to the shareholders to place their confidence in them, and permit them to finish the work they had begun. They were considering the taking of further land and laying down further plant with a view to increase the output, and at the same time, if possible, to reduce the cost.

The report states that a net profit of £1.015 has been earned to December 31st last, and, after setting aside £100 for depreciation, £100 for Directors' fees, paying interest on loans and debentures, and writing off the balance of the loss last year (£185), leaves £138 to be dealt with. The Directors recommend a dividend of 6 per cent. per annum on the

Preference shares, and of 2½ per cent. on the Ordinary shares, absorbing £102, leaving £36 to be carried forward. The Directors have applied for a Provisional Order, which they state is now practically secured.

The report was adopted.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1895, pages *304-332, &c. &c.*]

FENN AND CO. (LIMITED).—This Company has been registered, with a capital of £3,000, in £1 shares, to carry on the business of manufacturers of and dealers in machinery, mechanical and scientific appliances and apparatus, at 136, Borough High-street, London, S.E.

JOY'S PATENTS (LIMITED).—This Company was registered on March 25th with a capital of £15.000, in £5 shares, to acquire the patent rights of David Joy, engineer, of 17, Victoria-street, Westminster, for an improved valve gear, and to carry on the business of engineers and valve gear manufacturers.

LOIDIS ENGINEERING SYNDICATE (LIMITED).—This Company was registered on March 25th with a capital of £2,000, in £5 shares, to enter into and carry into effect an agreement to be made with Christopher W. Jones and George Watson, engineers, of Leeds, for the purchase of certain provisionally protected inventions relating to improvements in apparatus for exhausting, propelling, or inducing currents in air or other fluids, and to carry on the business of mechanical engineers, machine tool makers, boiler makers, &c.

PURE CARBON COMPANY (LIMITED).—This Company was registered on April 8th, with a capital of £12,000, in £1 shares, to adopt an agreement made between Alfred T. Hooper and Tribe, Clarke, Painter and Co. (for the Company) to acquire the patent rights specified in the said agreement.

TELAUTOGRAPH COMPANY (LIMITED)—This Company was registered on April 5th, with a capital af £42,000, divided into 26,000 Ordinary and 16,000 Preference shares of £1 each, to acquire the patents of Prof. Elisha Gray and others, relating to writing telegraphs, or which can be used in connection therewith, and all improvements in such inventions; to carry into effect an agreement between the Gray European Telautograph Company and this Company to establish, work, manage, control, and regulate telautograph exchanges, and works for the supply of electric light, heat and motive power; to transmit, and facilitate the transmission of telautographic, telephonic, and telegraphic communications and messages; to undertake the lighting of towns, streets, buildings, and other places, and to carry on the business of a telautograph, telephone, telegraph, and electric light, heat and power supply company in all or any of its branches. The signatories to the Memorandum of Association include the names of F. W. Cushing and L. O. McPherson, electrical engineers. The first Directors are to be appointed by the subscribers.

WANDSWORTH CHEMICAL WORKS (LIMITED).—This Company was registered on April 1st, with a capital of £10,000, in £1 shares, to enter into an agreement with the Wandsworth Chemical Works (Limited) and the liquidator thereof, for the acquisition of the business.

AKESTER ELECTRIC SYNDICATE (LIMITED).—A special resolution was passed on March 28th for the voluntary liquidation on account of liabilities, and J. Durie Pattullo has been appointed liquidator.

ANDER'S TELEPHONE COMPANY (LIMITED).—The annual return of this Company, made up to February 28th, has been filed. The nominal capital is £10,000, in £1 shares; 3,607 of these have been taken up and 3,000 have been issued as fully paid. The full amount has been called and paid on the remainder. During the year the vendor has sold his 750 shares.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).—The annual return, made up to February 8th, has been filed. The capital consists of £7,000,000 stock, all of which has been paid up in full.

BARNET AND DISTRICT ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to January 10th, was filed on April 3rd. The nominal capital is £5,000, divided into 490 Ordinary shares of £10 each, and 100 Founders' shares of £1. 80 Ordinary and all the Founders' have been taken up, the latter being issued as fully paid. The full amount has been called on 60 Ordinary, and £5 per share on the remainder.

BERNSTEIN ELECTRIC LAMP COMPANY (LIMITED).—The annual return of this Company, made up to December 31st, was filed April 5th. Out of a nominal capital of £100,000, in £10 shares, 2,814 have been taken up, and the full amount called and paid. Alexander Bernstein, electrician, of Mühlenkamp, Hamburg, holds 1,581 shares.

BIRMINGHAM ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to March 21st, has been filed. The whole nominal capital of £100,000, in £5 shares, has been taken up, and the full amount has been called on 10,000 shares, and £3 per share on the remainder.

BRITISH ELECTRIC TRAMWAYS AND GENERAL SYNDICATE (LIMITED). As this undertaking has not filed any return since July 31, 1893, the usual notice for removing its name off the Register of Joint Stock Companies has been returned to the Registrar marked "Gone away."

CAMBRIDGE ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to March 13th, has been filed. Out of a nominal capital of £50,000, in £10 shares, 4,030 have been taken up and allotted. £8 per share has been called up, and £32,256 paid.

DOVER ELECTRICITY SUPPLY COMPANY (LIMITED).—The statutory return of this Company, made up to March 1, 1894, was filed on April 4, 1895. The nominal capital is £50,000, in £5 shares, of which 2,444 have been taken up. A call of £1 per share has been made, resulting in the receipt of £1,432, leaving £1,012 in arrears.

NORTHAMPTON ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return of this concern, made up to March 14th, has been filed. The Company has a capital of £50,000. which is divided into 10 "A" and 49,990 "B" shares of £1 each. Of these all the "A," 10,000 "B" Ordinary, and 3,200 "B" Preference shares have been taken up, and on all the "B" shares the full amount has been called and paid. Nothing has as yet been called on the "A" shares.

WEYMERSCH ELECTRIC BATTERY COMPANY (LIMITED).—The annual return of this Company, made up to December 14th last, was filed on March 20th. The whole nominal capital of £20,000, in shares of £5 each, has been taken up, and of these 3,000 shares have been issued as fully paid. The full amount has been called and paid on the remaining 1,000 shares.

WREXHAM AND DISTRICT ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to February 16th, has been filed. 115 shares have been subscribed for and allotted out of a nominal capital of £20,000, in £5 shares. On each of these the full amount has been called, resulting in the payment of £257, and £318 in arrears.

CITY NOTES.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ended March 31st of 10s. per cent. on the Ordinary stock, and £1 per cent. on the Preferred stock, less income tax, payable on May 1st. The dividend for the corresponding period of 1894 was 9s. and 18s. respectively.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts of this Company for the week ended April 7 were £935, as against £852 in the corresponding period of 1894, being an increase of £83. The total receipts for the half-year amount to £13,583. against £12,887 in the corresponding period of 1894, an increase of £696.

GREAT NORTHERN TELEGRAPH COMPANY.—The nett receipts of this Company during 1894, including the balance brought forward from 1893, amount to £307,476. 8s. 9d. Deducting £47,527. 15s. 6d. towards interest on and amortisation of debentures, and interim dividends (already paid) £75,000, the Board propose to distribute the balance as follows:—Extra dividend (making the total dividend for the year about 8·60 per cent.), £54,166. 13s. 4d.; reserve and renewal fund, £83,333. 6s. 8d.; pension fund of the staff, £2,777. 15s. 7d.; directors' remuneration, £1,500. A balance of £43,170. 17s. 8d. is carried forward to next account.

INDO-EUROPEAN TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have, after adding £10,000 to the reserve fund, determined, subject to audit, to recommend the payment of a dividend for the six months ended December 31st last of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent., and a bonus of 20s. per share, both free of income tax, making in all 10 per cent., for the year. The dividend and bonus will be payable on and after May 1st.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 7th inst. amounted to £1,024. The amount for the corresponding week last year was £691.

ORIENTAL TELEPHONE AND ELECTRIC COMPANY (LIMITED).—The Directors of this Company have resolved to recommend, subject to audit, a dividend at the rate of 4½ per cent. per annum, free of income tax, for the period from the date of the reconstruction of the Company (March 12, 1894) to December 31st last.

RICHMOND (SURREY) ELECTRIC LIGHT AND POWER COMPANY.—At a meeting of shareholders of this Company, held on Tuesday, the following gentlemen were elected Directors:—Mr. F. W. Reynolds (Director of the City of London Electric Lighting Company), chairman; Mr. W. C. Braithwaite (Director of the County of London and Brush Provincial Electric Lighting Company), and Chevalier Soares. At a subsequent meeting of the Directors, Mr. A. J. Lawson was appointed engineer and manager, and Mr. G. A. Luke, secretary *pro tem.* Mr. Percy W. Northey remains resident engineer.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee appointed Tuesday last a special settling day in the further issue of 8,000 Ordinary shares of £5 each (£2 paid) of the Westminster Electric Supply Corporation (Limited), and ordered the same to be quoted in the Official List.

SUBMARINE CABLES TRUST.—Notice is given that on and after April 16th the sum of £1. 15s., on account of this Company's coupon due April 15th, will be paid by Messrs. Glyn, Mills and Co., of 67, Lombard-street, London, E.C., the coupons to be left four clear days for examination.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the week ended April 5, 1895, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,116.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, Apr. 3.		Price Tuesday, Apr. 9.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Apr. 9.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	14/0	Anglo-American	41	42	41	43	4 13 0	Jan., Apr., July, Oct.	41	..
£2,993,560	Stock	28/0	Do. Preferred	78	79	78½	79½	5 0 8	,, ,,	79½	78
£2,993,560	Stock	5/0	Do. Deferred	6½	7	6½	7	..	..	6¾	6½
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 17 8	January and July	..	..
130,000	£10	3/0	Brazilian Submarine xd	12	12½	12	12½	5 4 0	Mar., June, Oct., Dec.	12½	12⅜
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	109	113	109	113	4 9 6	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	148	152	148	152	4 12 1	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	—
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	,, ,,	..	..
12,931	5	1/8	Direct Spanish (fully paid)	4	4½	4	4½	4 8 11	April and October	..	—
6,000	5	10%	Do. Preference 10 per Cent.	9½	10	9½	10	5 0 0	,, ,,	—	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	—
60,710	20	2/0	Direct United States Cable, 1877	8½	9	8½	9	5 0 0	Jan., Apr., July, Oct.	9	8⅝
400,000	10	2/6	Eastern	16¼	16½	16¼	16½	3 18 9	,, ,,	16½	16 5/16
70,000	10	6%	Do. 6 per Cent. Preference	17¼	17¾	17¼	17¾	3 7 7	,, ,,	17 5/16	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	124	127	124	127	3 3 0	May and November	126¼	124½
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	108	105	108	4 13 0	February & August	..	..
250,000	10	2/6	Eastern Extension	17⅛	17⅜	17⅛	17⅜	4 0 8	Jan., Apr., July, Oct.	17⅜	17⅛
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	123	126	123	126	3 3 6	February & August	125¾	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	107	103	107	4 14 7	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	103	107	4 14 7	,, ,,	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106	109	106	109	3 13 9	February & August	..	—
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 10	May and November	..	—
180,227	10	1/6	Globe Telegraph and Trust	9⅞	10⅛	9⅞	10⅛	4 8 11	Jan., Apr., July, Oct.	10 1/16	9 15/16
180,042	10	6%	Do. 6 per Cent. Preference	16⅝	16⅞	16⅝	16⅞	3 11 3	,, ,,	16¾	16⅝
150,000	10	5/0	Great Northern	21¾	22¼	21¾	22¼	3 16 7	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 13 6	March & September	106½	..
17,000	25	12 6	Indo-European	52	54	52	54	4 12 7	May and November	..	—
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	—
£100,000	100	6%	* Do. 6 per Cent. Debentures	105	109	105	109	5 10 7	March & September	..	—
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	105	108	3 14 11	..	..	—
11,839	8	4/0	Reuter's	4	5	4	5	..	April and October	..	—
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	119	124	121	126	4 15 3	,, ,,	122½	..
15,609	10	5/0	West African Telegraph	4	5	4	5	..	January and July	..	—
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	101	104	4 16 7	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	—
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	98	103	7 15 4	June and December	..	—
88,321	10	6d.	West India and Panama	⅞	1⅛	⅞	1⅛	..	..	1⅛	1 1/16
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10¾	11¼	6 6 8	May and November	11¼	11 1/16
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	9⅝	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	108	111	4 11 1	June and December	..	..
64,242	15	3/0	Western and Brazilian	10	10½	10	10½	5 4 6	May and November	..	..
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	—	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	4	4½	3¾	4½	..	—	4	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 15 5	February & August	101½	—
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 15 6	,, ,,	..	—
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115	120	115	120	5 19 8	May and November	..	—
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	101	103	101	103	5 17 1	March & September	..	—
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	—	..	..	..
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	—	May and November	⅛	—
171,504	£1	..	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	—	..
484,597	5	2/6	National	5¼	5½	5¼	6½	4 10 11	June and December	6 7/16	6¼
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15½	16½	15½	16½	3 12 9	,, ,,	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	15½	14½	15½	3 17 5	,, ,,	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅝	5⅞	5⅝	5⅞	4 5 1	—	5⅞	5⅝
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	104	166	3 6 0	January and July	105½	101½
58,000	5	1/0	United River Plate	1	2	1	2	..	,, ,,	..	—
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	85	90	85	90	5 9 11	,, ,,	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	13	14	13	14	1 15 8	—	13⅝	..
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	14¾	15¼	14¾	15¼	3 18 8	..	15 3/16	..
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5	5½	5	5½	3 17 9	—	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	—
8,322	£5	..	House-to-House Electric	..		..		—	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		—	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		—	January and July	—	—
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7⅜	7⅝	7⅜	7⅝	—	—	..	—
111,000	5	..	London Electric Supply	..		..		..	—	..	—
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	10¼	10¾	10¼	10¾	2 6 6	..	10⅝	10⅝
£150,000	Stock	4½%	* Do. 4½% Debs.	118	120	118	120	3 15 9	June and December	118½	—
6,452	£10	2/0	Notting Hill Electric	7¼	7¾	7¼	7¾	..	..	..	..
19,980	£5	4/6	St. James and Pall Mall	7½	8	7½	8	..	—	..	—
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8½	9	3 17 0	—	8 11/16	..
69,000	5	5%	Westminster Electric Supply (fully paid)	7⅜	7⅞	7⅜	7⅞	3 3 6	—	..	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	8	1/6	Brush Electrical Engineering	2¼	2¾	2¼	2¾	6 6 7	—	..	..
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2⅜	2⅝	4 11 5	..	2½	..
£125,900	Stock	4½%	* Do. 4½ per Cent. Debentures	113	116	113	116	3 17 9	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2¾	3¼	2½	3	—	January and July	..	..
12,139	5	..	Edison and Swan United	1⅝	1⅞	1⅝	1⅞	—	..	—	—
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		..	..	—	..
120,000	2	..	Electric Construction	¼	½	¼	½	—	..	..	..
12,845	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	1¼	1¾	1¼	1¾	..	..	..	—
91,195	2	10/0	Elmore's Patent Copper Depositing	1¼	1½	1¼	1¾	—	..	1⅝	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	22	23	21½	22½	4 8 11	February & August	22⅜	22⅛
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	101	103	101	103	4 7 5	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	—	..	..
16,000	£10	..	Do. 8 per Cent. Preference	..		—		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	⅛	—	⅛	..	..	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	39	41	39	41	8 15 7	March and July	40	39
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 14 1	January and July	..	..
37,514	£6	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,008	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,870	10	12/0	W. T. Henley's Telegraph Works Ordinary	9½	10½	9½	10½	5 14 3	..	..	..
£30,000	10	..	Do. Preference	..		..		..	..	..	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1½%	City and South London Railway	45	47	45	47	2 13 2	May and November	—	..
7,000	10	5%	Do. 6% Perpetual Preference	14	15	14	15	3 6 8	..	14¾	—
£67,180	Stock	4%	Do. 4% Perpetual Debenture	130	133	130	133	3 0 2	May and November	..	..
87,500	£10	2%	Liverpool Overhead Railway	8 7/16	8 9/16	8½	8⅝	2 0 4	..	..	..
6,295	10	5%	Do. 6% Preference	14	14½	14	14½	3 11 5	..	..	..
125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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NOTES.

Colonel Yorke, in his report on the recent accident at Wood Green, which was caused by the fracture of a defective axle, describes the time-honoured tapping test as "inadequate." "What seems to be required," he says, "is some test, possibly by means of electricity, magnetism, or sound, by which it can be ascertained whether an axle is structurally perfect throughout." If the Board of Trade requires something scientific, it cannot do better than convert Captain de Place's "schiseophone" into a practical instrument. Even in its original crude form (see *The Electrician*, Vol. XXV., p. 386) it erred on the right side—that is to say, it impugned the soundness of apparently sound bars, but it did not allow a single concealed flaw to pass. A short account of some tests of the "schiseophone," carried out under the auspices of the South-Eastern Railway Company, will be found on page 320 of Vol. XXVI.

Judging by the remarks of Mr. J. W. Lieb during the recent discussion on Mr. Ward Leonard's Paper at the American Institute of Electrical Engineers, it is not all American electric supply stations which enjoy the delightfully high load factors which English engineers have so often been called upon to envy. We have many times been told that in some places in America the load factor attains or even exceeds 50 per cent. If this desirable result is to be achieved anywhere it ought, one would imagine, to be in New York. Yet Mr. Lieb tells us that the load factor of the combined stations of the Edison Electric Illuminating Company of New York on the one day of last year in which the output was greatest—December 10th—did not exceed 34½ per cent. Curiously enough, the load factor of the district where there is a large motor load was *less* than that of the district where few motors are used. Buildings where motors are used shut up early in the evening, and do not want lamps at night. The combined stations referred to do not, we believe, by any means represent the whole of the electric light business of New York, but they represent by far the larger part of it. Besides supplying some 235,000 16-c.p. glow lamps and about 3,000 arcs, these stations have an aggregate motor load of 7,600 h.p. Their combined output on the day already mentioned was about 60,600 units. That of the London stations on a date nine days later was 96,240 units; their equivalent 16-c.p. lamp connection being about 460,000, that is to say, 100 per cent. more than the *glow* lamp connection of the New York Edison stations. Now the London stations, it must be remembered, have a motor and arc-light connection, which, by comparison with that of the New York Edison stations, is practically a negligible quantity. Yet the load factor of the combined London stations on that date, December 19th, has been estimated by Mr. Crompton, in his recent Presidential address before the Institution of Electrical Engineers, at 33 per cent. The difference of the daily load factors is thus only a trifling one. But it is not unreasonable to expect that when the annual load factors, instead of two winter-day load factors, come to be compared, our London stations will be found, from this point of view, to be considerably behind those of New York owing to the steadiness of the New York motor demand during the summer.

Besides Mr. Leonard, there was last year yet another "chiel amang us takin' notes." M. Guido Semenza, whose lively *critique* of English men and manners from the engineering point of view will be found in another column, does not, it would appear at first sight, think so highly of us as did Mr. Ward Leonard. M. Semenza, however, lets off most of his fireworks in his first paragraph. After politely informing us that there is in England "little novelty, no dash, no tendency which indicates impending progress," he pours oil upon the troubled waters of our patriotism by the inspiriting assurance that nevertheless "a visit to English workshops and plants presents many points of interest," and that if we err we do so with something approximating a reason—"it is rarely out of mere obstinacy." Indeed, the only heresies of which we are persistently accused are such as all English electrical engineers will readily plead guilty to, to wit, a dogged determination to maintain the supply at all costs and a preference for safety and solidity, even if in the attainment of these *desiderata* we "suffocate the electrical requirements." M. Semenza has a Baron Munchausen tale to tell as to the customary way in which a broken-down Willans engine is set on its legs again, and both his description of a journey on a certain underground electric railway as "a succession of jolts from one end of the line to the other," and his designation of our attitude towards polyphase currents as that of ordinary men towards "dirigible balloons," should be forgiven for their wit—and accuracy. M. Semenza regrets that he did not visit London when its electrical men of light and leading were visible. So do we, since the public stock of harmless pleasure has certainly thereby been impoverished.

In another column will be found the full text of a Bill now before Parliament relating to the granting of certificates to men placed in charge of steam engines and boilers. It is a Bill which, if passed, may prove of some moment to the electric lighting industry, and it is in any case a characteristic sample of latter-day legislation. The *Engineer*, which published the text of the Bill in its issue of April 5th, and makes a lengthy comment on it in its last issue, scents trade unionism beneath every clause. For our own part, we are disinclined to believe in this piece of Machiavelianism. Surely the fact that we are living in the midst of an age of examinations, certifications, and general government by Board of Trade, is a sufficiently obvious reason for this latest legislative birth of time.

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At first thought there might not seem to be any close similarity between the working conditions of an electric supply station boiler and those of a boiler in a man-of-war. Closer inspection, however, will show that the conditions are almost identical. In both cases the boilers are required to stand heavy forcing, and to be capable of getting up steam at short notice; and in both cases, although economy is of importance, it must be considered in conjunction with durability and quickness and ease of repairs. Thus naval and electrical engineers ought to be able to teach one another something in this matter. The former, who appear not to be altogether satisfied with the return tube type of boiler, may find useful instruction in the behaviour of water-tube boilers in many of our electric supply stations. And the latter should watch the outcome of the recent action of the Admiralty in adopting the Belleville water-tube boilers for the two new "monster" cruisers, H.M.S. "Powerful" and "Terrible," and for other vessels of the new naval programme.

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Although differing in many respects from the familiar Babcock-Wilcox boiler, the Belleville steam generator is more akin to it than the types of water-tube boilers which have thus far been used in the Navy, for torpedo boats, and other small craft. The main difference between the two is that in the Belleville boiler the water circulation is carried in a zigzag path through several inclined longitudinal tubes, connected by headers or boxes, whereas in the Babcock boiler the course of the water traverses the tubes only once. As a land boiler the Belleville type has been largely used in France, where the experiences of its use have been very like our own with the Babcock boiler. We may expect, then, to receive a valuable lesson when H.M.S. "Powerful" and "Terrible" have been put through their paces.

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The short account of their researches, by Messrs. Campbell and Lovell, on the alleged magnetic fatigue, which they have contributed to our issue this week, comes as an additional confirmation of the general consensus of expert opinion that such a fatigue does not actually exist. Mr. Mordey has traced the pseudo-fatigue of the iron core of a transformer to the "baking" which the core receives during the working of the transformer; and Prof. Ewing showed, in our issue of January 11th, that when a core is maintained in a condition of rapid reversal of its magnetic induction, but with such provision for cooling that rise of temperature cannot take place to any appreciable extent, there is no change in the hysteresis losses in the iron. Messrs. Campbell and Lovell have adopted the method of comparing the **B-H** or 𝔅-ℌ curves, as they prefer to call them, initially and after the core had been subjected to rapid alternating magnetic induction for several days. Their results show no ground whatever for believing that a fatigue is set up in the iron, for the permeability of the iron does not appear to deteriorate in the least.

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The object which seems principally to have inspired the deputation from the Association of Technical Institutions, received by Mr. Acland last month, was to enable science teachers to gain information of changes in the regulations of the Science and Art Department at a much earlier date than they now do. The deputation was anxious that the Directory of the Department might be ordered to lie on the table of the House of Commons, so that it might be discussed as the Code of the Education Department now is; and they were further desirous that the dates of the May examinations might be fixed and published not later than the preceding May. It would seem that, under present arrangements, the information regarding the sessional plans of the Science and Art Department is published so late in the year that it is impossible to embody it in the yearly syllabuses of the various technical institutions controlled by the Department; though, from Mr. Acland's remark that no important change is introduced into the Directory without it having been advertised for some time before, there does not appear to be any very serious grievance here. It is true that the Code of the Whitehall Department is open for discussion in the House of Commons, while the Directory of the South Kensington Department is not; but that does not in itself constitute a grievance, and the two cases are by no means parallel. What sessional advantages do science teachers expect to derive from discussion of the Directory by the House of Commons? No one in the deputation seemed able to say, except that they hoped to get earlier information of the changes—which could be obtained in a more direct and less vexatious way.

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The Budapest Electric Tramway.—This line carried last year 12,500,000 passengers, as against 11,000,000 in 1893.

Engine Governing.—Owing to pressure on our space, we have been compelled to hold over a letter on this subject from Mr. W. C. Goodchild.

Electric Traction in the Isle of Man.—The electric railway to the top of Snaefell, Isle of Man, is being rapidly pushed on, and it is anticipated that the line will be completed in time for the coming season.

The British Association.—The Provincial Legislative Assembly of Ontario has unanimously authorised a grant of $7,500 towards defraying the expenses of a meeting of the British Association to be held in Toronto in 1897, should the Association accept the invitation to hold a meeting there.

Accident on the Liverpool Overhead Railway Station.—On Wednesday night of last week, Mr. C. Jones, an assistant engineer at the generating station of the Liverpool Overhead Railway, met with a serious accident while attending to some part of the electrical machinery, his hands and face being very severely burned.

The Laval Steam Turbine in Spain.—The Laval steam turbine appears to be coming into favour in Spain in connection with electric lighting. Although the turbine has only been on the Spanish market a short time, it is driving dynamos at Carthagena, Madrid, Salamanca and Argona, the turbines ranging from 10 H.P. up to 100 H.P.

Cable Interruptions:

	Date of Interruption.
Latakia—Cyprus	Nov. 27, 1894.
St. Louis—Noronha	Mar. 12, 1895.
St. Vincent—San Thiago	April 5, 1895.
Constantinople—Dardanelles	April 9, 1895.

The cable between Mozambique and Majunga in Madagascar was opened for traffic on the 11th inst.

Electric Railway Enterprise.—At the end of last month a company, calling itself the Inter-Ocean Electric Railway Company, was incorporated. The object of the Company is to obtain subscriptions to the amount of $200,000,000. After this object has been attained, it is proposed to construct an elevated electric railway between New York and Chicago for the transport of coal and grain. The duration of this Corporation is to be 99 years (?).

Electric Traction in Rome.—*L'Electricista* states that the Town Council of Rome, at their last meeting, decided to grant a concession for an electric tramway to the "Società Romana degli Omnibus." The line will run from the General Post Office, through the quarters of Villa Ludovisi and Macao, to the Central Railway Station. At several points the gradients are severe. The line is to be on the Thomson-Houston overhead system, and is intended to be opened about the middle of September.

Meteorological Signalling at Chicago.—On the summit of the Auditorium tower in Chicago, 300ft. above the level of the lake, a large marine search light has been erected, for the purpose of "signalling weather predictions over the City of Chicago and surrounding territory." The signals proposed are very simple. A solid beam of white light means a cold wave, if shown in winter, and an approaching frost if displayed in the spring or fall. A solid red light will convey warning of a marine storm, with high easterly winds. A beam half white and half red (the line of demarkation being horizontal) means a marine storm with high westerly winds. In each case the beam will travel slowly around the horizon, elevated at an angle of about 22½deg.

Heilmann Locomotive.—The discussion at the American Institute of Electrical Engineers on Mr. Ward Leonard's Paper on "Electric Engineering Developments in England and France" was especially directed to that part relating to the Heilmann locomotive. The speakers were not inclined to regard this combination with approval; in fact, before the presentation of Mr. Leonard's Paper, few of them thought it worthy of serious consideration. One point brought against the electric locomotive was that advanced by Mr. Forney, who showed that if the Heilmann plant was to cost £10,000, which is about five times that of the ordinary passenger steam locomotive of the largest size, the excess of interest charges would more than counterbalance the saving produced by economy in operation. —The Heilman Company has just secured a contract for the operation, by means of electric locomotives, of the St. Germain-Ouest—St. Germain-Grande-Ceinture Railway, which is about four kilometres long.

The Prevention of Street Explosions.—The *Journal of Gas Lighting*, while commenting on Major Cardew's report on the Southwark Bridge explosions, gives it as its opinion that where conduits can be solidly packed, it will be safer to do this than to rely upon artificial ventilation. "We take the opportunity," it says, "for reminding our electrical friends, *apropos* of street conduits generally, that the opinion of gas engineers has never been in favour of street subways, unless of considerable size, and capable of unquestionably efficient ventilation; and recent experience of the rabbit-holes made under the streets by electricians, with small knowledge of the consequences likely to follow their action in this regard, has not tended to remove this objection. Gas engineers have always preferred to bury their mains in the solid ground; and it is more than a little hard to blame them exclusively, or even preferentially, for the results of the adoption of a different policy by electricians with nothing like their experience of the vicissitudes of distributing plant."

Gas Heated Thermopiles.—According to the *Gas World* Gulcher's thermopiles, in which an electric current is obtained by simply lighting the gas, have been subjected to experimental measurement by C. Brüggemann, of Aix, who employed thermopiles which he had been using for two years. The greatest voltage was 3·92 volts, with a current of 2·51 amperes. The voltage was found to vary as the square root of the pressure of the gas used; it was, for pressures between 0·44 and 1·36 inch, equal to 7·3 times the square root of the pressure in inches. But since the outflow of gas is also proportional to the square root of the pressure, it follows that the voltage is directly proportional to the consumption of gas. The highest voltage is attained in about thirty minutes after the gas is lit; nine-tenths of the maximum in about eleven minutes. The internal resistance increases while the thermopile is in use, but soon reaches a maximum, and then remains constant; reaching about 0·912 ohms after two years in one of the piles. At a pressure of 1·2 inch of water, the consumption of gas was 7·8 cubic feet per hour with a voltage of 3·97 volts.

Electricity in Mills.—With the aid of a suitable glossary, no doubt the remarks of some of the speakers at a recent meeting of the Manchester Association of Engineers would be quite intelligible; as it is, a condensed report which appeared in an engineering contemporary is rather curious reading. The subject under discussion was electricity as the future motive power for mills. Mr. Thomas Ashbury thought the action of electricity on the cotton fibre was a serious question, although the sensitiveness of a system of electric driving was undoubtedly a point in its favour. Mr. Hans Renold also thought that he saw an objection to electric driving in cotton mills in the effect of the electricity on the fibre. Mr. Saxon thought there was certain to be a diffusion of energy which would injuriously affect the fibre, if a system of electric driving was adopted. Mr. Selby-Bigge assured the gathering that there was no serious difficulty with regard to "the magnetic influence on the fibre," as there were means for nullifying this influence. As to working the machine in wet places, this caused no difficulty, as they could heat the magnet coils electrically, and so keep them dry

A Large Three-Phase Lighting Plant.—The new State Library at Concord, United States, has recently been wired and lit on the three-phase system. The building is lighted by 1,000 incandescent lamps, wired on the Edison three-wire convertible system applied to the three-phase current. The system, says the *Western Electrician*, of Chicago, is so laid out that by changing the connections on the main distributing board five distinct wiring schemes may be made use of—three-phase current, three-wire direct current, three-wire alternating, two-wire direct and two-wire alternating. Any one of these plans is available at any time. Current is taken from the 2,250-volt primary mains of the Concord Land and Water Power Company, which, encased in lead cables, lead down through hollow steel tubing at the curbing, thence through a brick duct into the basement, and to three transformers which are placed in the rear of the distributing board, and which have a capacity of 20 kilowatts each. From this distributing board all the secondary mains are run in brass-armoured conduit to the nine centres of distribution, and also to the 15-H.P. three-phase motor which is used to drive the heating and ventilating systems.

Electric Transmission in California.—According to the *Engineering Record*, yet another large electric power transmission plant is to be laid down in California, this time near Newcastle. It is proposed to put in Pelton wheels and generator plant at a point a third of a mile from Newcastle, where there is a fall of about 500ft. on one of the irrigating canals. The electricity obtained in this way will be used in lighting Newcastle, Penryn, Loomis, and Rocklin, and about 600 H.P. will be transmitted to Sacramento for power and lighting purposes there. Should this venture prove successful, the South Yuba Water Company will develop two more falls on its system of canals in the same manner. The Company which is to carry out this undertaking is one of the outgrowths of the hydraulic mining operations carried on in California for many years. It was organised in 1854, and acquired successively the water rights of three more companies of the same character, so that to-day it controls a watershed of 150 square miles in Nevada and Placer Counties, and owns a network of over 400 miles of canals, 18 storage reservoirs, several distributing reservoirs, two systems of town waterworks, and furnishes power and water for many purposes, public and private, in the counties named.

Technical and Engineering Progress in Japan.—When we know that there are 26,000 primary schools in Japan, says the *Indian Engineer*, while in the United Kingdom and Ireland there are 31,000 inspected schools, we are able to form some idea of the rapid advance which has been made in Japan. These primary schools have laid a good foundation; but they by no means stand alone. Secondary and technical schools are to be found in almost every large town, while the Imperial University compares favourably with any similar institution in Europe or America. It is especially strong in the scientific and technical sides, and its students show by their work that they are not only able to appropriate what is to be found in books, but also to display ability in original research. The *Journal* of the College of Science contains most able Papers on the different departments of science, while the *Transactions* of the Institution of Engineers give accounts of the numerous works of all kinds which are being carried out in the country. That institution contains nearly 2,000 members, who may be looked upon as one of the chief forces behind the recent war; for although few of them took any active part in the direct operations, they rendered most effective service in preparing for them and making them successful.

Mendeléeff on Argon.—At a recent meeting of the Russian Chemical Society, Prof. Mendeléeff stated his views in regard to argon. He says we must first determine whether it is or is not a mixture, and then whether it is a simple or compound body. He does not think it is a mixture. Taking it as a simple body, we must then consider its possible atomic weight. The weight of its molecule being nearly 40, the atomic weight of argon may be considered in relation to the series of possible molecular formulæ, A_1 A_2 A_3 . . . . A_n. Upon the first supposition it would be a monatomic gas, and in this case there is no room for it in the periodic system. It appears, therefore, very unlikely that the atomic weight is about 40. The second supposition, A_2, makes the atomic weight about 20, and then argon finds a place in the eighth group of the second series. The third hypothesis makes its atomic weight about 14, and in such case argon may be considered as condensed nitrogen. There is much to be said in favour of this hypothesis: first, the concurrence of nitrogen and argon in nature and the similarity of their spectra; then, again, the inactivity of argon would be easily explained. The hypothesis of argon being condensed nitrogen might be decided by means of introducing boron or titanium into an atmosphere of argon strongly heated, and through which electric sparks would be passed.

A Jeffrey Mine Hoist.—The application of electricity to coal mine operations in America is steadily increasing. An electric hoist has recently been built by the Jeffrey Manufacturing Company for the Priceburg Mine at Dickson, U.S.A., which forms a part of a complete electric plant being placed at the mine, including an 80-H.P. electric locomotive, a 100-kilowatt generator and other machinery. This hoist, says the *Engineering and Mining Journal*, is of special interest. There are two motors, the armatures of which are not connected together, except by means of the gearing on the second shaft. There were a number of reasons for this construction, one being that the motors are interchangeable with the motors on the locomotive. The next reason was that the amount of work required from the hoist being variable and the speed of hoisting required to be the same, it was necessary to have some efficient means of controlling the speed of these motors, and this is effected by using two motors and a series-parallel controller. Another advantage is that the chance of a complete breakdown is just half what it would be with one motor. The general dimensions are as follows:—Diameter of drum 7ft., face of drum 7ft., grooves for $1\frac{1}{8}$in. rope, diameter of main gear 9ft. × 8in. face, 4in. pitch, diameter of friction-band ring 6ft. 3in. × 8in. face. The bearings are all very large and of heavy construction. The bed-plate is made of two pieces joined together with heavy wrought-iron shrinking rings. The gearing on second shaft and pinions on armatures are of steel and cut involute teeth. The hoist is of the friction type, having an internal friction gear.

An Electric Chronograph.—Mr. Carl Barus, in the current number of the *American Journal of Science*, describes a simple chronograph pendulum which is likely to be very useful to those who have no break-circuit chronometer or seconds clock at their disposal. It is a simple mechanism by which an ordinary seconds pendulum is both kept in motion and made to record its oscillations on one or more chronographs sharply. The heavy metallic bob of the pendulum is electrically connected with the knife-edge, and its top is surmounted by a soft iron armature, which is attracted during part of the swing by an electromagnet, and thus kept in motion. A longer and very much lighter pendulum, consisting of a flat bob suspended by two wires, is suspended by the side of the first, and swings in the same plane, but with a longer period. As the heavy pendulum approaches it, it touches a platinum spring projecting from the other bob, makes current for a moment, and works the chronograph, and at the same time sends the current through the electromagnet. The contact is quite momentary, as the spring causes the wire pendulum to be hurled off ballistically. On its return it is brought to rest, without rebounding, by a stop, against which it leans till the seconds pendulum returns. The bob of the light pendulum is made up of two small square parallel plates, between which the wires and the platinum strip are clutched by a single central screw. A band of platinum foil is wrapped round the heavy bob, in order to ensure reliable electric contact. The chronographs and the electromagnet are connected in parallel. The records show that the time of contact does not reach 0·1sec.

The Kingdon System of Electric Mains.—Systems of electric mains in which the conductors, whether insulated or bare, are drawn into iron or other pipes or laid in conduits, are open to the objection that an empty space is left round the cables or conductors, where an explosive mixture of air and gas may accumulate. Armoured cables are not open to this objection; but as the armouring can be easily penetrated by a pickaxe, additional protection is necessary. In the Kingdon system of laying electric mains these difficulties are overcome in a simple manner. The conductor, insulated with indiarubber, paper, or other material, is thoroughly protected against mechanical injury by an iron or steel channel of ∩-shaped section placed above the cable. The peculiar form of the exterior of the channel causes a pick or other tool to glance off to one side without penetrating the iron. The interior of the channel is of such shape as to approximately fit the cable. Below the cable is placed a strip of wood or iron, which is moulded to fit the cable. This is forced upwards within the channel, so that it is not liable to displacement or injury. Joints in the channel are covered by means of iron sleeves or clips, which serve also to secure the strip in place. For continuous current a single-stranded cable may be employed. For alternating currents two cables laid side by side, or a concentric cable, must be used. Concentric or triple concentric cables are also employed in the case of two or three-wire continuous-current systems. Where branches from the mains are required, cast-iron junction boxes are inserted, which are filled with solid insulating material after the joints are made and insulated. Where a branch is not immediately, but may subsequently be required, a short length of channel is placed, which can be easily removed by driving back the sleeves at either end for the substitution of a junction box. Bends can easily be arranged for where the cables have to pass round corners or to dip downwards so as to avoid obstructions. As there is no empty space round the cables, it is impossible for gas and air to accumulate. The cost of the new system is said to be not greater than the cost of armouring the cables with steel ribbon, and the ease with which the channel can be removed for the purposes of making joints should be an additional advantage. The system is the invention of Mr. J. A. Kingdon.

MOTIVE POWER AND GEARING.[*]

BY E. TREMLETT CARTER.

(Continued from page 698.)

Some Typical Steam Engines.

The Willans Engine.—As much because of the skill with which both important and minor details of construction have been adapted to the requirements of an electric supply station as because of the almost unsurpassed excellence of its economy in steam consumption, the Willans central-valve steam engine has taken a place which, as regards this country, is undoubtedly the foremost and leading one among electric power steam engines. We are, therefore, justified in giving to its construction and mode of working a more lengthy study than space can be afforded for for any other engine.

The Willans engine may be defined as a single-acting, vertical engine, in which the steam distribution is effected by piston valves contained within the hollow engine piston, and in which the several cylinders of the compound or triple form are placed in tandem, with the higher pressures uppermost. It combines several patents of the late Mr. Percy Willans with several other patents which that engineer took out in conjunction with Mr. M. H. Robinson and others. The earliest of the patents which has any substantial effect in the present form of the engine is, the author believes, No. 1,572 of the year 1880. The engine occurs in several varieties; it is constructed for either single, compound, or triple expansion, with the cylinders bolted together in tandem in a vertical column, and with one piston working on to a single crank; and, again, it is constructed of two or three of these sets of cylinders placed side by side, with two or three cranks on the same shaft; this arrangement being adopted for the purpose of balancing and for equalising the torque of the engine. If there are more than one of these vertical sets of cylinders they act independently, in so far as the steam is concerned; *i.e.*, the steam from one column of cylinders never passes over to any other column, as in some engines of another type. The two-crank or three-crank compound engine is the most common variety in English electric supply stations, and a longitudinal section of one of the two-crank compound engines is shown in Fig. 59. The cranks are here set at 180°. In the three-crank variety the only difference is that there are three, instead of two, columns of cylinders, each precisely as shown, but with the cranks at 120°. In the triple-expansion engines the only difference from Fig. 59 is that the combination of the piston valves, hollow ported piston rod and piston is repeated three times instead of twice. The diagram, therefore, represents all the essential features of every variety of the engine. This engine is usually said to be of the high-speed type, because the ratio of its speed in revolutions per minute to its horse-power is, for any given horse-power, higher than commonly occurs in other engines. The 100-I.H.P. Willans engine usually runs at about 460 revolutions per minute; larger engines run at speeds down to about 250 revolutions, and smaller engines up to about 900 revolutions per minute.

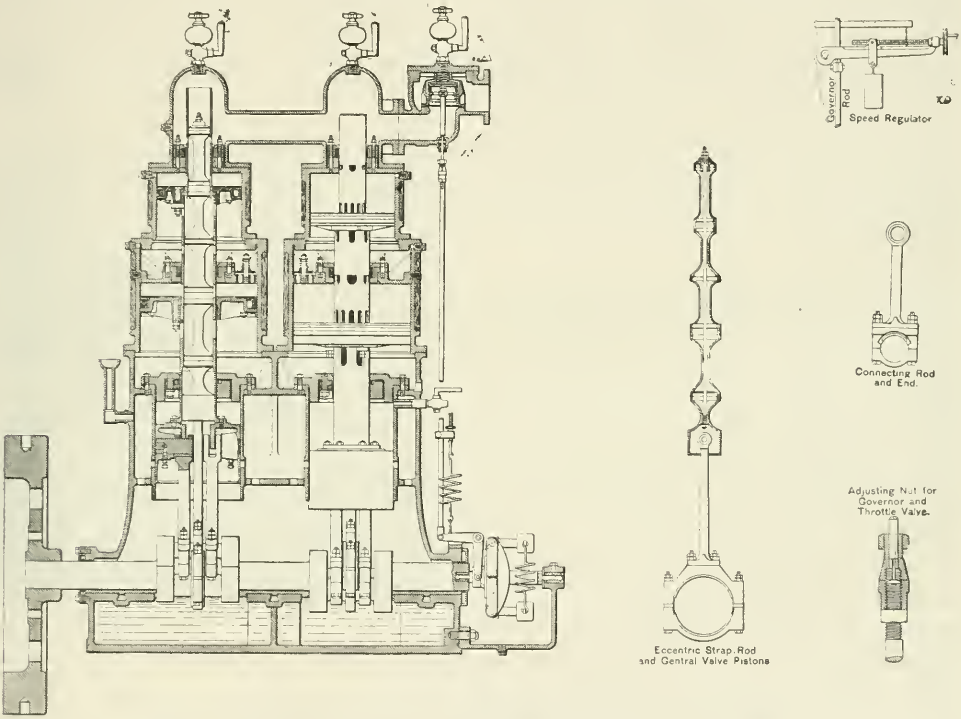
Governor Rod
Speed Regulator
Connecting Rod and End.
Adjusting Nut for Governor and Throttle Valve.
Eccentric Strap Rod and Central Valve Pistons

Fig. 59.—Vertical Section and Details of Willans High Speed Central Valve Steam Engine.

In Fig. 59 the left-hand portion shows one set of cylinders with the pistons and hollow rod in section, thus exposing the piston valves; and the right-hand portion shows a section through the other set of cylinders, exposing the outsides of the pistons and the hollow piston rod. In this latter portion the openings in the hollow piston which form the valve ports are shown in black. They are formed of a series of orifices arranged in circles at various points in the hollow rod; and they are periodically opened or closed to the passage of steam through them, by the action of the valve pistons, which move up and down on a valve rod within the engine piston. As it is necessary that the to-and-fro motion of the valve pistons shall be relative to the piston of the engine, and as this piston is already set in to-and-fro motion on its own account, it is necessary to superpose the harmonic motion of the valve piston upon the harmonic motion of the engine piston. This is done in a simple manner, by placing the valve eccentric upon the crank pin; by which arrangement the eccentric is carried bodily round in a circle according to the motion of the crank and engine piston, while at the same time rotating upon its centre according to the desired motion to be imparted to the valve pistons. Usually the eccentric is rigidly keyed to the crank pin, so that it has an invariable angle of advance. The eccentric is placed upon the centre of the pin, and on either side of it are two short connecting rods. These rods receive their motion from the piston rod, being joined to it at the cross-head. The cross-head is of an unique shape, being formed into a trunk piston; and it moves up and down inside a cylindrical guide-chamber, the enclosed air in the upper part of which chamber acts as a cushion to arrest the upward momentum of the moving parts. On the upper surface of the guide-piston or cross-head, as shown in the illustration, the lower end of the piston rod is bolted by a flanged joint. Immediately above this guide piston is the space formed by the lower part of the low-pressure cylinder; and this space is in direct communication with the exhaust pipe, and is usually called the exhaust chamber. The corresponding space formed by the lower part of each of the other cylinders acts, during the exhaust period of that cylinder, as a receiver, in which the steam is kept waiting until the piston of the cylinder immediately below is ready to make a working stroke. The working strokes are always on the down stroke, in all the cylinders of every variety of this engine.

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[*] From a forthcoming work to be published by *The Electrician* Printing and Publishing Company. All rights are reserved.

It will be observed that there is a row of valve ports in the hollow piston rod at the upper and at the lower sides of each piston, as well as in the neighbourhood of the glands in the cylinder ends. Now, when it happens that a valve piston is at a point somewhere between the two rows of holes on the two sides of any piston, it is evident that the steam on the upper side cannot pass to the lower side. While, when, at a little further on in its travel, the valve piston has moved up or down so as to allow a free communication between these two rows of ports, it is clear that the steam in the upper part will at once exhaust into the lower part, or receiver. The former state of affairs will happen during the down stroke, when the steam is doing work; and the latter state will exist from the moment of release to the moment when compression is about to take place, *i.e.*, during the greater part of the up stroke. In the up strokes, then, the steam merely shifts its side of the piston; it does not do any work. Referring now to the rows of port holes which are in the neighbourhood of the glands in the partition plates or cylinder ends, we will study their action. There are two of these rows in the compound engines, and three in the triple-expansion engines. In the illustration there is one row of holes close to the top of the high-pressure cylinder, and another row close to the top of the low-pressure cylinder. Now, it will be evident that when the piston is at the top of its stroke the upper row of holes will be projected into the space at the top of the engine—called the steam dome or chest—which is in direct communication with the steam pipe, and which is filled with live steam. If it happens that there is a valve piston plugging up the space in the hollow piston between the top row and the next lower row of port holes, it is clear that nothing will happen; but if, as is the case at the precise top of the stroke, this valve piston has moved down below the level of the second row of ports, then there is a clear way for the steam from the steam dome into the upper part of the high-pressure cylinder. This may go on until the engine piston has made any given fraction of its stroke, at which point it is arranged that the uppermost row of port holes will glide into the gland and pass out of the steam dome. As the steam is prevented from entering by the open top of the hollow piston, because of the uppermost valve piston blocking the way, the moment when the ports pass under the gland will be the moment of cut-off. Normally, the cut-off takes place at 0·6 of the stroke; but it may be made earlier by placing a distance piece under the gland, so as to raise its level. The glands in the illustration are shown thus levelled up for an earlier cut-off.

It must be pointed out that the moment of admission of steam into the high-pressure cylinder is not at the moment when its top row of ports re-enters the steam dome; for on the up-stroke, until the proper moment of admission, there is a valve piston travelling down in the space between the top and second row of ports, and this valve piston will, of course, block the way to the steam. The action of the row of ports in the neighbourhood of the lower gland is precisely the same as that described in connection with the top row, the receiver taking the place of the steam dome. It will be seen that a compound or triple-expansion engine may be run as a single-expansion engine if the upper pistons and their corresponding valve pistons are removed.

As the working strokes are always downwards, it is possible to arrange that the reciprocating parts shall always be under compression, never under tension. The absence of reversal of the forces on these parts has the exceedingly good effect of preventing knocking at the brasses, since there will never, under ordinary conditions, be any change over from the top to the bottom brasses. For this reason, the top brasses on the connecting-rod ends are made much more substantial than the bottom brasses, which only come into action when the engine races or when it is running very light; and, similarly, the bottom brasses at the crank shaft bearings are practically all the bearing surface which is allowed at these parts. It is this condition of constant thrust, combined with the efficient cushioning afforded by the air chamber above the guide piston, which enables this engine to be run at so high a speed with such small wear and noise. A third influence which contributes to the reduction of the wear is the copious and continuous lubrication afforded by the bath of mixed oil and water which partially fills the enclosed crank chamber. In their revolution, the cranks and eccentrics dip bodily into this bath, which is seen at the bottom of the figure, and the lubricant is splashed and circulated over all the wearing parts. The purpose in mixing water with the oil—which latter should be of a vegetable, not mineral origin, preferably castor oil—is to prevent excessive rise in temperature of the bath and of the bearings lubricated by it. It may be mentioned that the cylinders should be lubricated with mineral oil.

In its ordinary form a Willans engine is constructed to work with a fixed point of cut-off for every load, and to regulate by the action of a crank governor upon the throttle valve. This crank governor is shown at the extreme right of the shaft. The governor masses are held in position against the pull of coupling springs; and by a system of levers the throttle valve-rod, which runs up the side of the engine, is adjusted to give the right amount of opening to the steam. At full load the pressure of steam in the chest or dome may be as high as in the steam main; but as the load falls the pressure diminishes. The throttle valve is of the balanced or equilibrium type. The amount of opening of this valve at full load, when the engine is running at its normal speed, can be adjusted before starting by means of the nut shown in Fig. 59; and the speed at which the governor maintains equilibrium may be varied, some 5 per cent. up or down, from the normal by means of the speed regulator, which is also shown in the same illustration. One important effect of the lowering of the pressure at light load is that the downward force of the steam on the uppermost valve piston may become so small as to be insufficient to arrest the momentum of this part of the engine; the result of which is that a knock on the eccentric will be heard. On this account it is inadvisable to run this engine for long periods at light load, unless at reduced speed; but for short periods the effect is unimportant.

It will be noticed that the engine is not steam-jacketed. It is found that the supplementary heat of a jacket is not necessary to the economical working of the steam, for the period of the steam cycle in this engine is too brief to permit of a hot jacket having any useful effect. The cylinders are, however, thoroughly lagged with hair-felt and wood. The expansion of steam is, therefore, nearly adiabatic. Water formed in the cylinders on account of this expansion is not allowed to remain during the exhaust stroke, but is swept out of the cylinders immediately release occurs. In some of the Willans engines the upper surfaces of the pistons are dished, so as to induce the condensed steam to gather round the ports, thus further assisting the drainage of the cylinders.

Water is prevented from entering the steam dome by means of a separator, which is usually fitted on to the engine bedplate. The accompanying exterior view of a Willans 3-crank compound engine, Fig. 60, shows the separator at the extreme front corner of the bedplate. The steam enters at the top and descends through a hanging pipe into the body of the separator. After leaving the pipe it turns abruptly upward to the exit, which is near the top, while the particles of entrained water are shot downward to the bottom of the separator, where they collect. A gauge glass fitted to the bottom indicates the quantity of accumulated water, and when the amount has become excessive it is drained off by means of a drain cock.

Fig. 60 illustrates one of the 300-I.H.P., three-crank, compound Willans engines, designed to run at 350 revolutions per minute, which have been supplied for the Glasgow electric power station. The illustration shows the plant standing in one of Messrs. Willans and Robinson's workshops, and the steam and exhaust connections are, on that account, absent. At the Glasgow station, however, the engines have been strengthened to enable them to carry a maximum load of 360 H.P., which is very useful in view of the character of the load diagram usually met with at such a station.

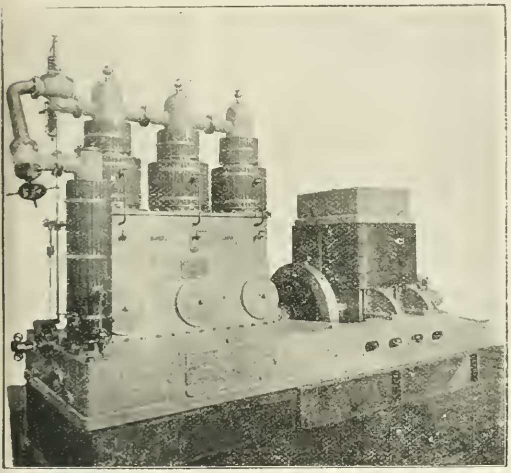

FIG. 60.– 300 I.H.P. Three-throw Compound Willans Engine, Direct-coupled to Continuous-current Dynamo.

This engine, together with the dynamo to which it is direct coupled, covers a floor space 16ft. long by 6ft. wide. The Willans engine has very largely been used in conjunction with direct-coupled dynamos, in the manner shown in this figure; but further discussion of this mode of driving must be reserved for a later chapter.

The performance of the Willans engine under careful trial, and under the most favourable conditions of working, has been discussed in former articles, but it may be mentioned that in actual work such a degree of excellence can hardly be expected, and is not maintained. The makers inform the author that an average figure for the compound engines, of a size and type such as that shown in Fig. 60, is about 20lb. of steam per indicated horse-power per hour when working non-condensing, and a proportionately lower consumption when condensing, according to the degree of vacuum maintained.

(To be continued.)

NOTE ON THE FORCE EXPERIENCED BY IRON-EMBEDDED ARMATURE CONDUCTORS.

BY W. B. SAYERS.

Some years ago, Mr. Swinburne originated the statement that in the case of armatures with iron-embedded conductors, the driving force was borne directly by the iron instead of by the conductors, as in the case of smooth core machines. The object of the present note is to show that this statement is substantially true for practical considerations, though not absolutely so.

In the case of a smooth core armature the strength of field in which the conductors are immersed is **N**, the total flux, divided by the interpolar area, the distortion being neglected for simplicity's sake.

In the case of a projection armature, however, the lines of force are for the most part gathered into the projections, and the field in the slot or tunnel in which the conductor lies is comparatively weak. The lines of force will, in fact, be distributed between the iron projections and the space occupied by the conductor inversely as the ratio of the permeabilities of the materials, and the permeability of copper and insulating materials being sensibly the same as that of air, the ratio of **B** in the iron to **H** in the slot will be $\frac{\mu}{1}$, μ representing the permeability of the iron for the value of **B** in the projections.

Let us now consider the case of an armature in which the thickness of each projection is equal to the space between them, the sides both of projections and of the spaces between them being regarded as parallel. Take $\mathbf{B} = 16{,}000$ in projections, then $\mu =$ (say) 320, and $\frac{1}{\mu} \times 16{,}000 = \frac{16{,}000}{50}$. The conductors will, therefore, be immersed in a field of $\mathbf{H} = 50$. If the armature were a smooth core of similar dimensions, and same value of **N**, the conductors would be immersed in a field of $\mathbf{H} = \frac{16{,}000 + 50}{2} = 8{,}025$. Now the force experienced by a conductor is equal to the product of the current into the field, so that the force exerted on the embedded conductor is $\frac{50}{8025}$, or about $\frac{1}{165}$th of that which would be experienced by a conductor of equal length moving at same velocity and generating same E.M.F. upon a smooth core. But we know that the same number of lines must be cut per second in each case in order to generate a given E.M.F., whether the conductors are embedded or not; therefore, in the case of the embedded conductor, the lines of force must travel across the slot at the rate of $\frac{165 - 1}{1}$ times the peripheral velocity of the armature, or generally $\frac{x - 1}{1}$ times, where $\frac{x}{1}$ is the ratio of the strength of field in which the conductors would be immersed if the field were equally distributed—as in the case of the smooth core—and that in which they would be immersed in the projection armature.

Velocity $= \frac{\text{work}}{\text{force}}$; so the velocity of the embedded conductor referred to the field in which it is immersed is $\frac{x}{1}$ times the peripheral velocity of the armature, or 165 times as great in the example taken. This again shows, then, that the lines of force must travel across the slot in a direction opposite to that of the rotation of armature at a rate of $\frac{165 - 1}{1}$, or 164 times the peripheral velocity of the armature.

The force experienced by each effective conductor on a smooth core is equal to the torque divided by the number of effective conductors, or

$$\text{force} = \frac{\text{torque}}{n}.$$

In the case of the armature with embedded conductors, the force on each conductor (supposing one per slot) is

$$\text{force} = \frac{\text{torque}}{n} \times \frac{1}{x};$$

the force on each iron projection must therefore be

$$\text{force} = \frac{\text{torque}}{n} \times \frac{x-1}{x},$$

or, in the example given, the force on the iron projections is $\frac{164}{165}$ths of the total turning force or torque experienced by the armature.

The curious point to notice is that the arrangement constitutes a kind of speed gear, whereby the relative velocity of the conductors and the field in which they are immersed is enormously greater than the actual velocity of the periphery of the armature, and that the force experienced by the iron must be due to the reaction of the lines of force which are being propelled at a high rate of speed in the opposite direction to the conductors.

If in another example we take $B = 20{,}000$ in the iron projections, we find that $H = 666$ in the conductors, and that the force on conductors is about $\frac{1}{10}$th, or 10 times as great as in the previous example, the difference being due to the greatly reduced permeability of the iron at this value of B. Similarly, if we take B at less values than 16,000, we shall find the force on conductors to be a still smaller fraction of the total; their velocity referred to the field in which they are immersed being proportionately greater.

THE ELECTRICAL INDUSTRY IN LONDON.*

BY GUIDO SEMENZA.

England is certainly not among the nations most advanced in electrical work. The applications of the new industry reduce themselves to illumination, to some few cases of traction, and to some transmissions of power in mines; and in these there is little novelty, no dash, no tendency which indicates impending progress. One might say that the English, in matters of mechanical industry, had stopped in doubt and diffidence before a form of energy which acts without apparent movements, and which is transmitted without the mediation of rigid organs. And yet a visit to English workshops and plants presents many points of interest. Although the bipolar dynamo dominates everywhere; although polyphase currents have only made a somewhat hasty appearance in the laboratories, we can see certain tendencies brought out which are, perhaps, too much neglected by ourselves, and a certain sense of the practical and of a breadth of ideas is gathered which leaves a good impression. It is a common saying that the English are conservative at bottom; but we find on close observation that they do not carry some things to perfection, because they have no need of them, nor some other things because there are principles and needs involved which are of greater importance than the progress itself, or which this progress would militate against—it is rarely out of mere obstinacy or from true principles of conservatism. Hence arise things which may appear contradictory. While, for example, they are reluctant to construct multipolar dynamos, they have, on the other hand, abandoned, with an amount of pluck which savours a little of French *emportement*, the slow steam-engine and transmission by rope-and-belt gearing, and have adopted, in the Willans engine and the direct-driving principle, two novelties which in other countries are slow in making their way. They use with great facility alternating currents for incandescent lighting, but they still look upon the distribution of power by polyphase currents in the same light as we do the dirigible balloon. But in all these things certain considerations may be discovered to which the English attach such importance that they become prejudices, and they sacrifice almost everything else to these. These prejudices come out strikingly in a visit to one of the many London central stations for illumination.

Let us visit one at random—no matter which, as they are almost all of the same stamp.

An unimposing entrance, a gloomy little back alley, and at the end the workshop of the station. A covered passage, broad enough to allow a coal-cart to pass, traverses the workshop. On the left-hand side, we will say, is the coal store, and to the right, up a few steps, we find the boiler room. I call it the boiler room for the sake of the word. There is a long row of Babcock and Wilcox's arranged along the passage, and between them and the wall perhaps a few yards. Proceeding in the same direction, we enter the engine room. Along the wall, separating it from the boiler room, are put up, parallel to the boilers, half-a-dozen or more Willans engines coupled direct to as many stout bipolar under-type dynamos mounted on the same bed-plate. On the wall facing us, the switchboard. Into the engine room a grey light falls from a skylight; the walls are grimy, and between one machine and the next, or the wall, there is hardly room enough to pass.

In visiting the station, you naturally question the engineer who accompanies you.

"Why do you use multitubular inexplosible boilers, which are less economical than the Cornish ones—for safety, perhaps?"

"No; a well-managed boiler should not burst. These boilers consume, perhaps, more than the Cornish, but they cost less, and occupy so little space; and then they are so quickly started!"

"And the Willans engines answer well?"

"Very well indeed. There are no accidents to speak of; and if, perchance, something breaks inside, nothing happens outside. In such a case it is not even necessary to look and see what is broken. You telephone to Messrs. Willans and Robinson, and a few hours afterwards the engine is replaced. Still, they have the defect of being somewhat cumbersome."

"Cumbersome?"

"Certainly, if you bear in mind that a Parsons steam turbine can take the place of four sets of these."

"But what about the efficiency?"

"We don't know much about that, but it appears that with a condenser it is pretty good."

And so on. The points aimed at are clear at once—space and safe working. The space, you will say, is a function of the price of land; but this condition is of such importance in the thickly-populated centres that it is kept up outside. As regards the second, they want to be sure that they can keep up the supply, whatever happens. To give an idea of the limit to which they stretch the point, I will only mention that in some stations the dynamos, or at least a couple of them, are not self-exciting; but the exciting current is taken from the mains, as the starting time of a self-exciting dynamo is found too long.

To complete the description of one of these stations, I should add that there is always a double battery of accumulators; that the distribution is on the three-wire system, and that the capacity of the stations varies from 60,000 to 100,000 incandescent lamps.

They are, however, not all of this type; some of them have original characteristics, which should be pointed out.

An entirely new station has just been started on the right bank of the Thames, under the direction of Mr. Mordey, of the Brush Company. The general arrangement is still the same, but there is more room, more grandeur, and even a little elegance. The generators are 500-kilowatt Mordey-Victoria alternators, coupled direct to marine-type engines running at about 100 revolutions. These alternators, from the mechanical point of view, are much more impressive when seen in reality than on reading the description. The delicate fixed armature is in reality very solid and rigid, and it seems that deformations are very rare. The whole arrangement of interruptors and commutators for the 2,000-volt currents is very ingenious and also new; the handles are connected to each other in such a way that the various connections can only be made in a certain order. This, and the fact of the whole being enclosed in steel columns, appears to safeguard against all possible dangers.

Another station which shows a striking contrast to the others is that of Ferranti at Deptford. Fundamentally, the idea which had impelled Ferranti to remove his central station four miles from the centre to be illuminated was not at all mistaken. A circumstance that may appear wonderful is that in the centre of London coal costs perhaps over £1 per ton, on account of the difficulty in transporting and storing such large quantities. Along the Thames, below London, it can be had for seven or eight shillings. The idea was, therefore, simple: to erect the station where coal costs little; to generate the current at a high potential, and to lower the pressure at the sub-stations for distribution.

Where things began to go wrong was in the machinery. Since it was a case for economy, it was thought proper to cultivate that in every particular; it was thought preferable to generate a current of 10,000 volts direct in order to avoid losses in the transformers, and, above all, to employ very powerful generators. Two alternators, of 1,200 H.P. each, were quickly constructed, and before the result was known a further step was taken. The construction of an enormous alternator of 10,000 H.P. was decided upon. The armature was to have a diameter of 12m.; two engines were to drive it direct, and to obtain steam from 24 boilers. The idea of making the biggest thing of the kind had much to do with this decision, which pushed a reasonable conception to a foolish extreme. The fact is, that the two dynamos of 1,200 H.P. gave rise to such inconveniences that their winding had to be modified, so as to reduce the difference of potential to 2,500 volts, and the station had to completed with four other groups of generators of ordinary power.

And the great dynamo? The heavy masses of metal which were to have composed it lie, ready forged, in a field along the river; the 24 boilers already in place are cold; the great machine will not be made! Ferranti attained great success, however, with his meters, which, with a recent improvement, seem to work very well. They are manufactured in a workshop close to the centre of London, a workshop which is interesting not only on account of the method of the work carried on there, but also on account of the traces of the contrivances for reducing its space to an area of 350 or 400 sq. m. There are five or six floors, and you climb up and down to them by wooden ladders. A motor is shut up in the damp cellar with three or four large shop machines.

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* *L'Elettricista*, November 1894.

In this factory I had occasion to see another fixed idea of the English pushed to extremes They will not feed arc lamps with alternating currents. May be that the regulators do not satisfy them, or that they require a good light efficiency; the fact is that in all alternate-current central stations the current is used exclusively for incandescent lamps, and besides the alternators there is always some continuous-current dynamo with high potential for the arc lamps. Ferranti has thought of eliminating this duality in a large plant which his firm is putting up at Portsmouth. The generators are alternators of a new type, similar to those of Brown and Boveri. At the central station itself are commutators driven by small motors with synchronous monophase currents, whose function is to convert the current for the purpose of the arc lamps. They say that the efficiency of these commutators is very high.

Among the electrical manufacturing works one of the finest is certainly that of Siemens Bros. They manufacture dynamos, alternators, transformers, and measuring instruments, and have a large plant for submarine cables. Here are seen the English dynamos with all their characteristics, bipolar under-type dynamos, up to 400 H.P.

The English have been bent upon making the dynamo a simple and solid machine above everything. Too much accustomed as they are to steam-engines, in which every part must resist some stress, it was natural that they should in dynamos also look for strong well-joined parts, which should be easily worked and easily mounted, and that to this idea they should sacrifice every consideration of electromagnetic inertia. This explains their predilection for bipolars, which reduce the number of interspaces to a minimum, and require the simplest winding. The field-magnets are made of three rectangular blocks of the most straightforward shape; the bed-plate generally bears the steam-engine as well; the armature, where possible, is drum-shaped, with rigid diagonal connections.

On the other hand, there is perfect workmanship, windings made with extraordinary care, armatures centred with precision, everything well adjusted, finished, exact; machines, in fact, which give satisfaction, and which, the type being given, could not be better.

Another firm which does a lot of work is Crompton and Co. But their dynamos, though highly praised, do not please the eye much. They are poor in iron, and have a shape which does not look like work, and dimly resembles the old Siemens and Halske type of 1880. In this factory some dynamos are at present being constructed without exciter winding, in which the magnetomotive force is furnished by the armature itself. The aspect of the machine is fairly good, but the winding of the armature is somewhat complicated, in order to avoid sparking. Mr. Crompton is also about to make quadripolar dynamos, but he disguises them under the name of bipolars with double magnetic circuits.

The only firm which turns out multipolars on a large scale is that of Johnson and Phillips, which, in precision of workmanship, is certainly on a level with Siemens Bros. The influence of Gisbert Kapp is here felt; he used to be their consulting engineer. Johnson and Phillips' machines are finer, more delicate than the rest; they approach to the type of the beautiful Swiss machines, in which the exigencies of mechanism do not suffocate the electrical requirements.

Each maker has a special arc lamp which he invariably represents as the best of all, a sign that probably none represents the ideal sought after. In many dynamo works there is plenty of electric transmission, but the example seems hitherto not to have borne fruit.

As regards electric traction, there is little, if we except the Liverpool railway and the underground railway between London and Clapham. The underground railway offers the great advantage of transit in a breathable atmosphere. But technically it is not very well designed; the use of locomotives instead of self-propelled cars is open to a good deal of criticism, and, besides, the permanent way is very bad. I believe that this is due to the fact of the track being rigidly connected to the steel tubes forming the tunnel, which very probably have sudden relative displacements. The fact is that there is a succession of jolts from one end of the line to the other, a thing which makes all the greater impression from being compared to the smooth and soft running of the ordinary English trains.

Works which one should not omit to see in a visit to London are those of Willans and Robinson. What makes them interesting, apart from the Willans high-speed engine which is made there, is the method of manufacture. The strong point of this factory lies in constructing only a few types of a single machine. Hence all the operations are organised; all the pieces turned out, being inter-changeable, are collected in a store after having undergone a scrupulous examination; and when an engine has to be made it is only necessary to take the various parts from the store and to build them up. Their perfection of workmanship explains to a great extent the perfect working of these engines.

The time of my visit to London, which fell in the summer vacation, did not enable me to see many of the best-known English electricians, by whom foreigners are generally received with much affability. Thus it would be one of the attractions of London to see Thompson, Ayrton, Swinburne, Hopkinson, Kapp, Kennedy, and others whose names have been so long familiar to us, and to learn from them what they are working at, and what ideas they have upon various subjects. I was only able to see Prof. Ayrton, who is actively engaged upon electrostatic voltmeters, and Mr. Swinburne, perhaps the only man in England who has a little faith in polyphase currents, and who occupies himself with them platonically, as he expresses it, since there are no machines as yet to experiment upon.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

MONDAY, April 22nd.

Society of Arts.

8 p.m. Cantor Lecture, "Recent American Methods and Appliances Employed in the Metallurgy of Copper, Lead, Gold and Silver," by James Douglas.

TUESDAY, April 23rd.

Royal Institution.

3 p.m. Afternoon Lecture, "Alternating and Interrupted Electric Currents," by Prof. G. Forbes, F.R.S.

WEDNESDAY, April 24th.

Institution of Mechanical Engineers.

7:30 p.m. Ordinary General Meeting at the Royal United Service Institution, Whitehall. Discussion on Capt. Sankey's Paper on "Governing of Steam Engines by Throttling and by Variable Expansion"; also, time permitting, the Third Report to the Alloys Research Committee will be read by Prof. W. C. Roberts-Austen, F.R.S.

Society of Arts.

8 p.m. Ordinary Meeting. The following Paper will be read: "The Use of Electricity for Cooking and Heating," by R. E. Crompton.

THURSDAY, April 25th.

Society of Arts

4:30 p.m. Indian Section. The following Paper will be read: "The Coming Railways of India and their Prospects," by J. W. Parry.

Royal Institution.

3 p.m. Afternoon Lecture. "The Liquefaction of Gases," by Prof. Dewar, F.R.S.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting at the Society of Arts, John-street, Adelphi. The following Paper will be read: "A Magnetic Tester for Measuring Hysteresis in Sheet Iron," by Prof. J. A. Ewing, F.R.S.

FRIDAY, April 26th.

Royal Institution.

9 p.m. Evening Discourse. "The Effects of Electric Currents in Iron on its Magnetisation," by Dr. John Hopkinson, F.R.S.

Physical Society.

5 p.m. Meeting at Burlington House. The following Papers will be read: (1) "A Theory of the Synchronous Motor," by W. G. Rhodwell; (2) "Note on a Single Graphic Interpretation of the Determinantal Relation of Dynamics," by G. H. Bryan.

Institution of Mechanical Engineers.

7:30 p.m. Ordinary Meeting at the Royal United Service Institution, Whitehall. Discussion of Prof. Roberts-Austen's Report, and reading of other Papers.

Examinations.—The bourne to which the examination mania tends is shown by the following extract from a cablegram, dated Pekin, April 16th:—The leader of the war faction, Wung Tung Ho, is now in the examination hall examining the essays of the students. This incident will probably be paralleled in this country, say, in the middle of the twentieth century by a cablegram, dated London, April 1st:—The Prime Minister is now at Burlington House superintending the examinations of the third-year students of the Battersea Training College for the Technical Instruction of Cabinet Ministers; and the Japanese Fleet is in possession of Chatham.

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SPECIAL NOTICE.

Owing to the growth of the electrical and allied industries the demands for space in "The Electrician" are, for the greater part of the year, so pressing that a permanent increase in the size of the journal has become necessary. To meet the increased cost involved by this step, and by other improvements, such as heavier paper and more numerous illustrations, the price of "The Electrician" will be advanced to 6d. on and after May 3rd next. Hitherto this sum has been charged when the number has contained a Supplement, and, as the industries grow, these may be more frequently necessary; but the practice of charging extra for Supplement numbers when issued will be discontinued.

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RECENT PAPERS ON DYNAMO DESIGN.

To such a surprising pitch of excellence has the continuous-current dynamo been brought within the fifteen years of its practical use, that one is almost tempted to regard it as having reached finality, at least in point of design. Yet we have recently had evidence that in the eyes of some its scientific design still falls short of full perfection, and that further progress need not be confined to the mere details of manufacture. A few weeks since the Institution of Electrical Engineers was engaged in the discussion of Mr. SAYERS' method of armature winding, and almost simultaneously, in a Paper, an abstract of which we reprint this week, Prof. RYAN and Mr. MILTON E. THOMPSON were describing before the American Institute a device of very similar character. The problem which the American electricians have set themselves is in fact precisely the same as that to which Mr. SAYERS has given another solution. The aim of both is primarily to render possible the construction of short air-space dynamos, which shall not spark at the brushes; secondarily to secure a fixed position of the brushes for all loads within the capacity of the dynamo: and it is interesting to compare the different solutions arrived at by experts on the two sides of the Atlantic.

Mr. Sayers devised a method of winding the armature which enabled commutation to be effected under or near to the trailing poletip. The dynamo designer is thus at once relieved of the bugbear of "armature reaction"; its very existence is turned to useful account, since the crowding of the lines into the trailing poletip assists in securing the second desideratum, fixity of the brush position. The method of Prof. Ryan and Mr. Thompson is entirely different, and does not appear in principle nearly so radical a remedy. Their starting-point is the use of "balancing coils" wound in grooves or tunnels passing through the pole-pieces near their face; these coils carry the main current of the dynamo, and are so arranged as to counteract the disturbing effect of the current in the armature conductors. When the number of ampere-turns in each pole-face, due to the balancing coils, is equal to those on the corresponding arc of the armature, and the direction of the two sets is opposed, there can be no distortion of the field distribution. How successfully this end can be attained in practice is shown by experimental curves which bear witness to the uniform density of the lines between pole-face and armature at the full load of the dynamo. So far, however, a fixed position of the brushes has not been secured, since the loop undergoing commutation must be brought into a stronger reversing field as the armature current is increased. The next step is obviously to make the coils over-balancing, and so to distort the field distribution in the reverse sense; then the density of the lines will become greatest at the leading poletip, and the increased current will find the stronger commutating field which it requires without a fresh adjustment of the brushes. Such an effect is shown in some of the curves which illustrate Prof. Ryan's Paper, but it is not the final solution from which the authors anticipate the best results. "Ideal commutation is attained" by the addition of a further refinement. Between the balancing and the exciting coils, the poles are bridged by a magnetic shunt of iron, and from this bridge projects a reversing pole-piece. At no load this latter carries no lines, but as it passes through the centre of a balancing coil, it tends to be magnetised thereby. The balancing coils rather more than counteract the armature ampere-turns, and hence, as the current in them increases, the lines which at no load are shunted directly across from pole to pole pass in increasing proportion through the reversing pole-piece into the armature. Thus the strength of the reversing field will automatically grow as the load is increased, and by the combined use of the balancing coils and reversing pole-pieces, the inventors claim to have attained sparkless commutation with fixed metallic brushes.

That the two suggested improvements of the continuous-current dynamo by Mr. Sayers and by Prof. Ryan are identical in their object is obvious. We may, therefore, expect that the adoption of either in practice will meet with the same objections, and fail or succeed from the same causes. Surely, it will be argued, sparking at the brushes is a thing of the past: so little attention is now required by the brushes of a good dynamo that it is not worth while striving to attain greater fixity of position at the cost of any complication. It will be said that "armature reaction" is not so pernicious as to call for any drastic remedy. The enthusiastic inventor, like the politician out of office, occupies a position of greater freedom and less responsibility, and is apt to recommend panaceas for evils which do not practically exist. The dynamo manufacturer, on the other hand, is content so long, as a matter of fact, any harmful effect can be entirely avoided by careful designing on ordinary lines. Certainly we cannot but agree that the dynamos of our modern central stations do not unduly tax the carefulness of the attendants, as witness among others the large two-pole dynamos of the St. James's and Pall Mall Company with their triple-wound armatures. Yet such arguments do not appear to us to close with the question at all. Granted that our present experience enables manufacturers to construct dynamos of great perfection, it may still be asked, At what cost is this perfection secured? A long air-gap is necessitated in order that the magnetomotive force of the armature ampere turns may never rise to equality with the magnetomotive force impressed by the field winding between the pole-faces, and thence results a large expenditure of copper in the exciting coils and a long magnetic circuit. The real aim of both Mr. Sayers' and Prof. Ryan's Papers is to show how it may be possible to use tunnel-wound armatures with short air-gaps, and so to decisively lessen the copper and iron of the field-magnet. Hence it is the armature reaction of the toothed core that the Americans have been at pains to obviate, and not that of the ordinary armature with smooth surface. The attention which both inventors have paid to the sparklessness of the brushes is really a tribute to the good qualities of the modern dynamo. They recognise the fact that the commutator of the short air-gap dynamo must, at the least, give as little trouble as that of an ordinary machine, but if at the same time the further advantage of a fixed position for all loads can be gained, so much the better. There must be many cases in which a dynamo is subjected to variable loads and yet cannot receive any great amount of attention. The junior engineer on board ship, for example, who adds to his other duties the care of a pair of direct-driven dynamos, cannot be expected to be so watchful of the commutators as the central station attendant. A further claim which has been advanced does not, however, appear to us to be so well founded as the advantage of a fixed brush position. It is that the output of an armature may be greatly increased, since we are no longer limited by armature reaction, but solely by the heating. We cannot help thinking that in the ordinary armature the limits fixed by heating and sparking are reached at nearly the same output, and that the equivalent tunnel armature will not carry an appreciably larger current without exceeding the heating limit. If so, the use of the new device must mainly rest on the cheapening of the field-magnet.

In spite, therefore, of their scientific appearance, it is by the practical test of economy that both inventions must stand or fall; and on this score, if both are equally efficient, the preference, it would seem, must be given to that of Mr. Sayers. The armature disc with its perforated edge is a more costly stamping than the plain circle, and this increased expense is common to both. It is the reverser bars, or loops, of Mr. Sayers which must be set against the balancing coils of Prof. Ryan. While the reverser bars are passed through the same tunnels as the main armature winding, Prof. Ryan adds the further expense of tunnels in the pole-faces; indeed, he is finally brought to a separate pole-ring carrying the balancing coils and fitting within the circle of the radial poles. An interesting point is raised in the same number of the *Transactions* of the American Institute as that in which Prof. Ryan's Paper appears. In the discussion of Mr. Leonard's Paper on "European Electrical Engineering," the question of big electrical corporations, as in America, *versus* the more numerous but smaller firms, such as we have in England, was alluded to. It was hinted in the Paper that the former crushed out inventions of merit. In the discussion it was roundly asserted that there was an equal readiness under either system to try new developments. The future history of the continuous-current dynamo should throw some light on this interesting issue.

ON SUPPOSED MAGNETIC FATIGUE.

BY ALBERT CAMPBELL, B.A., AND R. P. LOVELL.

Last December, immediately after Professor Ewing's suggestion that the question of magnetic fatigue by often repeated reversals ought to be set at rest, we had commenced a research on the subject before we found that several others were already at work on the same thing. In his Paper, published in *The Electrician* of January 11th, Professor Ewing most conclusively proves that his specimens of good wrought iron, when subjected to very many reversals of *small* magnetising fields, show no perceptible change in magnetic qualities.

As we worked with stronger magnetising fields, and made our tests on *cast iron* as well as transformer plate, some of our results seem of sufficient interest to be briefly mentioned. It is obviously unnecessary to go into all the details of the methods used and the corrections applied.

One series of tests was made on a laminated wrought-iron ring (which we may name ring A), of section about 2·5 sq. cms. It was wound with two layers of No. 16 copper wire, making in all 355 turns; this formed the magnetising coil, and it was capable of carrying the currents employed without rising more than a few degrees in temperature. A suitable secondary coil was wound over this, being well insulated from it by a wrapping of silk ribbon. A single $\mathfrak{B}-\mathfrak{H}$ curve was then found by the well-known ballistic method, the magnetising field being carried up to about $\mathfrak{H}=80$. Our method of procedure was very much the same as that employed by Professor Ewing, each point being determined independently of those already found.

Then, on December 15th, ring A, in series with another, was put on the 50-volt side of a transformer, supplied at 100 volts from a larger one on the mains of the London Electric Supply Corporation. In this way a current of about 1·4 amperes at 83 ∿ per second was kept passing in the magnetising coil, from December 15th till January 7th (with a short stoppage for an intermediate test). It was again tested for the $\mathfrak{B}$ and $\mathfrak{H}$ cycle on December 18th, and, finally, on January 7th. In each case the successive values of $\mathfrak{H}$ were made as nearly as possible the same as those on December 15th. The results of these three tests are given in the table herewith. When the three curves are plotted on the same sheet, they are found to be practically coincident.

Table.

Laminated Iron Ring A.

Dec. 15, 1894.		Dec. 18, 1894.		Jan. 7, 1895.	
$\mathfrak{H}$	$\mathfrak{B}$	$\mathfrak{H}$	$\mathfrak{B}$	$\mathfrak{H}$	$\mathfrak{B}$
78·8	16,360	77·0	16,340	79·5	16,350
38·7	15,580	38·6	15,540	40·5	15,580
27·9	15,290	28·4	15,240	28·1	15,290
21·4	15,010	20·1	14,940	19·8	15,000
15·0	14,770	14·4	14,830	14·3	14,740
11·2	14,570	10·9	14,490	10·8	14,580
4·0	13,860	4·0	13,790	4·0	13,870
0·0	12,160	0·0	12,220	0·0	12,340
− 4·0	− 6,920	− 4·0	− 7,020	− 4·0	7,260
−11·2	−12,560	−10·7	−12,500	−10·6	12,620
−14·9	−13,360	−14·3	−13,420	−14·0	13,300
−21·5	−14,080	...	...	−19·6	14,060
−27·9	−14,600	...	...	−27·7	14,700
−38·7	−15,280	−38·1	−15,300	−38·8	15,260

A very similar series of observations was made on a cast-iron ring, and, although the material showed a large amount of hysteresis, it will be seen from Fig. 1 that, after running with alternating magnetic field (a little greater than that used with ring A) from December 18th till January 7th, the hysteresis loss remains absolutely unchanged.

In addition to the $\mathfrak{B}$ and $\mathfrak{H}$ tests on ring A, it was also tested as a transformer with secondary coil on open circuit both before and after its long run in the alternating magnetic field. The primary and secondary volts were read on the standard multicellular voltmeter at Faraday House, whilst the magnetising current was measured on a Kelvin balance. Fig. 2 shows the relation between the magnetising current and the secondary volts, both being $\sqrt{\text{mean square}}$. Although no wattmeter tests were made, the tallying of the two sets of points in the figure seems to leave no doubt that the ring, as a transformer, behaved in exactly the same manner after the oft-repeated reversals as before them. Assuming that the magnetising current followed a sine curve, the values of maximum $\mathfrak{B}$ deduced from it and the ballistic tests were much lower than those deduced from the secondary volts. It is evident, therefore, that the latter assumption is not correct, and that the value of the maximum alternating field cannot be exactly calculated.

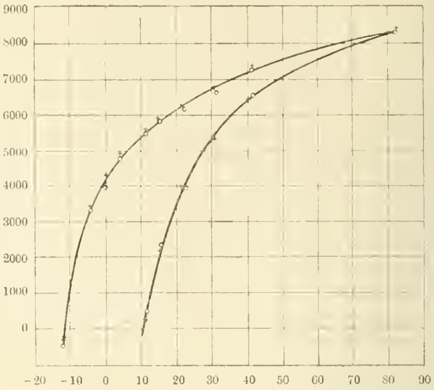

Fig. 1.—o o o Before Reversals. × × × After Reversals.

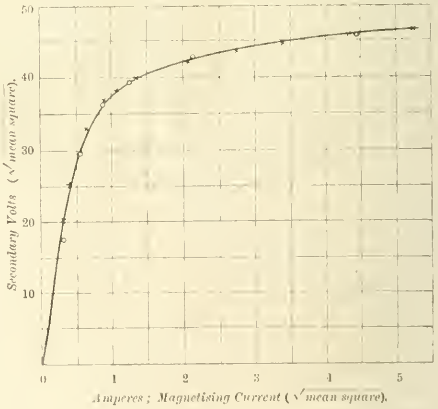

Fig. 2.—o o o Before Reversals. × × × After Reversals.

THE HOOKHAM ALTERNATE-CURRENT METER.

At the end of 1893 we described the latest form of Hookham continuous-current meter. A most ingenious feature of this meter was the device by which the disc spindle was floated up against the top jewelled bearing when at rest, and when running was made to drop upon the substantial lower bearing, thus securing the advantage of minimum friction at starting, and of a substantial bearing to take the wear when running. Another feature of interest was the method of keeping the operative magnetic field of the brake disc constant. In the alternate current meter, which has been brought out by Mr. Hookham, the "by-pass" magnet device is carried a step further, and an ingenious substitute has been made for the plan of floating the disc spindle up against the top bearing.

The Hookham alternate-current meter, like that devised some years ago by Mr. Shallenberger, is nothing more than a Ferraris motor controlled by an electric brake. An aluminium disc A (see Fig. 1) is made to rotate between the poles of a laminated shunt-wound electro-magnet B, the main current being carried by the spiral coils C C, the currents in the two coils differing in phase by nearly 90°.

On the side of the shunt magnet pole furthest away from the series coils is placed a small copper screen F. By means of this screen the meter can be made to start by as small a current as one pleases. The field in the shunt magnet induces eddy currents in the copper disc, and the screen shields that portion of the aluminium disc immediately above it. The non-shielded portion of the disc has eddy currents induced in it, which are in the same direction as those in the copper shield, so that the aluminium disc is constantly attracted towards it. Of course, in practice the screening effect is not made powerful enough to start the meter until the current in the series coil comes to its aid. Owing to this pretty device, there is no need to mount the disc spindle very delicately, and yet a 10-ampere meter is started by a current of 0·1 ampere.

The retarding force is supplied by means of a permanent magnet D, which produces eddy currents in the disc as it rotates between its pole-pieces. If the fields produced by the series and shunt circuits could be regarded as independent of one another, the resulting torque should be proportional to the current in the series coils, when the E.M.F. is constant. But, as a matter of fact, the core of the shunt magnet is magnetised by series coils, and the driving force is consequently increased or diminished according as these act with or against the shunt coils. Consequently, the meter when running in one direction tends at heavy loads to run too fast, and when running in the opposite direction, too slow. The error is about 5 or 6 per cent. either way. Mr. Hookham has elected to drive his motor in the direction in which the driving force tends to be too great at high loads, and he corrects this by means of a small air fan E. The constancy of the retarding effect of the permanent magnet D is obtained by "necking" the magnet at G, and supplying a "by-pass" H. It must be remembered that in a motormeter, in which the field of the motor is distinct from that of the brake, any change in the field of the brake will cause a variation of speed proportional to the *square* of the variation of the brake field. This, of course, is a very serious matter. Moreover, in an alternate-current instrument, especially in one in which the alternate currents are produced in the same disc that is acted on by the permanent magnet brake, the field of the permanent magnet is extremely liable to be affected by the alternating field. Consequently, with instruments of this type, special precautions are necessary to ensure a constant retarding force. The "by-pass" device results in any change in the total induction affecting only the number of

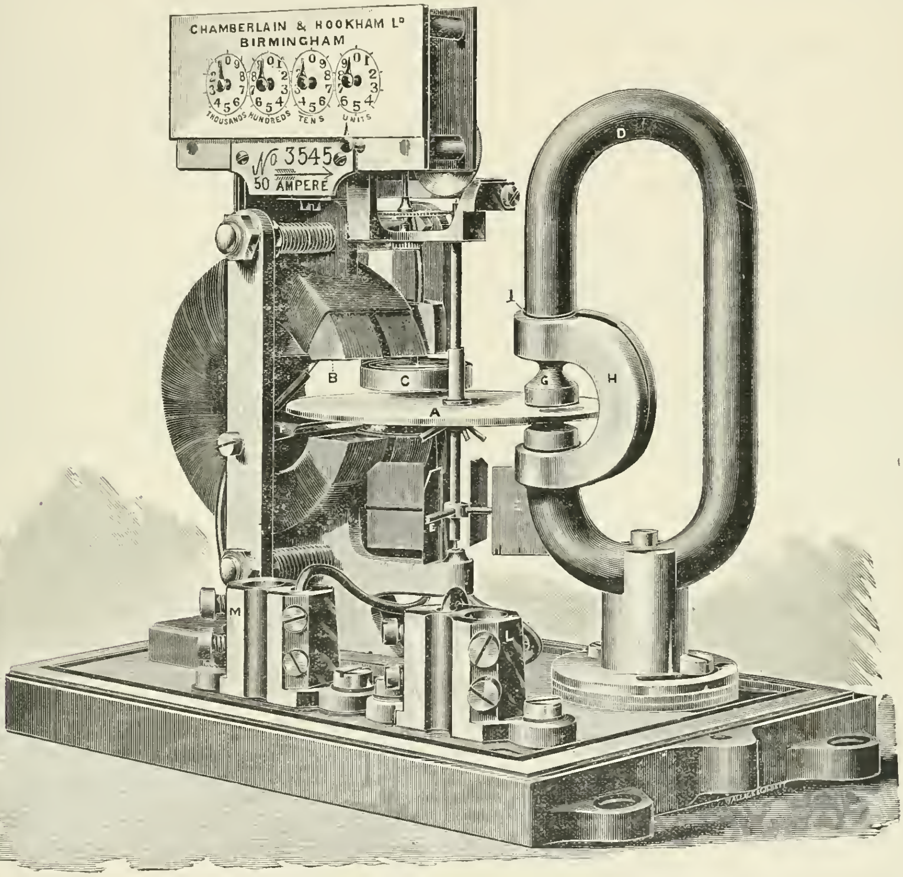

Fig. 1.—General View of Meter with Case removed.

lines of force passing through H, leaving the operative field unaltered. The poles are "necked" down to about one-eighth of the general section of the steel bar, and at this point the bar is saturated. The air spaces are so arranged in practice that one-half the total lines of force only go by the main circuit. Hence the total magnetic induction may vary through wide limits without the power of the brake, and consequently the rate of the meter being materially affected.

The meter is remarkably substantially constructed, and it should not only prove a suitable instrument to be installed in the out-of-way places meters usually are put into, but it should be one which can be turned out at a reasonable price.

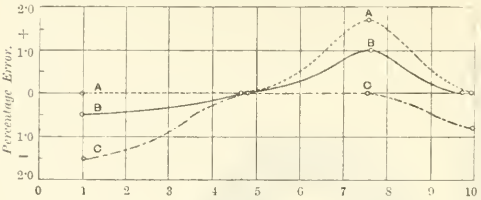

Fig. 2.—Percentage Error Curves of Hookham Alternate-Current Meters A, B, C.

Whenever desired, the makers will provide a high-speed pointer, to facilitate testing *in situ*. The top speed of the meter disc, we may add, is about 140 revolutions per minute.

We append some curves (Fig. 2) taken at Faraday House on an incandescent lamp circuit. From about one-tenth load upwards, the maximum error is never more than about 1½ per cent.

THE STEAM ENGINES (PERSONS IN CHARGE) BILL.

The following is the text of this Bill. The portions which refer to agricultural engines, railways, and steamships, have been struck out:—

1. This Act may be cited for all purposes as the Engines and Boilers Act, 1895.

2. This Act shall extend to the whole of the United Kingdom, but shall not apply to any boiler used exclusively for domestic purposes, or to any steam engine or boiler used in the service of her Majesty, or to any steam engine or boiler used in propelling a steamship having a certificate from the Board of Trade in accordance with the Merchant Shipping Act Amendment Act, 1862, except in cases where such steamer is in dock, and the certified engineer is off duty for the time being, when in such cases this Act shall apply to any person who may be placed in charge of steam donkey pumps, steam winches, or other machinery worked by steam on board the said vessel or steamer.

3. This Act shall come into operation on January 1, 1896, which day is hereinafter referred to as the commencement of this Act.

4. In this Act "boiler" means any closed vessel used in any trade, manufacture, or mining, or other industrial employment on land, for the generation or use, under pressure, of steam for the production of motive power; "engine" means any machinery used for a like purpose and worked by steam from a boiler, as herein defined; and "engine or boiler user" means every person who owns or uses in whole or in part, or who lets for hire, an engine or boiler. The term "court of summary jurisdiction" means any court or justice of the peace, metropolitan police magistrate, stipendiary magistrate, sheriff, sheriff substitute, or other magistrate or officer, by whatever name called, exercising jurisdiction in summary proceedings for the recovery of penalties. "Examiner" means any person appointed to examine applicants for certificates of qualification under this Act. "Horse-power" means nominal, and shall not include indicated or other trade terms other than the words "nominal horse-power."

5. Every person who, before January 1st, 1896, has had the practical control or management, for a period of not less than one year, of a steam engine exceeding 5 H.P., or steam boiler or any closed vessel for the generation of steam for such engine, at any works, railway, or manufactory in the United Kingdom, or on any river or coasting steamer of like power or pressure, shall be entitled to a certificate of service, to be delivered to him by the Board of Trade, on satisfactory proof that he has had such experience, and is a person of sobriety and general good conduct.

6. A certificate of competency issued to any engineer by the Board of Trade, under the Merchant Shipping Acts, shall be deemed to be a certificate of competency under this Act; and the holder thereof, when using it as a certificate of competency under this Act, shall be subject to the regulations in force under this Act, and to the penalties and liabilities imposed by this Act.

7. The Board of Trade shall from time to time appoint examiners with a practical and mechanical experience or knowledge of steam engines and boilers to conduct the examination of persons applying for first-class certificates of competency, and may from time to time make, alter, and revoke rules as to the qualification of the applicants, subject to the provisions of this Act, and fix districts for which any examiners are to be appointed, and determine the amount of remuneration of examiners, and make and alter regulations in relation to examinations, the qualifications to be required from applicants for certificates, and to the issuing and registration of certificates, and generally do all such acts as they think expedient in order to carry into effect the examination of applicants for certificates of competency.

8. The Board of Trade shall deliver to every person who is reported by the examiners to have passed the examination satisfactorily, and to have given satisfactory evidence of his sobriety and general good conduct, a certificate of competency.

9. Whenever such examiner or examiners shall hold an examination, they shall advertise the same in two local newspapers not less than fourteen days prior to such court being held.

10. The Board of Trade shall have power to charge as fees for examination or the granting of certificates at the following rates:—For applicants for examining or granting of first-class certificates the sum of five shillings, and in that of second-class certificates the sum of two shillings and sixpence.

11. The Board of Trade may at any time, whenever it appears expedient to do so, owing to the neglect, misconduct, or incompetency of any person holding a certificate, suspend, or cancel altogether, any certificate of competency or qualification; and they may at any time, on appeal being made to them by the person whose certificate has been suspended, and on production of evidence in favour of his appeal, re-issue any suspended certificate, with a statement to that effect appended thereon.

12. A register shall be kept by the Board of Trade, and printed annually, showing the names of persons who have received certificates from examiners, the date such were granted, or if suspended, the cause of the same, and if such suspension be cancelled, the reasons and conditions on which it has been re-issued.

13. Certificates under this Act shall be known as (*a*) first-class certificates, (*b*) second-class certificates, and (*c*) certificates of service, the first-class certificates being granted after examination by duly appointed examiners, and the second-class certificates by written applications to the Board of Trade, under conditions hereafter provided for.

14. In accordance with the provisions of this Act no person shall, after January 1, 1896, be in charge of a steam engine exceeding 5 H.P., or steam boiler, or any closed vessel for the generation of steam for such steam engine, at any works, railway, or manufactory in the United Kingdom, or on any river or coasting steamer of like power or pressure, unless such person is in possession of a first-class certificate, or a certificate of service; provided that on any works or establishment where there are more than one steam engine or boiler exceeding 5 H.P., it shall be sufficient for the purposes of this Act if there be one person constantly in charge who shall be the holder of a first-class certificate of competency or a certificate of service and the other persons shall be the holders of at least second-class certificates.

15. The applicant for a second-class certificate shall do so in writing, on a prescribed form to the Board of Trade; the application shall be accompanied by testimonials as to character and fitness, signed by not less than two persons who are holders of first-class certificates under this Act, provided that no person under 18 years of age shall hold a certificate except only for the purpose of having the control or charge of an engine of not more than 2 H.P.

16. In the case of locomotive drivers and stokers employed on any railway in the United Kingdom, the conditions for the granting of first and second-class certificates shall be as follows:—Any locomotive fireman or stoker desiring to secure a first-class certificate shall make a written application to the Board of Trade, and if he satisfy the Board of Trade that for a period of not less than six years up to the date of such application he has continuously followed the occupation of a locomotive fireman or stoker, and satisfy the examiners under this Act that he has a practical knowledge of the construction or management of locomotive engines, and is of good character, he shall be entitled to a first-class certificate of competency. Any person desiring to secure a second-class certificate shall make a written application to the Board of Trade, and if he satisfy the Board of Trade that he has been continuously employed, for a period of not less than 12 months up to the date of application, at work affording him a practical knowledge of the construction or management of locomotive engines, and is of good character, he shall be entitled to a second-class certificate.

17. No person, unless in the possession of a first-class certificate under this Act, shall be placed in charge of, or have the control of, any steam engine used in connection with any coal or other mines, for the purpose of winding minerals or workmen from said mines, nor shall any person employed about such mines have the control of any steam boilers, engines, or machinery other than winding engines, who is not in possession of a second-class certificate under this Act. No person in charge of any winding engine in connection with the working of any mine shall, under any pretext whatever, unless relieved by a person for that purpose, holding a first-class certificate, absent himself or cease to have continual supervision of such winding engine during the time it is used in working the mine.

18. Applicants for first-class certificates as colliery engine attendants shall produce evidence as to fitness by practical knowledge in the construction or management of steam engines, or steam boilers, or have been the holders of second-class certificates for at least *twelve months*, and during that period have had at least three months' experience in assisting at a winding engine.

19. Applicants for second-class colliery engine attendants' certificates must produce evidence that they have, within a period of two years prior to the date of examination, had at least *six months'* experience

as assistants in the working of engines or machinery used for mining purposes.

20. Applicants for the first or second-class certificates must give satisfactory proof that neither their hearing or eyesight is defective, nor are they subject to any other mental or bodily infirmity likely to interfere with the efficient discharge of their duties.

21. No steam tram or steam traction engine shall be worked on any highway without the person in charge of same is in possession of a first-class certificate under this Act.

22. Portable engines used for agricultural purposes, if under 5 H.P., shall be under the control of persons holding at least a second-class certificate; but if such portable engine exceeds 5 H.P., the same shall be under the control of a person holding a first-class certificate. In cases of small trading vessels, fishing trawlers, pleasure yachts, or other vessels propelled by steam power, the steam engines or steam boilers of the same shall, if exceeding 5 H.P., be in charge of a person in possession of a first-class certificate, and in cases where the steam engines or steam boilers of such vessels do not exceed 5 H.P. shall be in charge of a person possessing a second-class certificate, on conditions to be hereafter laid down by the Board of Trade. Every engine or boiler to which this Act applies shall be placed and kept at all times, when at work, under the supervision of some person holding a certificate of qualification under this Act, and no one person shall undertake, operate, other than the supervision of a greater number of engines or boilers, or of engines or boilers situate at a greater distance from one another, than may be prescribed by any regulations of the Board of Trade for the time being in force. Every engine or boiler user shall keep a book or register in which he shall enter and keep entered every engine or boiler owned, used, or let for hire by him, with sufficient particulars as to situation and otherwise to enable the same to be identified; and he shall enter and keep entered in the said book or register the name of the person under whose charge, control or supervision, each such engine or boiler is placed for the time being; and he shall at all reasonable times produce every such book for inspection by any authorised person, and permit copies thereof to be taken by any such person. The following shall be deemed authorised persons for the purposes of this section: Any examiner under this Act, any court of summary jurisdiction, any person nominated for the purposes of this section by the Board of Trade in writing under the hand of a secretary or assistant secretary of the Board of Trade.

23. Any engine or boiler user who makes default in complying with any of the provisions of this Act, by the employment of persons other than those in possession of certificates, shall be liable, on summary conviction, to a penalty not less than £2 and not exceeding £50 for every such default.

24. Any person or persons undertaking the charge or control of steam engines or steam boilers contrary to the meaning or objects of this Act shall be liable, on summary conviction, to a penalty not less than £2 and not exceeding £20 for every such default.

25. All fees received by examiners under this Act, or any regulations of the Board of Trade under this Act, shall be paid and accounted for to the Board of Trade in such manner as they direct, and shall be paid into the exchequer.

26. All expenses incurred by the Board of Trade for the payment of examiners, or otherwise, in carrying this Act into effect shall be defrayed out of moneys to be provided by Parliament.

A METHOD FOR PREVENTING ARMATURE REACTION.*

BY HARRIS J. RYAN AND MILTON E. THOMPSON.

In the designing of continuous-current dynamo machinery, probably nothing has presented so much difficulty as the problem of avoiding the various evils resulting from the magnetic effects of the current that passes through the armature of the machine. Such magnetic effects are usually spoken of as armature reaction. These evils are at the present time well known, and pretty well understood by the electrical fraternity in general, and the modern dynamo designer who is not thoroughly well posted on the subject, would be wholly unable to design machinery capable of successful competition with some of the machines now on the market. The tendency of the currents that circulate in the armature coils is to produce a cross magnetism through the core at right angles to the natural field, resulting in a distortion of the natural field of the dynamo—a piling up of the magnetic lines under the trailing pole corners, and a weakening of the field under the leading pole corners. This distortion, of course, increases with the current furnished by the machine, and if not specially provided against, it may result in bringing the trailing pole corners to complete saturation, and in completely reversing the field under the leading pole corners. While this distortion is no great evil in itself, the resultant effects may be, and usually are very serious evils. All distortion of the natural field of a dynamo is sure to be attended by a diminution of the field strength resulting in a falling off of the E.M.F. produced by the dynamo, and if the distortion be very great, no amount of compounding will cause such a dynamo to give constant potential. The most serious evil, however, arises from the fact that the weakening of the field at the leading pole corners results in a shifting forward of the neutral point or diameter of commutation of the dynamo. The amount of such shifting depends on the amount of distortion, and this in turn varies with the load on the machine. Consequently, if the brushes are set on the normal neutral point when running light, the machine will spark badly under load, and it becomes necessary to keep shifting the position of the brushes to meet every variation in load. More than this, unless the poletips or armature lugs are saturated, a point of loading is soon reached, beyond which one finds no diameter of sparkless commutation, and the output of the machine has reached a maximum at this point, notwithstanding the fact that the load may be below that allowed by a safe heating limit. These facts, as before stated, are well understood by the more competent dynamo designers, and receive the most careful consideration in the preparation of new designs. It must be confessed, however, that the principal part of the knowledge on this subject is the result of dearly bought experience and costly experiments, rather than of scientific study of the principles involved. Designers of dynamo machinery, with few exceptions, instead of aiming to prevent armature reaction, have endeavoured to avoid its bad effects in various ways, and in some cases with fairly good results. The distorting effects of armature reaction become less, in proportion as the reluctance of the air-gap and armature core teeth are increased, and the wiser designers of the present day, taking advantage of these facts, are producing some very creditable machines. Probably some of them still believe, as some of the very best authorities on the subject of dynamo machinery have confessed to believing until quite recently, that armature reaction is a necessary evil, and if it were possible to prevent it entirely, the whole utility of the machine would disappear at the same time.

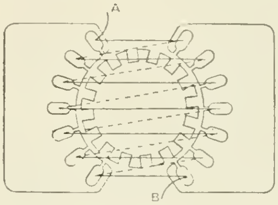

FIG. 1.

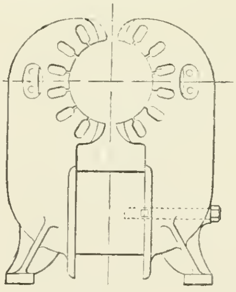

FIG. 2.

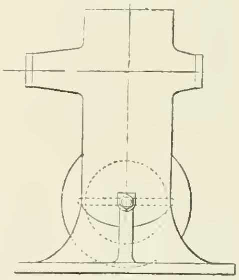

FIG. 3

While making a thorough consideration of the subject of armature reaction some time since, one of the authors of this Paper devised a means of entirely preventing armature reaction and resulting field distortion. On looking up the literature of the subject we found, mainly through the Patent Office records, that there were several workers in the field at a comparatively early date, viz.: Prof. Elihu Thomson, Messrs. Andrews and Spencer, Mather, Forbes, and possibly one or two others. The specifications given by Andrews and Spencer indicate clearly the technical side of this method for preventing armature reactions, while our part appears in the development of a plan for the practical application of the scheme technically outlined by them in 1886. This method consists in general in surrounding the armature with a stationary winding exactly similar in its magnetic effects to the armature winding, but directly opposed to it, and thus completely balancing all armature reaction. Fig. 1 is a diagram that shows the manner in which the coils are applied. Holes are provided immediately back of the pole surfaces, and through these holes are wound conductors which are placed in series with the armature. The number of ampere-turns of the balancing coils crossing each pole face is equal to, and opposite in direction to the number of ampere-turns on the corresponding part of the armature.

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* Abstract of a Paper read before the American Institute of Electrical Engineers.

A small bi-polar machine of about $2\frac{1}{2}$ kilowatts capacity was designed, constructed and tested during the spring and summer of 1891, and the results obtained were very encouraging, demonstrating beyond doubt the correctness of one's understanding of the principles involved. Since that time some half-dozen or more multipolar machines of various sizes have been designed and constructed. All employ these balancing coils with various modifications of design and gave the following results.

Brief mention of these results have been made heretofore in the literature, while a complete report of the same is now made for the first time.* Figs 2 and 3 are side and vertical views of the first machine; Fig. 4 is a side view of the toothed armature; and the following are the essential data of construction:--

Field of cast-iron, two poles	
Diameter of the armature core over all	6in.
Length of armature core	6in.
Number of teeth	64
Number of commutator bars	64
Armature turns per bar	3
Size of armature conductor, B. and S. G.	12
Resistance of armature, ohms	·34
Speed, R. P. M.	1,800
Output, amperes	25
Output, volts	100
Turns on field, 250 of No. 7, B. and S. G.	
Balancing turns, wound in six grooves per pole face, 16 turns per groove, or a total of 96 turns of No. 8, B and S. G.	
Resistance of balancing coils, ohms	·24

For dimensions of slots to accommodate balancing winding *see* Fig. 2.

The diagram of Fig. 5 gives the excitation characteristic at no load and a speed of 1,660 revs. per minute. Fig. 5*a* is a diagram of results obtained by actual observation made on this machine when overloaded at normal excitation and speed, with and without the balancing coils. The pressure readings were taken at the brushes, and do not include the drop through the balancing coils when they were used. Characteristic I. was obtained without the use of the balancing coils; characteristic II. with the balancing coils; and characteristic III. is the same as II. with the balancing coils, when corrected for drop in pressure due to armature resistance. The same field excitation of 2,600 ampere-turns was maintained at all times. It should be noted that without the balancing coils the pressure falls off uniformly and rapidly, from 109 volts at no load, to 41 volts at a load of 50 amperes, with violent sparking at all ranges of the overload. The potential differences due to the resistances of the carbon brushes were not nearly enough to reverse the currents in the coils while under the brushes, against the opposing E.M.F.'s produced by the reversed fields established by the powerful armature reactions. The E.M.F. at the brushes falls off with a rapidity that is greater than that which would be due alone to the resistance of the armature, because of the throttling action of those parts of the magnetic circuit that become saturated by the concentration of the induction by the route of the trailing pole corners. In marked contrast was the corresponding behaviour of the machine with the balancing coils in circuit, as illustrated by curve II. There was no sparking at any point of the overloading; the brushes were fixed on the no-load position, *i.e.*, at the zero of field induction, and at all loads the currents in the sections were easily reversed without spark, by the potential differences that were caused by the resistance of the carbon. There was no observable falling off of the induction through the armature under load when the balancing coils were used; and this is clearly indicated by curve III., which, as stated before, is curve II. corrected for the fall of pressure due to the resistance of the armature.

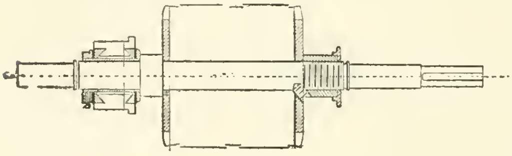

Fig. 4.

The diagrams with their respective legends that are given in Figs. 6 to 11 inclusive, are self explanatory. Separate excitation was used on all the experiments on this machine. The pilot or third brush method was used for making the field explorations. In each instance the "exploration curve" is a record of the pilot brush readings, while the ordinates of the "magnetisation" curve are proportional to the actual induction densities as deduced from the exploration curve. Fig. 6 shows that the induction is uniform over the entire pole face at no load, normal excitation and speed, as it should be without the coils. The motion of the armature conductors is from right to left. Fig. 7 shows the production of a reversed field in the presence of the brushes at a full load current, and normal field excitation without the balancing coil. Fig. 8 gives the result obtained for the same conditions, except

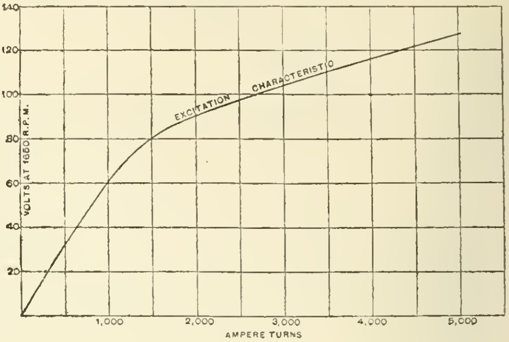

Fig. 5.

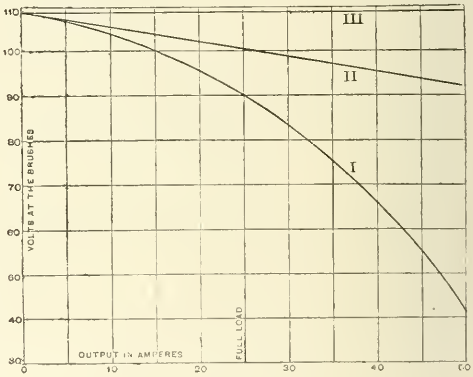

Fig. 5*a*.

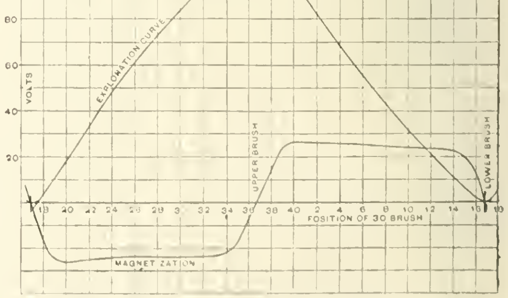

Fig. 6.—Exploration Curve at No Load. E.M.F. 105 v. Exciting Current, 10·4 c. Speed, 1,800 revs. Operated as a Motor. Without Balancing Coil.

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* "On a Method for Balancing Armature Reaction," *Sibley Journal of Engineering*, Oct. 1892, Vol. VII., p. 17. "Electromagnetism and the Construction of Dynamos," by Dugald C. Jackson, p. 172.

that the balancing coil was used. The magnetisation curve shows that the balancing coil slightly over-compensated the magnetic action of the armature, since the induction of the trailing pole tip is weakened, and that of the advanced tip strengthened, a phenomenon just the reverse of what commonly occurs. The diagrams of Figs. 9 and 10 are for substantially the same conditions as those of 7 and 8, except that the machine was operated as a motor. The results are precisely those one would expect—the same as those obtained for the dynamo, except that the sides on which the higher inductions occur are reversed in position. Figs. 11, 12, 13 and 14 give interesting results that were obtained by lowering the field E.M.F. and then operating as before. By operating as a dynamo or motor without the coil, extraordinary powerful armature reactive effects are produced. It is seen that the brushes are in the presence of a reversed field that is quite as great as the normal no-load field of 3,000 lines per square centimetre, and moderate sparking with the carbon brushes occurred. Here the balancing coils bring out an interesting effect. One would expect that the effects of their over-balancing action would be felt more at lower excitations. In this experiment the induction at the advance pole tip or the position of the "commutation fringe" is almost doubled from the normal no-load value, instead of being diminished as is ordinarily the case. It is appreciated that the effect of such a behaviour is to increase the strength of the commutating fringe at the leading pole tip in proportion to the load, thereby diminishing the range of change of the non-sparking point with metallic brushes, or enabling carbon brushes to be easily adjusted, so that when in a fixed position there will be practically no sparking at all ranges of load.

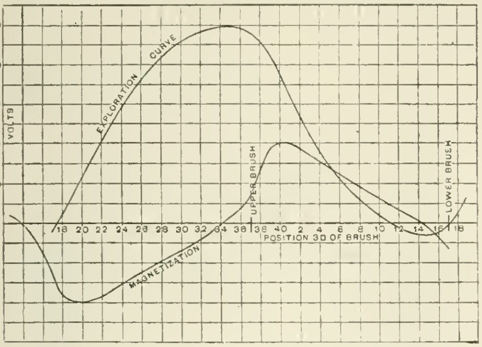

Fig. 7.—Exploration Curve, Full Load. v.=97. c.=24. Exciting Current, 10·4 A. Speed, 1,800 revs. Operated as a Dynamo, without Balancing Coil.

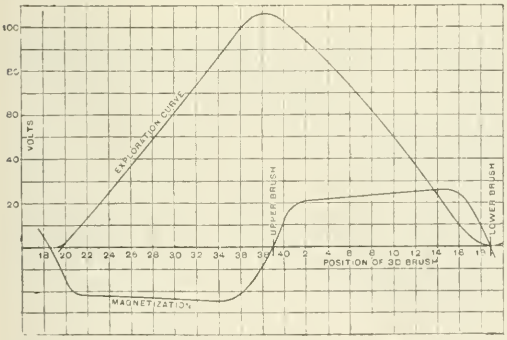

Fig. 8.—Exploration Curve, Full Load. v.=105. c.=24·5. Speed, 1,800 revs. Exciting Current, 10·4. Operated as a Dynamo, with Balancing Coil.

The second machine that was built, and which made use of balancing coils, was a small one of the four-pole type with cast-iron field-magnets. This machine was designed to have a capacity of 25 amperes at 80 volts, or 2 kilowatts when running at a speed of 1,200 revolutions. Fig. 15 is a diagram that shows the general design of the machine. The essential features of the design were as follows: Type of machine, 4-pole; field, cast-iron in two pieces. Armature two circuit drum winding through 58 grooves; 5 No. 10 B. and S. G. wires in each groove; 29 commutator bars; grooves milled out, size $\frac{5}{8}$in. by $\frac{3}{16}$in.; outside diameter of core, $7\frac{1}{2}$in., inside 3in., surface of completed armature wound with No. 14 B. and S. G. iron wire. Length of armature and poles, 6in. each. Effective length of iron in armature core, 5in., magnetic leakage, 15 per cent. Field cores, 5in. by 2in., with rounded ends; area, 9·14 square inches. Mean length of field magnetic circuit, 12·5in. Magnetic density in armature core, 5,400 gausses; in air-gap, 4,900; in the armature teeth, 8,400; in the field cores, 6,800. Field winding, mean length of turn, 15in., requisite exciting M.M.F. for field circuit, 1,145 gilberts*; for armature, 31·3 gilberts; for air-gap, 1,258 gilberts; or a total of 2,434 gilberts; size of field wire, No. 18 B. and S.G. Number of holes for balancing coils, five in each pole-piece, even conductors per pole, or 140 conductors total. Weight of complete machine, 400lb.

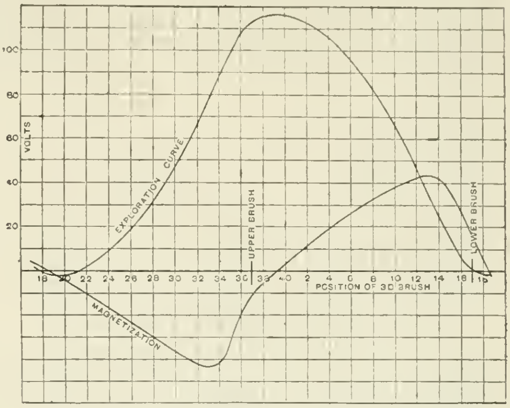

Fig. 9.—Exploration Curve, Full Load. v.=114. c.=26. Exciting Current, 10·4 A. Speed, 1,920 revs. Operated as a Motor, without Balancing Coil.

An examination of this data discloses the fact that no regard is had for the pernicious effects that are ordinarily met with in the use of so short an air-gap with a comparatively large number of armature ampere-turns. With the use of the balancing coils no such effects were observed; the machine performed precisely in accordance with the original estimate made in designing it, and exactly as theory shows that ordinary machines would perform if armature reaction were entirely absent.

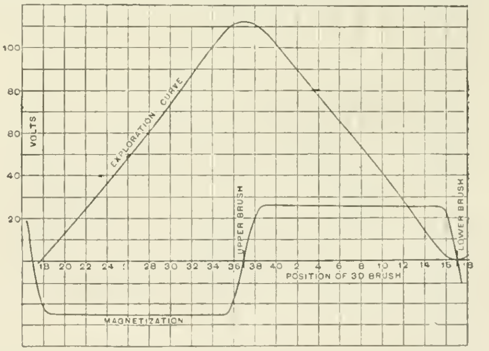

Fig. 10.—Exploration Curve, Full Load. v.=112. c.=25. Exciting Current, 10·4 A. Speed, 1,920 revs. Operated as a Motor, with Balancing Coil.

During test the machine was belted directly to a 10-H.P. Sprague motor, and ran at a speed varying from 1,500 to 1,650 revs. The commutator was quite small for a four-pole machine; it

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* A *gilbert* is an American unit of magnetomotive force, equal to $\frac{10}{4\pi}$ ampere-turn.—[Ed. *E.*]

had only 29 segments, and was very poorly suited for the pressure of 100 volts at which it was tested. The machine was loaded down to 43 amperes at 100 volts, speed 1,650, and an exploration curve taken around the commutator. This curve is shown in Fig. 16 and clearly indicates the entire absence of field distortion. It was found that the machine would easily carry a load of 45 amperes continuously without over-heating. After this curve was taken, the machine was loaded down as heavily as the driving belt would permit, and ran at a load of 80 amperes and 80 volts for about 15 minutes. Under this load there was no appreciable difference from light load in the behaviour of the commutator. The balancing coils were short-circuited for an instant while the machine was loaded to 40 amperes, and the vicious sparking that ensued showed that the dynamo could not be operated at this load without the balancing coils. Indeed, the indications were, that it would have been fatal to the welfare of the commutator, and perhaps to the armature itself, to entirely cut out the balancing coils when the machine was carrying this load. The balancing coils were then cut out, and the dynamo gradually loaded down to test the performance without balancing coils. The brushes were shifted forward to prevent sparking as the neutral point changed, and the potential was kept up as much as possible by cutting out field rheostat. The maximum current reached was 37 amperes at 85 volts, with field rheostat all out, and speed 1,800 revs. At this speed, and with this excitation, the machine would have given 120 volts, instead of 85, if the balancing coils had been used to prevent armature reaction. After a load of 37 amperes was reached, it was found impossible to raise the current by cutting down the external resistance, owing to the rapid fall of potential due to armature reaction. The capacity of this particular machine was about doubled by the addition of the balancing coils, and a comparison of the 37 amperes maximum with the 80 amperes, which was by no means the highest possible current, shows that the overload capacity of this machine may be doubled by their use.

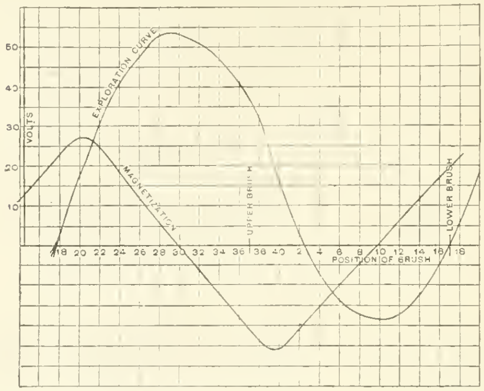

FIG. 11.—Exploration Curve. Full Load. V.=36. C.=20. Exciting Current, 2·5 A. Speed, 1,800 revs. Operated as a Dynamo, without Balancing Coil.

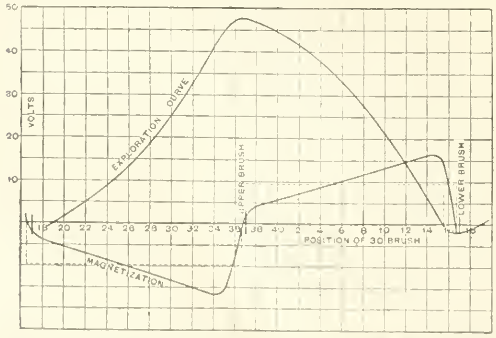

FIG. 12.—Exploration Curve, Full Load. V.=48·5. C.=22·5. Exciting Current, 2·5A. Speed, 1,800 revs. Operated as a Dynamo, with Balancing Coil.

Two more machines of the same general design as the latter were built and tested. These machines were built with field-magnets of mitis metal, and the pole-pieces and armature cores were 1in. longer than the machine last described. The armature windings were different from each other and different from the cast-iron machine. One was wound with a two-circuit winding, and the other with a four-circuit winding. Total weight of each machine was 450lb. Each machine, after running at 1,200 revolutions carries a load of 85 amperes at 110 volts for two hours continuously, and was then loaded down to 100 amperes for a quarter of an hour. The performance of the machines confirmed in every particular the results previously obtained.

Two other machines of this same type were built—one of which was wound for a current of 10 amperes at 600 volts, and the other for a current of 550 amperes at 110 volts, or 60 kilowatts.

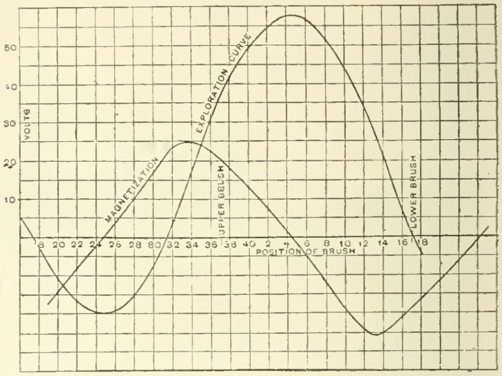

FIG. 13.—Exploration Curve, Full Load. V.=36·5. C.=23·5. Exciting Current, 1·6A. Speed, 1,600 revs. Operated as a Motor, without Balancing Coil.

This type of machine was found to be expensive to construct, and, owing to its exceeding compactness, very hard to ventilate. The main plan in view when designing these machines was to lessen the total weight for a given output by taking advantage of the fact that when the balancing coils are used, one may greatly increase the amount of copper on a given armature, and still obtain the same satisfactory performance at the commutator. As Fig. 15 indicates, a too compact design was adopted; the ventilation was cut down so that full benefit of the large amount of armature copper was not obtained.

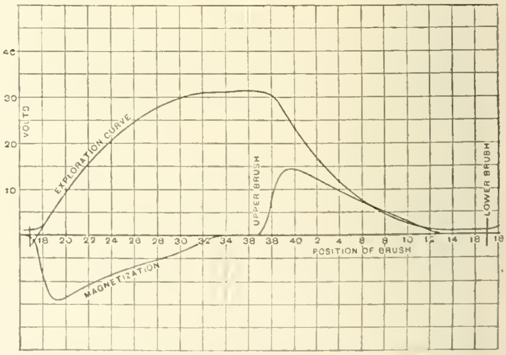

FIG. 14.—Exploration Curve, Full Load. V.=31. C.=24. Exciting Current, 1·6A. Speed, 1,520 revs. Operated as a Motor, with Balancing Coil.

Machine No. 7 was therefore built with a field of the ring type. This machine embodied a number of important improvements in details of construction as will be hereafter noted. Both commutator and armature core were hollow, and the winding thoroughly ventilated. All armature coils were wound simultaneously, and the winding was perfectly symmetrical. The pole ring which carries the six balancing coils was made in halves, and the pole-pieces were joined together by small connecting lugs in order to make the casting continuous. This construction permits the field coils to be wound in a lathe, and to be easily removed from the fields at will. It is also a decided advantage to have the balancing coils and the pole-pieces through which they are wound separable from the rest of the field. The following are the more important details of the design of this machine :—Capacity, 91 amperes at 110 volts or 10 kilowatts. Type of machine, six-pole, ring field of steel. Armature winding of cable through grooves in core. Armature 10in. in diameter outside, by 5in. inside ; number of grooves, 61—six conductors per groove. Grooves, $\frac{7}{32}$in. wide by $1\frac{1}{4}$in. deep ; number of commutator bars, 122 ; total number of conductors, 366. Armature core and pole-pieces, 5in. long. Mean distance between poles, $\frac{3}{4}$in. Total magnetic flux, 1,800,000 webers ; maximum density in armature teeth, 14,400 gausses. Maximum radial density in armature core, 8,500. Mean air-gap density, 5,000. Maximum field density, 14,000 ; length of air-gap, $\frac{1}{16}$in. ; M.M.F. for field, 642 gilberts ; for air-gap, 1,600 gilberts ; for armature, 99 gilberts ; total M.M.F., 2,341 gilberts. Fields wound with No. 20 B. and S.G. wire. Armature, 366 conductors of No. 6 cable ; five holes in each pole-piece for balancing coils. Balancing coils wound with copper ribbon. Compounding, two series turns on each field coil.

Weight of field casting, actual	213lb.
„ armature core, shaft and spider	98lb.
„ „ and commutator complete	185lb.
„ „ copper	48lb.
„ copper for balancing coils, actual	55lb.
„ field copper, actual	40lb.
„ dynamo complete, including base bearings, brush holders, brushes and 14in. by 9in. pulley	865lb.

This machine was completed and tested in October, 1894, and the results of test were as follows :—Speed of dynamo, 1,065 revs. per minute ; voltage, 110. Current, 110 amperes. Time of run, one hour. Temperature of room, 71° F. Temperature of armature, 128° F. Temperature of field, 108° F. Rise of armature, 57° F. Rise of field, 37° F. Field resistance, 110 ohms. Field current, 1·00 amperes. Field energy, 110 watts. Armature resistance, 0·0512 ohms. Armature winding loss, 618 watts. Balancing coil resistance, 0·0202 ohms. Balancing coil loss, 242 watts. Series resistance, 0·00955 ohms. Series loss, 115 watts. Core loss, friction, &c., obtained from energy absorbed as motor running light at full pressure, 450 watts. Total losses, 1,408 watts. Total output, 12,100 watts. Gross energy absorbed, 13,508 watts. Commercial efficiency, 88·7 per cent. For lighter loads the efficiencies are given by the curve in Fig. 17. This test was made after the machine had been running for several hours under various loads. On another occasion the machine ran one hour and twenty minutes under a load of 115 amperes at 105 volts with a rise of temperature of armature of 48° F. While carrying this load, which it will be noted is 25 per cent. above the rated full load, the pilot brush exploration curve, shown in Fig. 18, was taken. This curve shows the entire absence of armature reaction. The machine has also carried 135 amperes for one-quarter hour, and has several times been loaded down to 180 amperes for a few minutes at a time without damage.

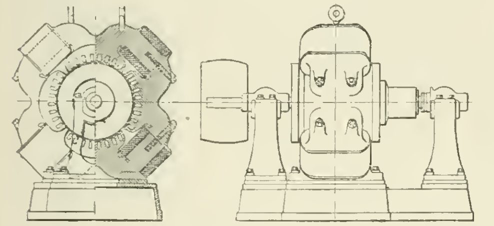

Fig. 15.

While the "balancing coils," as may have been seen from the foregoing results, entirely prevent field distortion and shifting of the neutral point, there is still something lacking for ideal commutation. In a constant potential dynamo the following are the conditions for perfect and sparkless commutation. When a coil is short-circuited as it passes under a brush the current in the coil must fall to zero, reverse, and rise exactly to the original value in the opposite direction at the instant the short-circuited coil is opened by the passage of the tip of the brush from the commutator bar. To bring about this reversal properly, the short-circuited coil must move during short-circuit through a field whose strength is proportional to the armature current. In other words, the short-circuited coil should move in a neutral field when the machine is unloaded, and should move in a field of considerable strength when fully loaded. The field strength required for sparkless commutation under any particular load depends first on the resistance of the short-circuited coil ; second, the self-induction of the short-circuited coil ; and third, the duration of the short-circuit which in turn depends on the width of brush and speed of the dynamo. Preferably the short-circuited coil should move in a uniformly distributed field. It is evident from this consideration that we do not get the conditions for perfectly sparkless commutation even where armature reaction is prevented if we attempt to commutate under pole corner. It is also evident that if armature reaction and field distortion *are* not prevented we get just the opposite effect on our commutation from what we would wish—that is, our commutation field grows weaker as the current increases, instead of growing stronger as it should. From this we may set it down as a settled fact that no dynamo of any considerable voltage and range of capacity which commutates under the leading pole corner, and is not provided with some special spark preventing device or arrangement for preventing field distortion can be worked from no load to full load without sparking or without shifting the brushes. During their experimental work on balancing armature reaction, the writers devoted considerable time to the problem of sparkless commutation, and as a result have devised an improvement to be used in connection with balancing coils, by means of which ideal commutation is attained. The device is simple, and accomplishes the desired end perfectly. It consists in bridging across the gap between the pole-pieces, attaching a commutation lug to the centre of this bridge, and making this lug the centre of the balancing coil, the latter being provided with a few extra turns. The arrangement is shown in Fig. 19, which represents a portion of the field circuit sectioned centrally in the plane of rotation. Referring to the figure, *a a* and *b b* are two field coils wound round the pole necks C and D ; G is the commutation lug which is attached to the middle of the lugs H I, which latter bridge across the gap between the pole-pieces E and F. The balancing coil (not shown) is wound through the holes K, L, M, N, O, P, with the commutation lug G at the centre of the coil. The path for magnetism is indicated by the dotted lines. It will be noticed that a part of the magnetic lines are shunted across between the pole-pieces E and F, through the bridge lugs H I, and do not pass through the armature. Now when there is no current in the armature or balancing coils, it may be easily seen that the fall of magnetic potential from E to F is the same by either the path through the bridge lugs, or through the armature, and that the commutation lug G attached to the middle of the bridge lugs, must be at the same magnetic potential as the armature teeth opposite, for the latter are connected to the middle of the armature circuit. Therefore, under these conditions, which are practically what we have when the machine is running light, there will be no field between the surfaces R and S of the commutation lug and arma-

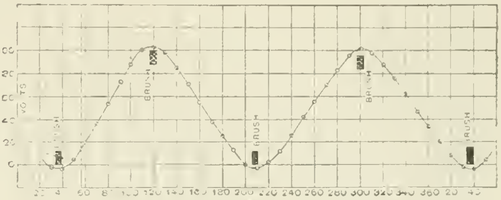

Fig. 16.—c.=43 Amperes. Speed=1,650 revs.

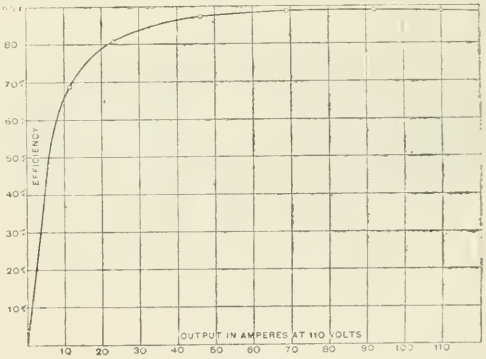

Fig. 17.

ture respectively. If then our brushes are set so that commutation takes place while the short-circuited coil is passing under the commutation lug, we have the correct conditions for sparkless commutation. When the machine is loaded, the excess of ampere-turns of the balancing coils over ampere-turns of the armature brings a magnetising force to bear on the lug G in the direction indicated by the arrow. This tends to increase the magnetism through H, and diminish it through I; but as H is normally saturated, there will be very little increase in its magnetism. There will, however, be a field established under the commutation lug, by the deflection of the lines from the bridge lug I through the commutation lug and armature, and it is evident that the stronger the current in the balancing coils, the stronger will be the field under the commutation lug. We, therefore, again have the correct condition for sparkless commutation when the machine is loaded, provided our balancing coils are so proportioned as to give us a commutation field of proper strength. From this it will be seen that at all times the commutation field is proportional to the current, and that for all loads we have the requisite conditions for sparkless commutation without shifting the brushes.

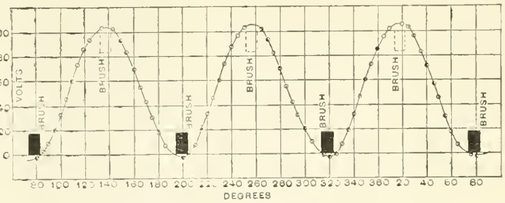

Fig. 18.—C = 115 Amperes. Speed, 1,050 revolutions per minute.

So much for the theory of this plan; and now comes the important question, "Will it work in practice?" We are able to answer without hesitation that such a machine performs as well in practice as in theory, and that actual tests show absolutely sparkless commutation from no load to 50 per cent. overload with fixed metallic brushes. More than this, practice confirms another theoretical advantage of this improvement which we have not yet touched upon. It will be noticed that the commutation field is obtained by the deflection of lines from bridge lug I, and that the lines so deflected pass through the armature, and consequently are added to the useful magnetic field. We might expect from this, and from the fact that since the brushes are midway between the poles, there are no back ampere-turns, that the machines would compound somewhat without a regular compound winding. This theory was entirely sustained by actual trial. It was found under test, that by slightly shifting the position of the brushes forward or backward, it was possible to make a few of the armature turns act with or against the field-winding at will, and this without any effect on the sparkless commutation, so long as the brushes were not moved beyond the limits of the commutation field. The result of this is that by simply shifting the brushes, the compounding of the machine may be so changed that it can be adjusted at any point from 10 per cent. drop to 10 per cent. overcompound, and this without interfering with the commutation in any way.

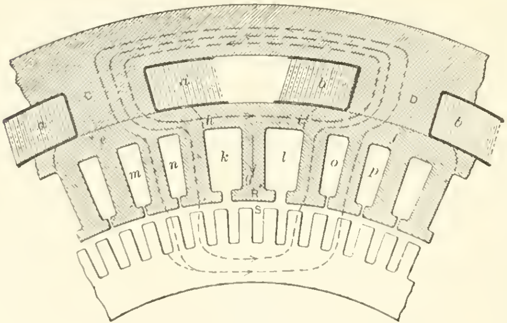

Fig. 19.

Thus by this simple contrivance we attain sparkless commutation without shifting of brushes, and a compounding adjustable at will. It is not claimed that the broad idea of a commutation lug is new, but the success of such a contrivance depends altogether on the way in which it is applied. Unless the magnetic effects of the armature currents are taken care of properly, a commutation lug would prove worse than useless, and we would be likely to get an effect just the opposite of that desired. Thus it will be seen that the advantages which we have shown as resulting from the use of this system of commutation, arise not from the use of a commutation lug alone, but from its use in connection with coils for balancing armature reactions. Direct experiment has shown that this system of commutation will not give satisfactory results except when used in connection with balancing coils. Aside from the effect on commutation, however, balancing coils have some very important advantages to which we will briefly call attention. By their use the capacity of a machine of given size and weight may be greatly increased, and the resulting machine still be far better in quality and operate more satisfactorily than those of ordinary design. The reasons for drawing this conclusion are briefly these: Since the output of these machines is in no degree limited by armature reaction, it is possible to load the armature with as much copper as can be crowded on to it and to work this greatly increased amount of copper to its safe heating limit—the heating of the armature conductors being the only limit to the capacity of a given armature; and the core losses may be much less in a machine of this type since the magnetic densities in the core may be made as low as we choose, and this will permit the armature to be loaded with still more copper.

With the standard peripheral velocity of 3,000ft., it is easy to get an output of 20 to 30 watts per pound total weight of dynamo, and for large sizes of machines even still greater output per pound. With armature reaction balanced, there is no necessity for high reluctance in air-gap and teeth, and it is therefore made as low as possible for the whole magnetic circuit. The air-gap is reduced to what suffices for clearance, and the armature and field are worked at as low densities as is consistent with economy of iron. By this means from one-half to three-fourths, or even more, of the ampere-turns on the field may be saved with a corresponding saving in field copper and field energy. This, and the reduced core losses, reduce the fixed losses in the dynamo to a minimum, bringing them below what is possible with the ordinary construction, and the result is a very material change in the shape of the efficiency curve of the machine. Since the fixed losses are very small, the machines will have unusually high efficiency on light loads, the efficiency curves run up very sharply, and bend off to a very uniform efficiency throughout the greater part of the range of load. This is a very decided advantage where machines are expected to work under considerable range of load, as they usually are, both for lighting and power purposes. In desinging machines it is also an easy matter to proportion materials according to their relative prices. Thus, with a design containing a given amount of copper, we can increase the copper slightly and reduce the iron and steel, keeping the capacity of the machine the same, and thereby effect a saving in cost perhaps, or we may increase the iron and steel and reduce the copper to effect a similar saving. With ordinary designs such an adjustment as this would be out of the question, except at a sacrifice of valuable qualities of the machine, for the invariable rule is that the M.M.F. of the armature ampere-turns may never exceed the M.M.F. impressed by the field between the pole faces.

The value of sparkless commutation is almost beyond price. Commutation has long been recognised as the greatest bugbear of continuous-current machinery. Whatever adds to the life of the commutator adds to the durability of the machine, and the entire prevention of sparking is, therefore, an important feature. To be able also to have the brushes permanently fixed is of decided value, and this, when taken with sparkless commutation, makes a dynamo self-attendant to a greater degree than usual. The extra cost of applying these improvements to a dynamo is far more than balanced by the saving effected in materials, and the writers believe that the application of these methods of design in dynamos would make a pronounced and important step towards the practical perfection of this class of machinery.

BOOKS RECEIVED.

"Problems and Solutions in Elementary Electricity and Magnetism." By W. Slingo and A. Brooker. (London: Longmans, Green and Co.) Price 2s.

"Die Elektrotechnik auf Der Weltausstellung in Chicago." By Dr. Johann Sahulka. (Vienna: Verlag Der K. K. Central-Commission.)

"Hydraulic Motors, Turbines, and Pressure Engines." By G. R. Bodmer. Second Edition. (London: Whittaker and Co.) Price 14s.

"Electric Light for Country Mansions." By John Henry Knight. (London: Crosby Lockwood and Son.) Price 1s.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *April 7, 1895.*

The General Electric and Westinghouse Companies.—The terms of the agreement in relation to patents between the General Electric Company and the Westinghouse Electric and Manufacturing Company, to which I have referred in this correspondence, are said to be completed, though no official announcement has yet been made. It is reported on credible authority, however, that the arrangement will only affect patents, including future issues to either party. Both companies will use all patents at pleasure, subject to royalties to be paid to each other on a basis to be determined by a board of experts to be appointed by themselves, the rates and amounts due to be determined quarterly. This plan, it is said, will result in a saving in law expenses sufficient to pay a dividend of 2 or 3 per cent. on the common stock of the respective companies. It may be added that the agreement was brought about by the banking interests controlling the stock, without reference, it is believed, to the wishes of the officials of the two companies.

A New Telephone Company.—An important announcement has just been made relating to the entrance of a rival to the American Bell Company into the telephone field, backed by well-known capitalists, including the Sugar Trust, the Standard Oil Company, the Crocker interests of California, and the Pullman Company interests. The Company proposes to put in telephones all over the country at a uniform price of $25.00 per annum, the instruments to embody the Bonta-Clamond all-carbon multiple contact principle. The president of the Standard Telephone Company, as it has been named, announces that the purpose is to go into business in every State.

Niagara.—The Buffalo municipal committee, which has been considering the terms under which a franchise would be granted for the introduction of electric power from Niagara into the city, have reported and advised that the rate to be charged be fixed at $20.00 per annual horse-power. As this figure is an absurd one and cannot be accepted, it may, if adhered to, result in the transfer of Buffalo's manufacturing interests to Niagara Falls.

Interurban Railways.—The Supreme Court of the State of Pennsylvania has just decided that rural officials cannot grant free right of way to electric street railway companies over country roads. As a result of this, interurban roads will hereafter have to purchase their right of way from frontagers, instead, as heretofore, receiving it as a gift from township and county official bodies.

PARIS NOTES.

(FROM OUR OWN CORRESPONDENT.)

PARIS, *April 12, 1895.*

The Claret-Wuillemier System of Electric Traction.—The Claret-Wuillemier underground system of electric traction, described in your columns in September last, will receive its first application in Paris, on the line running from the Place de la République to Romainville. The concession for this line was granted to M. Larmoyer in 1893, who wanted to pass it over to an English company, proprietor of an underground system of electric traction; this transfer, however, not having been made, the concession was taken away from M. Larmoyer, and in November, 1894, a competition was opened. After a first elimination, two competitors remained on the field—M. Claret and a new company which proposed a system, or rather two systems combined, that is to say, accumulators in the city and the overhead system in the suburbs. The line has a length of four kilometres *intramuros*, and three kilometres *extramuros*, and is entirely a double-track road; the maximum grade is four per cent. over a length of 300 metres. The competition between the promoters of the two proposed systems was a very lively one, and it was only owing to the reputation M. Claret had acquired as general contractor at the Lyons Exhibition, that the concession was granted to him. The contract is, however, under the condition that if within two years the system does not give entire satisfaction, M. Claret will have to adopt another system, having given proofs as to its good working.

Accumulator Traction.—At a meeting of the Société Internationale des Electriciens held on April 3rd, M. Sarcia described some new improvements in the storage battery system of electric traction at Paris. The charging of the accumulators was formerly effected at constant potential, but the very large current at the beginning weakened the plates. The difference of potential was of 255 volts for 108 elements. To-day the difference of potential has been brought down to 220 volts during the first period of charge, and at the end of one hour and a-half a *survolteur* or booster is put in series and brings the potential to 255 volts. The total duration of the charge lasts four hours, or thereabouts. The cars, 25 in number, will be modified. They are composed of two separate trucks between which is disposed a box containing the storage batteries. Formerly, the batteries were placed under the seats of the passengers, and the result was frequent accidents owing to the upsetting of the sulphuric acid. Further, changing the cells involved a large amount of time. Now a hydraulic press, placed in a pit, will lift the battery, which will then be easily removed and another put back in a very short space of time. The weight of the car, with the batteries, will be of about 12 tons, the accumulators weighing 2½ tons. The negative plates are the same; the positive plates are of the *type à échelons*, with a core of antimonous (10 per cent.) lead. The coal consumption for the last year was 2½ kilogrammes per car-kilometre.

CORRESPONDENCE.

THE HOUSTON-KENNELLY ILLUMINATION PHOTOMETER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We notice that in the editorial columns of your issue for March 22nd you allude to our illuminometer. We believe that you have failed to notice that while the instrument is not a laboratory instrument, and is, therefore, not intended to possess the accuracy of such an instrument, it is for that very reason free from the objections to which so many laboratory instruments must necessarily be liable, namely, that it is very portable, swift in its operations, convenient in its use, and requires no standard light. Although we do not claim a higher degree of accuracy than 10 per cent. for this instrument, yet we think that this degree of accuracy is worth securing, for at present illumination is a matter of guesswork, except in the laboratory photometer, or except in cases where a portable standard of light has to be carried about.

You mention that you do not find in our paper a definition of the "lux" as employed by us. Our paper very distinctly points out that the unit of illumination we use is that produced by the accepted international standard of light at the present time, as defined by the International Electrical Congress of Paris in 1889; namely, the illumination produced by the *bougie-decimale*, or the one-twentieth Violle upon a normal surface at the distance of a metre. We are fully aware that Mr. Preece proposed this name from the carcel-metre, but the carcel has not been adopted by any International Electrical Congress, while the bougie has been so adopted, and consequently there is more reason for employing a bougie-metre than a carcel-metre at the present time.—Yours, &c.,

HOUSTON AND KENNELLY.

Philadelphia, April 2, 1895.

[The absence of a standard light in Messrs. Houston and Kennelly's "illuminometer" is, of course, an advantage, and the only question is whether in securing this single advantage the inventors have not sacrificed other things equally valuable. The illumination photometer described before the Institution of Civil Engineers by Mr. A. P. Trotter, in May, 1892, and used by him in measuring the illumination of the streets of London, was as portable and as rapid in operation as could be desired, and possessed in addition a high degree of accuracy. The standard light (a small glow lamp run off a miniature battery of lithanode accumulators) gave no trouble whatever in practice. We were in error in asserting that Messrs. Houston and Kennelly gave no definition of their own particular "lux." They did so in the full Paper (see *Electrical World*, March 9th, p. 310), but none was given in the abstract upon which we based our remarks. We cannot recognise the decrees of the so-called International Electrical Congress of 1889. There were no regularly appointed delegates, as at Chicago In affixing to a little-known, little-used unit of illumination a well-known name proposed for a well-used unit, Messrs. Houston and Kennelly do their best to render the confusion of photometric nomenclature worse confounded.—Ed. *E.*]

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NOW READY.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Although about 100 pages are added to the book, no addition is made to the price, which is 7s. 6d., post free 8s. 3d., abroad 9s.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices :—*

Laboratory Notes and Forms.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A Large-Sheet Table, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s. —each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"Electro-Chemistry."—This useful work, by Dr. G. Gore, is still on sale, the price being 2s., post free.

"The Work of Hertz."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. net., is now ready.

"Electrical Engineering Formulæ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"Drum Armatures and Commutators."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"The Electrician."—A special notice concerning certain changes in the price, &c., of this journal (commencing with the new volume on May 3rd) will be found on page 760.

Tenders Invited.—The Corporation of Londonderry invite tenders for the supply of electric light carbons for one year from June 1st next. Schedules of quantities, &c., can be obtained of Mr. John Crombie, electrical engineer to the Corporation, Strand, Londonderry, and tenders must be sent in to Mr. R. N. Chambers, Town Clerk, The Guildhall, Londonderry, not later than May 1st. Some further particulars are given in our advertisement columns.

Tenders Invited.—The Huddersfield Town Council invite tenders for cast-iron spigot and socket pipes. Tenders must be sent in to the borough electrical engineer, Mr. A. B. Mountain, by April 26th. Some further particulars appear in our advertisement columns.

——— Tenders are invited until May 4th by the Telegraph Department of the Saxon State Railways, Dresden, for the supply of 1,000 small porcelain insulators, 10,000 large porcelain insulators, 100 tons of galvanised iron wire of varying diameters, 2,000 copper cylinders, and 10,000 zinc cylinders.

——— The La Plata Telegraph Department invites tenders for the supply of telegraph apparatus and material.

Tenders Accepted.—The Edmonton District Council have accepted the tender of the Consolidated Telephone Construction and Maintenance Company, of 109, Farringdon-road, London, E.C., for street fire-alarms.

——— The tender of Messrs. John Musgrave and Sons (Limited), of Bolton, has been accepted by the Southport Town Council for additional engines at the Council's electricity works. The firm will supply two horizontal compound engines each of 250 h.p.

——— The Electric Lighting Committee of the Hull Corporation have accepted the tender of Messrs. Willans and Robinson for the supply and erection of an engine for the electricity works at £1,295, and from Messrs. J. H. Holmes and Co., for a dynamo for the sum of £700. Messrs. Crompton and Co's. tender for switchboard and apparatus has, we understand, also been accepted. The tender for the boilers required are to be obtained from Hull firms in accordance with the decision of the Council at a recent meeting.

Sale by Auction.—It is gratifying to announce the dispersal of the effects of the "Medical Electrical Institute (Limited) and the Electropathic and Zander Institute." The sale of these effects, which include a quantity of electrical apparatus, batteries, machinery, gas engines, fittings, &c., is to take place on the premises, 52, Oxford-street, on Tuesday next and following days. Messrs. Baker and Sons, of 11, Queen Victoria-street, E.C., are the auctioneers.

Vacant Appointment.—The Governors of the South-West London Polytechnic, Manresa-road, S.W., invite applications for the appointment of Head Master of the department of Mechanical Engineering, at a salary of £250 per annum. Some further information is given in our advertisement columns, and applications must be made not later than Monday the 29th inst.

——— The Vestry of St. Pancras require a chief electrical engineer to undertake the charge and management of the whole of the Vestry's generating and distributing stations and mains. Applications must be sent in to Mr. Albert E. Pycraft, Chief Clerk of the Electricity and Public Lighting Department, Vestry Hall, Pancras-road, London, N.W., by May 2nd. Further particulars appear in our advertisement columns.

——— The Vestry of St. John, Hampstead, are prepared to receive applications for the post of electrical engineer for their central electricity station. Applications must be sent in by May 2nd. Some further particulars are given in our advertisement columns.

Removal.—Messrs. Fenn and Co. (Limited), makers of engineers' tools for the electrical and mechanical trades, announce that they have removed from 10, Railway-approach to 136, Borough High-street, London, S.E.

——— Messrs. Blackburn, Walker and Co., electrical engineers, have removed from Bradford-road, Dewsbury, to the Tofts Mill, Cleckheaton.

Business Changes.—Messrs. Edlin and Stevenson, electrical engineers, of 36, Church-street, Cape Town, notify us that Mr. H. W. Edlin has retired from the business. The business is now being carried on under the same style by Mr. A. D. Stevenson, who takes over the assets and liabilities. Creditors are required to furnish statements of their accounts owing to February 28th.

Agency.—We are asked to state that Messrs. Willing and Co. (Limited) have ceased to be the sole agents for the patent Chameleon electric signs manufactured by Messrs. E. L. Berry, Harrison and Co.

Bankruptcies.—Notice is given that the first meeting of creditors of Joseph Torr Todman, of Colombo, Ceylon, but lately trading at 36, Bermondsey-street, S.E., and 11, Queen Victoria-street, E.C., as an electrician, will be held on April 26th, at 11 a.m., at Bankruptcy-buildings, Carey-street, London, W.C. The public examination takes place on April 30th, at 11:30 a.m.

——— The first meeting of creditors of E. H. Berry, lately trading as an electrical engineer and contractor under the style of E. H. Berry and Pope, at Burnley, Lancs., will take place at the Exchange Hotel, Nicholas-street, Burnley, on April 22nd, at 3 p.m. The public examination is announced for May 2nd, at 11 a.m., at the County Court, Burnley. The statement of affairs shows a deficiency of £1,481. 16s. 5d. The debtor attributes his failure to "pressure from creditors," and makes no offer.

Bankruptcies.—The first meeting of creditors of W. J. Kelly, stated in the bankruptcy notice to be a "manufacturer of electric light fittings," of 58, Bread-street, E.C., and 43, King's-road, Kentish Town, but who was some time back appointed receiver and manager for the debenture-holders in Poole and White (Limited), will take place at the Bankruptcy Court, Carey-street, London, W.C., on April 24th, at 2:30 p.m. The examination of the bankrupt takes place on May 3rd, at 11 a.m. It is especially advisable that all creditors in this failure should be represented.

———— The first meeting of the creditors of the Medical Electrical Institute takes place at 33, Carey-street, London, W.C., on April 23rd, at 11 a.m., and the meeting of the contributories on the same day at 12.

Liquidations.—Notice is given that Mr. George Stapylton Barnes has been appointed Official Receiver in the winding-up of the Ford-Lloyd Manufacturing Company (Limited). The first meeting of creditors will be held on the 24th inst., at 11 o'clock, and of the contributories at 2:30 o'clock, at 33, Carey-street, Lincoln's Inn, London, W.C.

———— On March 29th it was resolved that J. G. Statter and Co. (Limited) be wound up, and Mr. F. J. Tingle, of 110, Cannon-street, London, E.C., was appointed liquidator.

Tariff Changes.—Various alterations have been made and new regulations issued by the Russian Customs Department, and future consignments of lustres, brackets, candelabra, and similar fittings of common materials for electric lighting, although fitted with electric wire and switches, are to be cleared according to material. The Swedish Customs Office have recently revised their tariff, and the new duty on electric lamps is 1 kr. 50 ore per kilo, against the previous duty of 60 ore. Copper wire and electric cables specially insulated, which were previously allowed into the country free, have a duty of 10 kr. per 100 kilos, and the duty on twisted ropes or cables without insulation is increased from 10 to 15 ore per kilo.

Bell's Asbestos Company's Manufactures.—This Company have just issued a new folding pocket list giving illustrated descriptions and prices of a large variety of goods manufactured by the Company, and also a descriptive circular of Field's patent gauge-glass protector, copies of which can be obtained on application.

Wood-Preserving Process.—Those interested in the preservation and seasoning of wood have an opportunity of inspecting at 2, Dean's-yard, Westminster, London, S.W., samples of wood treated by the Haskin process, which is known as "Haskinising" or Vulcanising. The process is the invention of Col. S. E. Haskin, and is carried out by a mechanical means and apparatus. It is claimed that vulcanising the wood is superior to creosoting it, and costs less, is without smell, and can be worked with tools with ease. The process is recommended for telegraph, telephone, and electric light poles.

The "E.N.S." Dry Battery.—The Electric Novelty Syndicate (Limited), of 7, Queen Victoria-street, London, E.C., call the attention of the trade to their new dry cell, for which it is claimed that in point of price and efficiency it compares favourably with any dry cell yet put on the market. The battery is suitable for all purposes for which Leclanché and other similar cells are used. The E.M.F. of the cell is 1·6 volts, and the internal resistance of a No. 1 size cell is 0·1 of an ohm. With a normal working current polarisation is very slow, and recovery rapid on open circuit. The Syndicate recommend the batteries for blasting purposes, telephones, bells, lamps, and experimental work. They are stocked in four standard sizes, in round, square, and rectangular forms, ranging in price from 8s. to 16s. per dozen.

Messrs. John Wilson and Son.—This firm, who some time back purchased the patent rights, drawings, patterns, &c., of the old firm of J. and W. Weems, and also the works, tools, plant, &c., of the old firm of W. Robertson and Co., have combined the two businesses at Vulcan Works, Johnstone, Scotland, under the supervision of Mr. Alexander Wylie. More recently a considerable extension has been made to the works by the addition of new premises, 250ft. by 42ft., which have been fully equipped with special up-to-date machinery, which enables the firm to execute orders of any magnitude for hydraulic machinery for covering telegraph, telephone, electric light, and other cables with lead in long lengths, and for all kinds of engineers' tools, castings, engine and boiler tubes and fittings, screw-cutting lathes, valves, &c. A new circular, containing an extensive list of the firm's manufactures, can be obtained on application.

Epstein Accumulators.—We have received a notification that the demand for Epstein accumulators has necessitated the erection of a new factory, with a plant equal to 600 H.P., which enables the Epstein Company to execute large orders expeditiously. The prices of these batteries have been materially reduced, and the makers claim that they are now the cheapest in the market.

The Journal.—Part 116 of the *Journal* of the Institution of Electrical Engineers is now ready, price 3s. This part contains the Papers (and discussions thereon) by Mr. W. B. Sayers on "Reversible Regenerative Armatures and Short Air-Space Dynamos," and by Dr. John Hopkinson and Mr. E. Wilson on "The Propagation of Magnetism in Iron."

"Annuaire" pour la Année 1895.—We have received from the Société d'Encouragement pour l'Industrie Nationale of Paris, a copy of their Annual for 1895, containing calendar, list of members, &c.

"Willing's British and Irish Press Guide."—We have received a copy of the twenty-second annual issue of this useful and comprehensive guide to the British and Irish Press. Those who have occasion to make reference to books of this character will find Willing's Guide the handiest book of the kind published. The method adopted in dividing the book into sections lends itself to ready reference. In addition to the British and Irish Press, useful lists are given of Continental, Colonial, and American publications.

Accrington.—Messrs. Simpson Bros., of Hapton, have written to the Town Council notifying that proposals have been made to them for the formation of a local company for the supply of electric current to this town, and inquiring whether the Council would oppose an application by the Company for a Provisional Order, and the Town Clerk has been instructed to reply that the Council's Order is still in force, and that they have borrowing powers to the extent of £10,000, out of which a site for a supply station has been purchased, and the work of laying mains, &c., would be proceeded with "as soon as the Council are convinced of its expediency, having regard to the demand for electric current." The Council would, therefore, oppose any application on behalf of the proposed Company.

Bath.—It will be remembered that Major Cardew, in his report on the recent application of the City of Bath Electric Lighting and Engineering Company for a Provisional Order, in place of their present licence, recommended that the Order be not granted without the consent of the Corporation, but added his opinion that consent might be given on condition of the Corporation having power to purchase, taking over concurrently with the purchase the powers of the Order. The Electric Light Committee have just presented their report on this point, and they recommend the Council to adhere to their original decision to refuse their assent, and to themselves apply for a Provisional Order. This was agreed to at the meeting of the Council on Tuesday.

Belfast Exhibition.—This Exhibition, which promises to be a great success, is now nearly complete. It is stated that the lighting of the building by electricity will, when finished, be one of the largest lighting jobs yet undertaken in Ireland. The work is being carried out by Messrs. W. Coates and Sons, of Fountain-street, Belfast ; 1,000 16-c.p. incandescents and 100 2,000-c.p. arcs are already being installed under the supervision of the firm's engineer, Mr. S. Dashwood. Eight dynamos, built by Messrs. J. H. Holmes and Co., of Newcastle-upon-Tyne, all specially designed for this work, are now erected. Crompton-Pochin arc lamps are used. The Exhibition was formally opened last week. Mr. Philip Shrapnel, who is well known in connection with exhibitions held at the Agricultural Hall, London, is the manager.

The Berne Vocabulary.—If further evidence were needed of the unskilful character of the compilation recently published by the Berne Bureau, it is supplied by a correspondent of *The Times*, "W. B.," in the issue of Tuesday last. After giving a list of a few unsuitable English words which a cursory glance at the book discloses, "W. B." writes :—"To say that its compilation has been carelessly performed would be far too mild a term to employ. In my opinion, the 20 examples I have given prove that the compilation has been performed by men who possessed but a very elementary knowledge of the work entrusted to them. That such a vocabulary should be issued under the sanction of the representatives of the European States of the International Telegraph Conference reflects but little credit on the arbiters of the telegraphic communities of Europe. But that such an ill-selected vocabulary should be compulsorily forced upon the mercantile communities of Europe three years hence should be most strongly protested against without delay. As regards price, the vocabulary under remark would be a marvel of cheapness if it was a good one, but, owing to its faulty compilation, it must be considered dear at any price." It is satisfactory to note that the strictures of its correspondent have the full support of *The Times*, which in its editorial comments says : "We do not suppose that the authorities will be very ready to amend the proposed vocabulary unless those interested put pressure on them." As the next Telegraphic Conference is to be held shortly, it is important that code users should be energetic in their efforts to insist upon a revised edition of the vocabulary being at once prepared, or that its compulsory adoption should be rescinded. In the event of a revised vocabulary being prepared, the one thing needful, without doubt, is that English experts, who have a greater knowledge of the requirements of the coding public than any other telegraphic body, should be either consulted or directly employed in its preparation. But assuredly time is pressing, as the work of private code compiling is both laborious and time-consuming. We have known such codes to take over three years in preparation.

Blackpool.—At last week's meeting of the Town Council, a letter was read from the National Telephone Company, calling attention to a disturbance of the telephone wires by certain electric lighting plant, the property of the Corporation.

Brazil.—It is stated that work has been commenced on the Santa Theresa Electric Railway at Santo Antonio, Brazil.

Brighton.—The Brighton and Rottingdean Seashore Electric Railway will, it is expected, be completed during the coming summer. The line is provided with two jetties, one at Paston-place and the other at Rottingdean Gap. The cars will be so raised that, even at the highest tide, they will run a safe distance above the water. The cars to be used are to be deck-shaped and fitted with a saloon and upper deck, and will carry about 130 passengers.——The Directors of the famous Brill's Baths, so well known to Londoners as well as to residents of this noted health resort, recognising the importance of suitable lighting, have recently fitted their bathing establishment for the electric light, which was inaugurated on Saturday last. The light was switched on by the Mayoress.

Burglary.—The enterprising burglar appears to be particularly in evidence in the "E. C." district of London. The premises of the Brush Company in Queen Victoria-street have recently been visited, and it is stated that about £300 is missing.

Cardiff.—The Lighting Committee of the Corporation have agreed to extend the electric lighting mains through several additional thoroughfares at an estimated outlay of £1,860.

Cheltenham.—An experimental run of the electric light took place last week, and amongst the premises lighted were those of the *Cheltenham Examiner*. In the composing room an 8 c.p. lamp for each man takes the place of a dim gas light, which formerly "illuminated" two compositors. 112 incandescents of various candle-powers are used in the building. The wiring work for this installation has been carried out by Messrs. R. E. and C. Marshall, of Cheltenham. The trial proved completely successful, and Mr. Kilgour, the borough electrician, was congratulated by those present on the result. As at present arranged, the formal handing over of the supply station by the contractors (Messrs. Siemens Bros. and Co.) will take place on Tuesday, April 30th.

Church and Chapel Lighting.—The parish church of Buckland, near Dover, was lighted by electricity on Easter Sunday for the first time.——Salem Chapel, Cheltenham, is now lighted electrically, to the complete satisfaction of the congregation and officials.

Croydon.—The result of a canvass by the Croydon Chamber of Commerce on the electric lighting question has proved the wisdom of the course adopted by the Chamber. The result of the canvass in the compulsory area is as follows:—Number of circulars sent out 372, replies received 197, unqualified yes 89, conditional yes 44, no 44; in favour of the Corporation working the scheme 142, of a private company 24. In addition to the above 372 circulars, 432 were addressed to residents outside the compulsory area; 170 replies were received as follows:—Unqualified yes 57, conditional yes 30, no 72; while 102 were in favour of the work being carried out by the Corporation. It will thus be seen that out of a total of 804 circulars and 369 replies, 146 were unconditionally favourable, 74 conditionally, and only 121 unfavourable. The Chairman of the Chamber (Mr. Alderman Thrift), in commenting upon the result, said he fully endorsed the action taken by the Corporation, on the recommendation of their consulting engineer, and which was reported in our last issue. A resolution, approving the action of the Corporation and supplying the information above referred to to that body, was unanimously adopted.

Dewsbury.—The Town Council have agreed to the proposal that the new baths and library should be fitted throughout for the electric light.

Ealing.—The Electric Lighting Committee reported to the last meeting of the District Council that the supply station had been formally taken over on behalf of the Council by the surveyor. It was decided to appoint Messrs. Bramwell and Harris for a term of three years as consulting engineers to the Council at a fee of £105 per annum. An extension of the electric lighting mains was also agreed upon at an estimated cost of about £650.

Edinburgh.—On Friday evening last the ceremony of turning on the electric current was performed by Mrs. M'Donald, wife of the Lord Provost. About 500 invited guests assembled previous to the function at the supply station in Dewar-place, when an inspection of the machinery took place. The Lord Provost pointed out that about £100,000 was invested by the Corporation in its electric lighting undertaking. About £9,000 have been paid for land; £15,000 for machinery; boilers, £6,500; switchboards, £1,709; batteries, £1,400; cables and copper, about £24,000; casing, £9,500; road-work, £17,000—or about £115,000. He referred to the services of Prof. Kennedy and his confidence in the success of the scheme, and to the efforts of Mr. Monkhouse, their resident engineer. He considered the Edinburgh public were also deeply indebted to Councillor Mackenzie for his superintendence of the work.—Councillor Mackenzie explained the necessity of providing for future extensions by building a larger station than that at present required. He cited the cases of several towns in which the original accommodation had been very inadequate for later wants. Referring to the demand for electric light, he pointed out that whereas Glasgow began with only 6,000 lamps, they in Edinburgh began with an equivalent of 20,300 8 c p. lamps applied for already and ready to be wired on. The 175 street lamps were equivalent to 3,000 lamps more. They were quite sure a further 6,000 lamps would be applied for within the next few months, and they had the full expectation that by the coming winter 10,000 8 c.p. lamps would be applied for. This would at once necessitate an extension of their plant. They were quite safe in going on until they had 40,000 lamps wired. With regard to the opposition to gas, he did not see that there should be any antagonism. It was only when the electric light became a question of practical lighting that gas engineers woke up from their lethargy. As to the cost of the electric light, they might take his word for it that it was likely to be a little dearer than gas, but though at 6d. per unit electricity was 25 per cent. dearer than Edinburgh gas, with the economies that could be practised in the way of turning off the light the price of the one would really not be more than the price of the other.—Prof. A. B. W. Kennedy said he was very glad to be there with their troubles all past. He did not think there was any place in the United Kingdom other than London, and he was not quite sure of London either, which offered the same certainty of success as Edinburgh did. He had not the slightest doubt of the financial success of the scheme, and no other city, he thought, had started with anything like the same number of lamps applied for.—A dinner was subsequently held at the Rutland Hotel, where the actual ceremony of turning on the electric current took place, at eight o'clock, and as the long line of light swept instantly into view an admiring multitude raised a loud cheer. Many thousands of people congregated in Princes-street, and at the West-end the throng was dense enough to interfere seriously with the traffic. The inauguration proved a complete success, the light burning bright and steady. In order that the painful contrast between the gas-lighted and electrically-lighted portions of the city may be less conspicuous it has been recommended by the Cleaning and Lighting Committee of the Town Council that in future none of the street gas lamps shall be turned out at midnight, as has previously been done. The Edinburgh installation seems to have deeply concerned a correspondent of our contemporary the *Journal of Gas Lighting*, and his remarks on the outlook for the electric lighting scheme are of a very pessimistic character. He, however, admits that the work has been well done, but talks of the deficits "which always arise" from Corporation electric lighting undertakings.

Electric Coal-Cutting.—At the eighteenth annual meeting of the Mining Institute of Scotland last week, Mr. G. A. Mitchell, the president, read a Paper on "Electric Coal-Cutting at Glenclelland Colliery." The Paper is to be discussed at the next meeting.

Electric Motive Power for the New York Central Railway.—The *Financial News* states that President Depew, of the New York Central Railway Company, recently remarked that the subject of the equipment of the Niagara Falls branch of that line with electric motive power was now under consideration. Several of the leading spirits of the Niagara Power Company are connected with the New York Central system.

Electric Traction on the Continent.—The American technical journals have, perhaps, done more by means of their pictorial efforts to set the ordinary British mind against the use of overhead wires for traction purposes than has any inherent defect in the system itself. That the overhead system can be established without any appreciable disfigurement of the thoroughfares or the surrounding scenery may be seen by a set of views now being sent out by Mr. R. W. Blackwell, of 39, Victoria-street. The 15 views included in the sheet relate to the electric tramways of Bremen, Lübeck, Hamburg, Baden-Voslau, Essen, Breslau, Chemnitz, Halle, Remschied, and Kiew, and as the work in all these cases has been carried out on approved European principles, Mr. Blackwell's efforts to popularise the overhead system deserve success. We would recommend that the sheet of illustrations should be freely distributed by those interested in electric traction, more particularly amongst local authorities.

Export of Telegraph Wire and Apparatus.—Exports of telegraph wire and apparatus connected therewith during March last reached a value of £19,598, as compared with £113,423 in the corresponding month of last year. The great shrinkage which has taken place this year in this branch of trade is shown by the returns for the three months ending March, the total being £61,202, against £205,279 in the same quarter of 1894, and £391,959 in 1893.

Forthcoming Lectures.—A popular lecture on "The Applications of Electricity" is to be delivered by Mr. A. Scheley at the Croydon County Polytechnic to-morrow (Saturday) at 8 p.m.

Hamburg Tramways Company.—The report of the Directors of this Company speaks in glowing terms of the conversion of several lines to electric traction, the results being considered highly satisfactory. It is intended to convert all the lines of the Company, with the exception of the Wandsbeck line, to electric traction by 1897.

Hammersmith.—The Electric Lighting Committee recommend the Vestry to treat for the purchase of two pieces of land abutting upon Fulham Palace-road, known as the Gardens Estate, to be used for erecting an electric light generating station, for the sum of £7,000.

Hampstead.—At the meeting of the Vestry, on Tuesday, it was decided to expend a further £2,500 in laying down mains, &c., for the supply of current to private consumers. It was announced that there was a large increase in the number of customers. 7,338 8 c.p. lamps are now connected up, and the revenue for the past three months was £770. At the same meeting the resignation of the chief electrical engineer (Mr. R A. Chattock) was accepted, and it was decided to advertise for a successor. The commencing salary of the new electrical engineer was fixed at £300 per annum.

Huddersfield.—At the meeting of the County Council on Wednesday the Electric Lighting Committee presented their statement of accounts, which showed a deficiency of £2,065 on revenue account. Councillor Calvert explained, however, that there was not a deficit on the undertaking; but they were obliged to pay both principal and interest in 15 years.

Keswick.—The Electric Light Sub-Committee of the Town Council have decided to call a meeting of the ratepayers to discuss the whole question of the lighting of the town. The decision has been taken practically on the question as to whether the Council shall give its consent to the application of the Windermere Company for a Provisional Order for lighting the district electrically.

Killarney.—The action brought by the local gas company against the Town Commissioners has ended in a verdict for the company. This decision follows the success of the local electric lighting company in a similar action, and the question of whether an appeal should be lodged against the decision of Judge Shaw was discussed at the last meeting of the Commissioners, when, by the casting vote of the chairman, it was decided that the decision should be abided by, and that the local electric lighting company should be asked to discontinue the lighting of the town. It is doubtful, however, whether this triangular dispute is even now terminated.

King's College (London).—A course of evening lectures and laboratory work is to be given in the Siemens Laboratory, commencing on April 29th. Prospectuses can be obtained of the secretary.

Kingswood (near Bristol).—The Urban District Council has approved of the action of the local tramways company, by which the poles for the overhead running of the Kingswood section of the tramways are to be placed on the edge of the footpath.

Lectures.—In connection with the electricity class of the Whitgift Grammar School, Croydon, Mr. J. M. Densham delivered a lecture last week on "Electricity," and after the lecture Mr. H. T. Haws gave an address to the class on "The Education of an Electrical Engineer." There was an exhibition of electrical apparatus, some of which had been constructed by the present students of the class, and other exhibits had been fitted up by the students. The lecture proved a great success, the audience including the Mayor and Deputy Mayor.——Mr. H. Byrom Ranson delivered a lecture on "The Mechanical Principles of Electric Engineering" at the Croydon County Polytechnic yesterday (Thursday) evening.——Mr. C. L. Eclair-Heath gave a lecture last week at the Central Higher School, Sheffield, on "Some Applications of Electricity to Industrial Purposes." The Mayor presided, and those present included a number of the leading manufacturers of the town. The lecturer dealt chiefly with the applications of electricity to special Sheffield industries, such as razor-making and metal-heating, and the lecture, which was well illustrated, proved of great interest to a large audience, who expressed a hope that a series of similar instructive entertainments would follow.

Middlesbrough.—The Electric Lighting Committee, after considering the subject of the replies to their circular-canvass referred to in our last issue, have recommended that the question of electric lighting should be deferred. Alderman Jones, in moving the adoption of the Committee's report, and while agreeing with the recommendation, said that with the number of tradesmen who were at present prepared to have the light the Corporation would start with three times the number of customers originally obtained by the Corporations of Newcastle and Bradford. He therefore proposed at the next meeting of the Council to ask them to come to a definite decision in the matter, and either themselves apply for a Provisional Order or cease to stand in the way of a private company making the customary application for sanction. Alderman Bell thought that a small station costing between £10,000 and £20,000 should be started, and he moved that an estimate be prepared of the cost of such an installation, but a proposal that this amendment should be withdrawn was agreed to on the understanding that the Committee would be prepared with a definite proposition at the next meeting of the Council.

Montrose.—As a hitch has occurred in the carrying out of the arrangements between the Town Council and the Scottish House-to-House Company for supplying the town with electric current, it was proposed at the last meeting of the Council that the matter should drop awaiting further developments. This was agreed to. A similar course has been adopted at Brechin.

Newport (Mon.).—A long discussion took place at the meeting of the County Council of this town last week on the subject of electric lighting. A sub-committee recommended the appointment of a works manager at £180 per annum and an assistant manager at £130, making with mechanics and other employés a total of £950 per annum for salaries. Alderman Moses, the Chairman of the Electric Lighting Sub-Committee, in reply to objections taken to the proposals, pointed out that many of the members appeared to have a desire to see the installation of the electric light prove a failure, but up to the present no such failure had taken place, and everything had proved highly successful. Applications equal to 2,000 8 c.p. lamps had been received, exclusive of the lighting of the public buildings. As to the final completion of their works, this would probably take place in about two months.

Provisional Orders.—Applications made to the Board of Trade by the local authorities of Swindon New Town, Leigh, Radcliffe, Pontypool, and Walthamstow for Electric Lighting Provisional Orders have been granted, and now only await confirmation by Parliament.

The River Plate.—Mr. A. Roca has, it is stated, petitioned the Government for permission to transfer to the River Plate Telegraph Company a concession which he holds for a cable between Buenos Ayres and Monte Video.

St. Helens.—It has now been decided that the conversion of the Warrington-road Baths into an electric supply station building shall not be proceeded with, but that Rimmer-street shall be closed, and the cottages razed to enable a supply station to be erected upon the site.

St. Pancras (London, N.W.).—At the meeting of the Vestry on Wednesday, the Electricity and Public Lighting Committee presented their statement of accounts for the year ended December 31st. The generation expenses in 1893 amounted to £6,103. 4s. 1d., and in 1894 to only £73. 5s. 10d. in excess of this amount, while the increase in the current sold to private consumers reached £2,510. 12s. After paying for repairs and maintenance there was a sum of £7,233. 1s. 4d. available for payment of interest, repayment of loans, &c. The net profit on the year's working amounted to £1,753. 18s. 2d., which, with the amounts paid for interest and repayment of loans, was equivalent to a dividend of over 6 per cent. on the capital expenditure. The sums paid off loans in 1894 were equal to about 2 per cent. on capital, or to the total sum set aside for depreciation by three London companies who were working on similar systems to that of St. Pancras, while, if compared with the total capital expenditure of the whole of the London companies, the amount set aside by them for depreciation was under 1 per cent. The charge for public lighting during the year, although more lamps had been erected, was reduced by £515. 16s. 11d. in one quarter, owing to the charge for current being reduced from 6d. to 5d. per unit. The current sold to private consumers at 3d. per unit realised £1,236. 13s. 9d., and at 6d. £10,819. 15s. 9d. It is estimated that, owing to the success of the undertaking, it could now be sold at a profit to the ratepayers of £30,000. The Chairman of the Electricity Committee (Mr. A. Sweet) moved the adoption of the report, which was unanimously agreed to, and the Committee were complimented upon the result of their arduous labours.

Wakefield.—At their meeting last week, the City Council received the recommendations of the Electric Lighting Committee to the effect that tenders for electric lighting works should be obtained, and that application be made to the Local Government Board for permission to borrow £25,000 to defray the cost of the works. The matter is to be discussed at the next meeting.

Weston-Super-Mare.—The District Council has received a further letter from Mr. F. H. Medhurst, in which he proposes that the Provisional Order obtained by the Council should be transferred to a Company, which he undertakes to form. The Company, when formed, is to give an undertaking not to charge more than 6d. per unit for current for private lighting, the Council supplying the Company with the town's refuse free of charge. The Council, however, decided to retain the Provisional Order in its own hands, and as soon as a suitable opportunity offers to put the Order in force.

Willesden (London, N.W.).—The District Council have considered the offer of the Hampstead Vestry to light the High-road, Kilburn, by electricity, the cost being shared by the two bodies. It was decided that the offer be declined. The subject will not, however, be allowed to drop.

COMPANIES' MEETINGS AND REPORTS.

◆

Oxford Electric Company (Limited).

The ordinary general meeting of the shareholders of this Company was held recently at the offices, 45, Broad-street, Oxford, Sir Henry C. Mance, C.I.E., in the chair.

The CHAIRMAN, in his opening remarks, said: You will observe that our capital account has been increased by £5,408. The greater part of this money has been devoted to mains required to extend our system to Beaumont-street, Magdalen schools, the north of Oxford, and other places. Our lamp posts have been fitted with an automatic arrangement to extinguish the lamps at the required hour, a contrivance, designed by our engineer, which has resulted in a saving to the company, as it is now no longer necessary to employ a man to go round at midnight and before dawn to turn off the current from the arc lights. With regard to the amount paid for accumulators, we deemed it advisable to provide increased capacity for storage so as to avoid as far as possible the necessity for running the engines in the early morning. This increased storage is the more necessary, as in consequence of some of our customers using motors we are more likely to be called upon for current during the day. The share capital remains as before. The small balance of debentures which remained unissued at the end of 1893 have since been applied for and issued with the exception of one debenture for £50. The loan capital item has necessarily increased, as we have had to provide funds to meet the capital outlay to which I have just referred. At present this is the most economical method of obtaining the money required for college wiring or extension to the system, and the balance of £1,600, which will shortly be required, has already been arranged for. Although the large stock of cable required for the extension (costing nearly £4,000) was delivered during 1894, payment for the greater part was not due until the present year, and this accounts for the heavier item of "bills payable." The quantity of current generated during 1894 was 231,674 units, being an increase of nearly 60,000 units over the previous year. Bearing this in mind, the revenue account will, I think, be considered very satisfactory. The number of units consumed in lamps and motors was 157,257. The commercial efficiency of the system works out, therefore, at about 68 per cent., and the total cost of the current delivered per unit (which, of course, does not include interest on capital) slightly under 4d. The machinery and plant have been maintained in efficient order, £381 having been expended on maintenance. Our receipts from all sources were £4,427. 15s. 1d. The balance of gross profit carried to net revenue account is £1,701. 17s. 2d. After providing for the debenture interest and and other interest there remains £456. 2s. 10d., which, added to the amount brought forward, leaves an available balance of £524. 11s. 3d. With this sum the Directors propose to pay a dividend of 1 per cent., free of income tax, on the Ordinary shares, and carry forward £195. 4s. 8d. It is gratifying that we have joined the ranks of the dividend-paying companies, and that the anticipations which were expressed by me last year in this room have been more than fulfilled. I anticipated that we should reach 10,000 lamps by January 1st, but I am glad to say that on that date we had an equivalent of 11,206 lamps connected with the system, being an increase of nearly 4,200 8-c.p. lamps during the year. We have made no provision for depreciation, but have maintained our plant in a thoroughly efficient condition, and also entered into a contract for the maintenance of our batteries at a fixed percentage with the Electrical Power Storage Company. The principal additions to our customers last year were Oriel College, Wadham, the University Galleries, Magdalen Schools, and Worcester College, and Trinity College greatly increased its installation. The latter fact is, I think, very satisfactory, as it shows that the authorities of the college find the light answers. There are still about a dozen colleges in which the light has not yet been introduced, so we have plenty of fresh ground to work upon. If our anticipations are fulfilled and we go on adding lights as we have been, the capacity of our plant, towards the autumn, will be taxed to its utmost, and it will hardly be prudent for us to rely altogether on what we have at present. Our engineer strongly recommends that we should supplement it with another engine, and also a generator sufficient to supply another 3,000 lamps. I hope next year to be able to announce a larger dividend.

Mr. SELBY-BIGGE: With regard to the business of the past year, there have been practically no complaints whatever. Suggestions have come that the price of the current should be reduced, but those suggestions were based solely on the argument that current was being supplied cheaper in other places. But in Oxford they were unable, from various causes, to supply current at a rate at present. Coal was dear, and the vacations at the colleges were frequent.

After a few remarks from Mr. G. OFFOR, who congratulated the Company's engineer, to whom the great economics referred to by the Chairman were chiefly due, the report and accounts were approved.

Sir Henry Mance and Mr. J. W. Barclay were re-elected as Directors, and a vote of thanks to the Chairman terminated the proceedings.

The Directors' report states that the gross profit for the year is £1,701. 17s. 2d., which, after providing 5 per cent. for debentures and for interest, leaves, with £63. 5s. 5d. brought forward, £524. 11s. 3d., from which the Directors recommend a dividend of 1 per cent., free of income-tax, carrying forward £195. 4s. 8d. to next account. The plant has been running during the whole of the year entirely satisfactorily, and no interruption in the supply of current has taken place from the time the Company first commenced operations. At the date of the closing of the account (December 31st last) 11,208 8-c.p. lamps were connected. Thirteen colleges at Oxford are on the Company's books. Considerable extensions have been made during the past year, involving considerable capital expenditure, for which provision has been made. The total quantity of units of electrical current generated during the year was 231,974, of which the quantity lost in distribution, transformation, &c., was 74,717 units, private consumers taking 136,473 units, and public lighting 20,784.

Indo-European Telegraph Company (Limited).

The following is the report of the Directors of this Company for the year 1894:—

The revenue from all sources amounted to £119,117. 18s. 3d., compared with £122,860. 10s. 4d. for 1893, or a decrease of £3,742. 12s. 1d. The expenses show a decrease of £121. 4s. 2d.—£64,838. 13s. 4d., against £64,959. 17s. 6d. Deducting the expenses, taking credit for £6,452. 3s. 8d. brought forward, and debiting income-tax, there remains the sum of £58,289. 2s., from which sum £10,000 has been placed to reserve, and that sum, together with £10,625, amount of interim dividend, when deducted, leaves a balance of £37,664. 2s., from which it is proposed that a dividend for the six months ended December 31st, of 17s. 6d. per share, should be paid, making, with the dividend already paid, 6 per cent. and a bonus of 20s. per share, both free of income-tax, or 10 per cent. for the year, carrying forward £5,789. 2s.

It has been determined by the Governments and companies interested, under slight modifications of the guarantee arrangements (owing to which the existing low tariff with Australasia was originally established) to continue its application for a further period of five years.

Major-Gen. G. B. Tremenheere, R.E., and Mr. J. H. Tritton seek re-election as Directors.

Metropolitan Electric Supply Company (Limited).

The following report of the Directors of this Company for the year ended December 31st last will be submitted at the eighth ordinary meeting, to be held at Winchester House, London, E.C., on Wednesday next, at 12 o'clock:—

The capital expenditure, which at the end of 1893 amounted to £585,932. 8s. 9d., now shows a total of £628,931. 7s. 1d., being an increase during the year of £42,998. 18s. 4d. This increase is mainly accounted for by the growth of the Company's business, necessitating an increase of plant as well as the continual extension of mains, and the additional provision of transformers, meters and other appliances.

Litigation has taken place in connection with the works at South-street, Manchester-square, arising from complaints that vibration was caused to the neighbouring houses. The measures which the Directors have taken to remove all cause for such complaints have now been successfully carried out. Considerable difficulty was experienced in maintaining the public supply while the alterations were in progress, and a material increase in working expenditure throughout the Company's entire system was thereby incurred.

The gross revenue for the year amounted to £85,345. 18s. 7d., against £69,195. 4s. 4d. in 1893, being an increase of £16,150. 14s. 3d., as compared with an increase of £14,623. 5s. 4d. in 1893. It will be seen that the growth of the income has steadily kept pace with that of the lamp connection, notwithstanding that the Directors have found it necessary to introduce a sliding scale of charges in favour of large consumers of current. The balance to the credit of the revenue account, before providing for depreciation, is £29,998. 2s. 4d. The Directors have set aside £8,000 as an addition to the depreciation fund, carrying to the credit of net revenue £21,998. 2s. 4d., which, with the balance brought forward from last account and other receipts, makes a total of £23,761. 12s. 4d. After deducting debenture interest and other charges, there remains a balance of £16,909. 2s., of which the Directors have appropriated a further sum of £1,000 in reduction of the preliminary expenses account, which is now diminished to £2,052. 10s. 4d. The Directors recommend that a dividend of 6s. per share on the Ordinary share capital be now paid, which will absorb a sum of £14,970, and leave a balance of £939. 2s. to be carried forward.

In view of the increased capital expenditure consequent on the extension of the Company's business, and to take advantage of the favourable condition of the money market, the Directors decided to replace the Five per Cent. Debenture Bonds by the creation of £250,000 Four and a-Half per Cent. First Mortgage Debenture Stock, of which a portion, amounting to £150,000, was issued in July. With the funds thus obtained, the whole of the £100,000 Five per Cent. Bonds have been redeemed, and a further sum of £50,000 provided for current capital expenditure. The net premium derived from the issue has been carried to the credit of the depreciation fund.

The number of 8-c.p. lamps supplied by the Company increased during the year 1893 from 166,000 to 209,000. The present number of lamps connected is 224,000, and the applications show no signs of decrease.

Admiral Sir George H. Richards, Sir Eyre Massey Shaw, and Mr. J. B. Verity offer themselves for re-election as Directors; and Messrs. Deloitte, Dever, Griffiths and Co. seek re-election as auditors.

A report of the Company's Chief Engineer (Mr. Frank Bailey), dated April 4, 1895, follows the Directors' report, and is to the effect that "the Company's stations, machinery and plant are being maintained in an efficient condition, and have worked satisfactorily up to the present date."

The accounts show that 49,900 Ordinary shares and 100 Founders' shares of £10 each have been issued and paid up, that the 100,000 Five per Cent. Debentures have been paid off, and an issue of £150,000 First Mortgage Debenture Stock, at 4½ per cent., has been made, leaving the Company with £350,000 borrowing powers still unissued. The revenue for the year by sale of current is £79,067. 9s. 2d., by meter rents and other apparatus, £5,922. 7s. 7d., and sundry items, £356. 1s. 10d.

County of London and Brush Provincial Electric Lighting Company (Limited).

The first annual general meeting of this Company will be held at Cannon-street Hotel, London, E.C., on Monday next, at 2 p.m., when the following Directors' report and the statement of account to December 31st last will be presented :—

The report states that since the balance-sheet was made up the first issue of 10,000 Preference shares of £10 each has taken place, and the amount offered was very largely over-subscribed. An application for the quotation of both the Ordinary and Preference shares in the Stock Exchange Official List has been made. The accounts show a considerable capital expenditure within this the first year of the Company's operations upon works now in progress. On the profit and loss account for the year, after payment of the usual general charges and writing off preliminary expenses on account of the Canterbury Electricity Supply Company's undertaking (which amounted to £308. 12s. 2d.), a credit balance of £332. 5s. 10d. remains.

The laying of pipes for mains and construction of drawing-in boxes within the St. Luke's and Clerkenwell districts is approaching completion. The cables are being delivered and laid, and it is hoped that by the end of September next both these districts will be supplied with current from the station now being built at the City-road basin of the Regent's Canal. Street works in the Wandsworth district have been unavoidably delayed, but upon settlement of the regulations by the Board of Trade main laying can be forthwith commenced. The plans of the generating station buildings are nearly completed. An application for a Provisional Order for the district of St. Olave, Southwark, has been made to the Board of Trade, the consent of the Local Authority having been obtained. This district adjoins that of St. George the Martyr, Southwark (for which the Company now holds a Provisional Order), and both areas can be supplied from one generating station.

The Bournemouth station, in which the Company holds a controlling interest, has made material progress. The number of consumers has increased, showing an equivalent of 19,000 8-c.p. lamps, or 4,500 in excess of the number supplied at the end of 1893. To meet the increasing demand, a further capital expenditure for extension of station buildings and additional plant and mains has been necessary. Upon the completion of the work in progress the Bournemouth station will have a capacity of 27,000 8-c.p. lamps connected, with a total capital expenditure not exceeding £75,000. The Company is also the principal shareholder in the Dover Electricity Supply Company, whose station is now completed and part of the plant erected. Current is now being supplied, and the remainder of the machinery under the original contract will shortly be delivered. Contracts for public and private lighting are already entered into for the equipment of 2,200 8-c.p. lamps and other contracts are in course of negotiation. An Order has been applied for in the name of the Windermere and District Company for the supply of current in the towns of Ulverston, Grange, Cartmel, Bowness, Windermere, Rydal, and Grassmere, and in all these cases the consents of the local authorities to the Company's application have been obtained. A controlling interest in the Company holding the Provisional Order for Richmond (Surrey), with a central station well equipped and in active work, has recently been acquired on reasonable terms.

The Directors seeking re-election are the Right Hon. D. R. Plunket and Mr. F. W. Reynolds, and the auditor, Mr. R. H. Marsh, also seeks re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

ALTERNATE-CURRENT ELECTROMOTOR SYNDICATE (LIMITED).—This Company was registered on April 11th, with a capital of £6,000, in £1 shares, to acquire the provisional patent rights obtained by Mr. W. Langdon-Davies for alternate-current motors entitled "Improvements in electromotors and like electromagnetic apparatus," to carry into effect an agreement between the said patentee and Mr. G. W. de Tunzelmann (acting as the representative of the Company), and to carry on the business of commercially developing and obtaining contracts for the supply and sale of alternate-current motors, and also that of engineers, light and power contractors, electricians, electrical manufacturers, and makers of dynamos, motors, apparatus and fittings. The subscribers, with one share each, are G. W. Tunzelmann, Capt. R. L. Cowper-Coles, Charles E. Cree, Godfrey M. Hoyland, E. A. Hoyland, W. Langdon-Davies, and Arthur W. Cree. The first Directors are Godfrey M. Hoyland (Chairman), Charles E. Cree, and G. W. de Tunzelmann.

TOURTEL GAS AND GENERAL ENGINEERING COMPANY (LIMITED).—This Company was registered on April 11th with a capital of £3.000, in £1 shares, to carry on the business of engineers, machinists, and manufacturers of mechanical, electrical, and other appliances.

CITY OF BATH ELECTRIC LIGHTING AND ENGINEERING COMPANY (LIMITED).—The annual return of this Company, made up to February 27th, has been filed. The nominal capital is £60,000, divided into 5,500 Ordinary shares of £10 each, and 50 Founders' shares of £100 each ; 3,384 Ordinary, and all the Founders' shares, have been taken up. Of these 2,250 Ordinary and the Founders' shares have been issued as fully paid, while the full amount has been called and paid on the remainder.

EDISON-BELL PHONOGRAPH CORPORATION (LIMITED).—The annual return of this Company, made up to March 29th, is filed. The whole nominal capital of £60,000, in £5 shares, has been taken up, and 4,000 have been issued as fully paid. The full amount has been called on the remaining 8,000 shares.

ELECTRICAL ACCESSORIES COMPANY (LIMITED).—The annual return of this Company, made up to February 14th, has been filed. Out of a nominal capital of £5,000, in £1 shares, 2,257 have been taken up, and of these 1,500 have been issued as fully paid. The full amount has been called and paid on the remaining 757 shares.

ELECTRICAL INSTALLATION COMPANY (LIMITED).—The annual return of this Company for 1894, made up to February 14th of that year, was filed on March 26th last, when the whole of the nominal capital of £2,800, in shares of £1 each, was taken up, and paid for in full. Since the compiling of that return, the capital has been raised to £3,300, in £1 shares, and on March 21st, when the return for 1895 was made up, the whole of the additional shares had been subscribed for, and in all £3,300 paid.

ELECTRIC BATTERY COMPANY (LIMITED).—An agreement has been entered into with Harry T. Barnett, electrical engineer, for the sale to the Company of the following patents :—17,099 (1892), for carbon electrodes ; 23 460 (1892), for electromotors ; 757 (1893) for platinised electrodes ; 758, for carbon electrodes ; 2,557 (1893), for electrically-driven screw propellers ; 20,625 (1893), for electrode connections ; 4,113 (1894), for dry electric batteries (provisional) ; and 23,590 (1894), for gas batteries, and of all launches now afloat, movable buildings, fixtures, plant, &c., in and about the works at Petersham, Richmond, and 53, Victoria-street, Westminster, for £15,500, £7,000 in cash, and the allotment as fully paid of 1,700 shares of £5 each. The vendor agrees to accept £2,000 in cash, and the rest in fully-paid shares, should only £10,000 be taken up. He also agrees to remain with the Company as General Manager for three years with a salary of £350 per annum, while Stephen B. Saunders is to be Managing Director with a salary £400 per annum for at least three years.

CITY NOTES.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended April 14th were £779, against £840 in the corresponding week of 1894, being a decrease of £61. The total receipts for the half-year amount to £14,362, against £13,727 for the corresponding period of 1894, an increase of £635.

GREAT NORTHERN AND CITY RAILWAY.—This Company have lodged a Bill in Parliament asking authority to insert an amending clause to Section 8 of the Great Northern and City Railway Act (1892), by which authority will be given to work the railway by steam locomotives in addition to or in substitution for electricity or other motive power referred to in that section of the original Bill.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 14th inst. amounted to £1,243. The amount for the corresponding week last year was £655.

MIX AND GENEST (BERLIN).—The management of this Company propose a dividend of 11 per cent. for the year 1894, against 8 per cent. in 1893. The gross profit is 281,224 marks (£14,060), compared with 219,497 marks in 1893.

ORIENTAL TELEPHONE AND ELECTRIC COMPANY (LIMITED).—The share transfer books of this Company will be closed from the 20th to the 29th inst. inclusive.

PHOSPHOR BRONZE COMPANY (LIMITED).—The report of the Directors to December 31st last states that the condition of trade generally, and particularly so far as the Company is concerned, has in 1894 been even worse than in 1893, the turnover being considerably less. During the whole of the year the Company continued to suffer severely from the effects of the gross mismanagement at their Birmingham works during the previous three years. An action brought against the Company by the late Mills Manager at Birmingham was, owing to the absconding of the plaintiff to avoid criminal proceedings about to be commenced against him, abortive, the Company being saddled with a heavy expenditure in connection therewith. The Directors state that it is only just to Mr. Lagerwall, the Managing Director, to say that not the slightest blame attaches to him for the mismanagement at Birmingham, and that it was upon his initiative that the investigations took place, although his suspicions were discredited at the time by the local committee representing the Board at Birmingham. The Directors are giving careful consideration to the important subject of reorganising the Mills plant. The Company's trade in concentrated phosphorised alloys has largely increased, and its business in Bull's metal is developing satisfactorily. The number of orders received during the past year has been larger than in any previous year, but have been smaller and less profitable. A scheme for dealing with the capital of the Company was submitted to the shareholders at an extraordinary general meeting. At the general meeting of shareholders, held on March 29th, the Directors' report was adopted, and Mr. Henry Seebohm and Mr. Lazare Weiller were unanimously re-elected Directors. At the extraordinary general meeting two resolutions regarding a modification of the capital of the Company were carried, and will shortly be submitted for confirmation.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY (LIMITED). The sale of electric current for the quarter ended March 25th (representing the supply at 6d. per unit) amounted to £13,907, against £10,375 (at the same rate) for the corresponding period of 1894.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended April 12th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,684.

WILLANS AND ROBINSON (LIMITED).—There was an error in our report of the meeting of the shareholders of this Company last week. The meeting was held on Wednesday, April 10th, and not on Thursday.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, Apr. 9.		Price Wednesday, Apr. 17.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Apr. 17.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	10 0	Anglo-American xd	41	43	41	43	4 13 0	Jan., Apr., July, Oct.	–	..
£2,993,560	Stock	20 0	Do. Preferred xd	78½	79½	78½	79½	5 0 8	" "	..	–
£2,993,560	Stock	5/0	Do. Deferred	6½	7	6¾	7½	..	..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 17 8	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	12	12½	12¼	12¾	5 2 0	Mar., June, Oct., Dec.	12 3/16	12¼
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	109	113	110	114	4 8 11	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	148	152	148	152	4 12 1	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	13¾	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid) xd	4	4½	4	4½	4 8 11	April and October	..	–
6,000	5	10%	Do. Preference 10 per Cent. xd	9½	10	9½	10	5 0 0	" "	..	–
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	..
60,710	20	2/0	Direct United States Cable, 1877 xd	8½	9	8¾	9¼	4 17 0	Jan., Apr., July, Oct.	8¾	8 13/16
400,000	10	2/6	Eastern xd	16¼	16½	16½	16⅝	3 19 6	" "	16½	16⅜
70,000	10	6%	Do. 6 per Cent. Preference xd	17½	17¾	17¼	17¾	3 7 7	" "	17 3/16	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	124	127	123	126	3 4 5	May and November	125½	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	108	105	108	4 13 0	February & August	..	..
250,000	10	2/6	Eastern Extension	17⅛	17⅜	17⅛	17⅜	4 0 8	Jan., Apr., July, Oct.	17½	17⅛
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	123	126	123	126	3 3 6	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	107	103	107	4 14 7	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	103	107	4 14 7	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106	109	106	109	3 13 11	February & August	..	–
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 10	May and November	..	–
180,227	10	2 3	Globe Telegraph and Trust xd	9¾	10¼	9¾	10	4 10 0	Jan., Apr., July, Oct.	10	..
180,042	10	6%	Do. 6 per Cent. Preference xd	16⅝	16¾	16⅝	16¾	3 11 3	" "	16⅝	..
150,000	10	5/0	Great Northern	21¾	22¼	22	22¼	3 15 7	Jan., April, and July	22¼	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	105	108	4 12 10	March & September	107	106
17,000	25	12/6	Indo-European	52	54	52	54	4 12 7	May and November	52¾	52
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	" "	..	–
£100,000	100	6%	* Do. 6 per Cent. Debentures	105	109	105	109	5 10 7	March & September	..	–
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	105	108	3 14 9	..	..	–
11,839	8	4/0	Reuter's	4	5	4	5	..	April and October	..	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	121	126	120	125	4 16 0	" "	120	..
15,609	10	5/0	West African Telegraph	4	5	4	5	..	January and July	..	–
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	101	104	4 16 7	March & September	101½	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	–
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	98	103	7 15 4	June and December	100	..
88,321	10	6d.	West India and Panama	⅞	1¼	1	1¼	..	..	1⅛	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	11	11½	5 4 4	May and November	11½	11¼
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	108	111	109	112	4 10 8	June and December	..	..
64,242	15	3/0	Western and Brazilian	10	10½	9¾	10¼	4 9 5	May and November	10⅛	10
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	–	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	3¾	4¼	3¾	4¼	..	..	4⅛	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 15 5	February & August	..	–
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 15 5	" "	..	–
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115	120	115	120	5 19 8	May and November	..	–
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	101	103	101	103	5 17 4	March & September	..	–
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	–	..	3 9/16	..
224,850	10/0	2⅜d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	–	May and November	..	–
171,504	£1	..	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	–	..
484,597	5	2/6	National	5¼	5½	5¼	5½	4 10 11	June and December	5⅜	5¼
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15½	16½	15½	16½	3 12 9	" "	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	15½	15	16	3 15 0	" "	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅝	5⅞	5½	6	4 3 4	–	5 13/16	5½
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	104	106	3 6 0	January and July	105½	104½
58,000	5	1/0	United River Plate	1	2	1	2	..	" "	..	–
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	85	90	85	90	5 9 11	" "	..	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	13	14	13	14	1 15 8	–	13 7/16	..
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	14½	15½	15	15½	3 17 5	..	15 5/16	15¼
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5	5½	5	5½	3 17 9	–	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	..	–
8,322	£5	..	House-to-House Electric	..		..		–	–	..	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		–	–	..	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		–	January and July	–	–
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7⅜	7⅝	7½	7¾	–	–	..	–
111,000	5	..	London Electric Supply	..		..		..	–	..	–
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	10¼	10¾	9¾	10¼	2 8 9	..	10 3/16	10
£150,000	Stock	4½%	* Do. 4½% Debs.	118	120	118	120	3 15 11	June and December	..	–
6,452	£10	2/0	Notting Hill Electric	7¼	7¾	7¼	7¾	..	..	..	..
19,980	£5	4/6	St. James and Pall Mall	7½	8	7½	8	..	–	..	–
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8½	9	3 17 9	–	..	..
59,000	5	5%	Westminster Electric Supply (fully paid)	7⅜	7⅞	7⅜	7⅞	3 3 6	–	..	–
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2¼	2⅜	2¼	2⅜	6 6 7	–	2 5/16	2¼
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2⅜	2¼	2⅜	4 11 5	..	2 5/16	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	113	116	113	116	3 18 1	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2½	3	2½	3	–	January and July	..	..
12,139	5	–	Edison and Swan United	1⅛	1⅜	1⅛	1⅜	–	..	–	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	–		–		..	..	–	..
120,000	2	..	Electric Construction	¼	½	¼	½	–	..	..	..
12,845	2	2 9¾	Do. 7 per Cent. Cumulative Pref.	1¼	1¾	1¼	1¾	..	..	..	–
91,195	2	10/0	Elmore's Patent Copper Depositing	1¼	1½	1¼	1½	–	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	..	..	..
60,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	February & August	22¼	21
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1890	101	103	101	103	4 7 5	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	–	..	..
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	–	⅛	–	⅛	..	..	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	39	41	39	41	8 15 7	March and July	40	..
£150,000	100	6%	Do. 5 per Cent. Bonds	104	107	105	108	4 12 7	January and July	107	..
37,511	£5	–	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,870	10	12/0	W. T. Henley's Telegraph Works Ordinary	9½	10½	9½	10½	5 11 3	..	..	..
£30,000	10	..	Do. Preference	..		..		..	..	..	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1½%	City and South London Railway	45	47	45	47	2 13 2	May and November	–	..
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	..	–
£67,130	Stock	4%	Do. 4% Perpetual Debenture	130	133	130	133	3 0 2	May and November	..	..
37,500	£10	2%	Liverpool Overhead Railway	8½	8¾	8 11/16	8 13/16	2 6 4	..	..	..
6,295	10	5%	Do. 5% Preference	14	14½	14	14½	3 11 5	..	..	..
125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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NOTES.

There are so many good things in Prof. Ewing's new magnetic tester that one scarcely knows which to refer to first. The need for a quick and expeditious method of measuring the commercial values of hysteresis in dynamo and transformer iron has led Prof. Ewing to devise an instrument whereby these values may be directly read on a scale; nothing else being necessary than to fit a sample into its place and turn a handle. Knowing that work was the real thing to be measured, he has made his instrument in the form of an absorption dynamometer, taking the torsional reaction between the revolving sample and the inducing field-magnet as a convenient quantity wherewith to gauge the work done in spinning the sample round. The method has the advantage of giving an average value for several samples of iron, in a single reading; for the sample to be tested may be built up of a number of strips cut from various parts of a batch of plates.

One possible source of error there is, the elimination of which Prof. Ewing has not made quite clear in his Paper. We refer to the windage or fanning which the revolving sample may exert on the delicately suspended magnet. This would be liable to affect the reading on the scale, and would not, of course, be eliminated by spinning the sample in the reverse direction. It is interesting to notice in our Paris Notes this week that M. Marcel Deprez has recently exhibited a hysteresis-meter "based on the torque brought about by the attraction of sheet-iron discs by turning electro-magnets rapidly." The principle of this is similar to that of Prof. Ewing's instrument; but the use of discs instead of strips might eliminate the windage of the samples. We can only echo the author's hope that his instrument "may contribute indirectly to the betterment of the iron used for magnetic purposes, by making it easy for a purchaser of iron or a purchaser of transformers to specify a maximum of hysteresis and to see that he gets what he specifies"—or, rather, less than he specifies, and the less the better.

The initial lecture of the series which Prof. Forbes is delivering at the Royal Institution, on the subject of "Alternating and Interrupted Electric Currents," dealt more particularly with mechanical analogues of the electric circuit, and especially the analogues of resistance and capacity. It was only reasonable, therefore, though it may have been a little confusing to some of his hearers, that the lecturer should cover ground ranging from Teslaically-lit glow lamps to "curbing" submarine cable signals. The mechanical analogues employed by Prof. Forbes were designed to show the energy-absorbing effect of resistance and the retardation due to capacity; and he did not despise the well-worn hydraulic analogy. What would the mathematicians have said had they seen one of Prof. Forbes' models, in which he places the resistance in the environment and the elastic capacity—represented by a spiral spring—actually inside the circuit? However, the model worked perfectly, and admirably conveyed a popular explanation of electrical phenomena in submarine cable work. Another analogue used in the lecture is worth mentioning. It is well known that the signalling current which is sent into a submarine cable should be swept out, so to speak, by a reverse current promptly following it. Prof. Forbes likens this reverse curbing current to the pull back when a whip is flicked, the sharp jerk back causing, as many a quadruped knows to its cost, a better defined and more vigorous effect than if the whip is merely thrown forward.

Perhaps the most praiseworthy feature about the very timely and instructive discourse on electric cooking, of which Mr. Crompton delivered himself at the Society of Arts on Wednesday evening last, was the absence of "gas." Not only were no extravagant claims put forward, but the few insignificant difficulties still met with in the manufacture and management of apparatus were frankly confessed to on the healthy principle that it is better so to do than to give this advantage to the Philistines. As Mr. Crompton pointed out in his reply to the desultory comments of the audience, the success which has crowned the persevering efforts of the pioneers of electric cooking has been in a very large measure due to the splendid accuracy with which they have been able to measure the temperature actually obtained, and the quantity of heat actually required in various culinary operations. Until exact data had been obtained on these points, not even the best-informed person could credit the tremendous wastefulness of existing methods, and therefore could not have any faith in the future possibilities of electric heating, which, being supplied at the start with a mere 6 per cent. of the total heat energy of the coal, could scarcely *a priori* have been expected, even with a 90 per cent. efficiency, to compete with coal fires, until it was ascertained that the efficiency of these rarely exceeded 2 per cent. Thus once more have precise measurements borne good fruit.

The view taken by the St. Pancras Vestry Electric Lighting Committee in their annual report, published last week, that the amount repaid annually off municipal loans is in reality equivalent to setting aside a sum for depreciation, is a correct one, so far as it goes. The question, however, that would have to be considered by anyone managing a public company on a sound commercial basis would be this: Are the loans being repaid at the same rate as the plant is wearing out or becoming antiquated or obsolete? Judging from what we know of such matters, we should say in this case they are not. The phrase, "two per cent. on the capital expenditure," does not easily enable anyone to determine whether the amount is sufficient or insufficient for the depreciation. After allowing for the fact that some of the items included under capital expenditure, such as land, may not depreciate at all, and that substantial buildings, especially if they are freehold and kept in proper repair, would also want very little set aside for depreciation, and might possibly form a substantial asset at the end of any given period, we still have to consider the life of boilers and machinery, accumulators, transformers, and other plant and apparatus. The percentage ratio, therefore, between depreciation and total capital expenditure is very little guide; but we certainly cannot consider an average of 2 per cent. over the whole a sufficient sum to set aside each year.

It would be advantageous to class the various items of capital expenditure according to their estimated life, and it would then be possible to see whether a sufficient amount had really been set aside for depreciation in the case of those that do deteriorate. It is scarcely up to the usual standard of a "progressive" municipality to do the same in this matter of depreciation as "three London companies who are working on systems similar to that in St. Pancras." It must be remembered that most of the companies have started on a comparatively new industry with money provided by a body of shareholders who up to the present time must have looked upon their investment as a more or less speculative one. Shareholders expect a portion of the surplus revenue to be distributed to them by way of dividend, and those who manage public concerns must recognise this in the earlier years at the expense of the Depreciation Fund, hoping that as the business develops and the revenue increases they will be able to put aside out of future profits such substantial sums as will place the Depreciation Fund on a sound footing. This may be the principle which managers of public companies starting comparatively new enterprises must recognise, but it is not such as should actuate a municipal electric lighting committee. Unless, therefore, the Electric Lighting Committee of the St. Pancras Vestry can see their way to replace certain portions of their plant from time to time out of revenue as they become worn out or antiquated during the next 12 years, they will find that the repayment of the existing £110,000 loan spread over a like period will not be equivalent to what should be set aside for depreciation each year by a soundly managed commercial undertaking. The Committee will probably find it necessary to increase the rate charged for the current, or preferably to effect further economies if they wish to provide an ample Depreciation Fund. This should be done at once, so that the consumers who are now enjoying the benefit of a cheap electric supply may be made to contribute a fair amount, otherwise the burden will fall unduly heavily upon the consumers in the future.

The London County Council, it will be remembered, some few months back decided, after consultation with the Treasury, to only grant loans repayable in 50 years when the money was to be spent on land, buildings, culverts, and copper mains; in all other cases the money was to be refunded in 20 years. If we were to apply this very reasonable arrangement to the existing capital expenditure of the St. Pancras Vestry, the sum which would have to be set aside this year for repayment of loan would completely wipe out the balance of £1,754 now carried forward and leave a small deficit. The more rapid repayment of loans would, of course, have the advantage of reducing the amount of interest to be paid year by year, and would thus in its turn lighten the burden upon municipal electric light undertakings.

A brief Paper on the subject of the products of combustion of the arc has recently been presented by M. N. Gréhant to the Académie des Sciences, and is of sufficient intrinsic interest to merit a brief notice. The mode of investigation adopted was simple and unsatisfactory, its salient feature being the selection of physiological methods for the solution of a chemical problem. The plan in question consisted in enclosing an arc—"brilliant and steady," in the words of the author—in a box, and causing an experimental dog to breathe the air from the box, containing, of course, the products of combustion of the arc. Removal of blood from the carotid artery and analysis of the gases evolved therefrom, proved the presence of carbon monoxide in minute amount. Ordinary analytical methods showed that carbon dioxide was also present, and that its quantity was much greater than that of the carbon monoxide. The author has, therefore, satisfactorily demonstrated that carbon heated to a high temperature in free contact with air gives as its main product of combustion carbon dioxide, and as a minor product a small quantity of carbon monoxide, results equally startling and novel. No attempt has been made to ascertain the quantity of both gases per candle-power-hour, and, indeed, the method of experiment involving the use of so clumsy a piece of apparatus as a dog forbade any such attempt.

The Paper, which is an admirable example of misapplied and futile ingenuity, would not need comment but for the possibility that it may be regarded by some as indicating a latent danger in arc lighting. It may safely be said that any method of illumination involving the combustion—as distinct from incandescence *in vacuo*—of carbon, is certain to produce not only carbon dioxide but also less oxidised products, *e.g.*, carbon monoxide, or stable hydrocarbons in the event of the carbonaceous matter in combustion containing hydrogen. There is no reason to suppose that the quantity of imperfectly oxidised products arising from the combustion of the carbons of an arc lamp is greater than that from other sources of illumination attended by, or dependent on, combustion. Moreover, the total amount of carbon burnt per unit of light is certainly smaller in the case of the arc light than in any other comparable method of illumination. The curious can compute the relation holding between various systems of lighting with little more trouble than is involved in searching for the requisite data in text-books and journals. But few would propose in the present year of grace to run an indefinite number of arc lights in an exiguous space destitute of ventilation, any more than they would suggest the collection of a crowd of human beings in an airtight box. Ordinary methods of ventilation, if sufficient for the purpose of carrying off the products of combustion of the human being, will suffice for the disposal of the products of combustion of the electric arc.

It has long been taught from professorial chairs, on the authority of the printed Rankine, that the resistance of vessels moving in water varies as the square of the speed, and the power absorbed as the cube. It has nearly as long been suspected by practical engineers that there is more sweet simplicity than truth in the statement. Builders of electric launches may be interested in the latest generalisations in regard to this matter. From the recent progressive speed trial curves of their torpedo boat destroyers "Hornet" and "Havock," made by Messrs. Yarrow and Co., a correspondent of the *Engineer* has deduced that the power of V, the velocity, which expresses the horse-power absorbed, varies from 8·1, where the speed is only 11 or 12 knots, down to 1·99, where the speed is 27 or 28 knots. The decline in the value of the exponent, as V increases in value, appears to be fairly regular; its rate of decrease tending gradually towards zero. Whether the lower limit of the exponent is arrived at, at a speed of 28 knots, is not shown by Messrs. Yarrow and Co.'s curves; but the value does not appear to differ sensibly from 1·99 between 26 and 28 knots. It would be interesting to know if the exponent falls very much below 1·99 at very high speeds. Of course, the value must always be greater than unity. Messrs. Yarrow and Co.'s curves should throw a fresh light upon the obscure phenomenon of the friction of liquids.

The people of Dover who happened on the night of last Sunday week to see the electric light on the Sea Front suddenly go out, and reappear a few minutes later, may be glad to know, on the authority of a local paper, that "the cessation was not due to any fault in the machinery, or any defect in the wires, but was simply the result of an experiment on the part of the manager of the company. He wished to show the public the difference between the new illuminant and gas, and took this method of demonstrating it." It seems that a similar innocent little experiment, not without a humour of its own, was perpetrated last Monday evening on a Primrose League "At Home" which was being held at the Town Hall.

Royal Society.—The following Paper was down for reading yesterday:—Dr. Hopkinson, F.R.S., and E. Wilson, "Alternate-Current Dynamo Electric Machines."

Obituary.—Dr. Lothar von Meyer, the eminent chemist, died at Tübingen on April 12th. His death was caused by a stroke of paralysis. He was 66 years of age.

Personal.—Mr. Marcus S. Chambers has been appointed by the Crown Agents for the Colonies resident engineer in connection with the Government electric lighting scheme at Malta, on the recommendation of Mr. W. H. Preece.

Frankfort.—A fourth steam alternator of 750 H.P. has been ordered of Messrs. Brown, Boveri and Co., and which will be erected in the course of a few months. This addition will bring the total output of this station up to 3,000 H.P.

Meter Competition.—The Société Industrielle de Rouen is offering a gold medal for an improved electricity meter, to be capable of accurately registering the current consumption from very low up to large quantities. All competitive designs should reach the President of the Society before September 2nd next.

Nominal Horse-Power.—In the proposed Steam Engines Bill this moribund phrase receives a new lease of life, for it is explained in the 4th clause of the Bill that where H.P. is mentioned it "means nominal, and shall not include indicated or other trade terms other than the words nominal horse-power."

Cable Interruptions and Repair:

	Date of Interruption.	Date of Repair.
Constantinople—Dardanelles	April 9, 1895.	April 17, 1895
Latakia—Cyprus	Nov. 27, 1894.	—
St. Louis—Noronha	Mar. 12, 1895.	—
St. Vincent—San Thiago	April 5, 1895.	—

Accumulator Lighting Extraordinary.—According to a French contemporary, there is a proposal on foot to light the various towns and villages near the Seine from Paris to Havre by means of accumulators charged from a huge floating central station, which is to parade up and down the river charging the batteries in turn.

Fire at the Crocker-Wheeler Factory.—The Crocker-Wheeler Electric Company Works, near Ampere Station, at East Orange, N.J., were partly destroyed by fire on Sunday, April 7th. Over £20,000 worth of motors and dynamos, which were stored in the main building, were ruined, together with about £10,000 worth of machinery. The total loss will amount to about £50,000. The Company is insured, and will rebuild at once.

The Institution of Civil Engineers.—The Institution of Civil Engineers has adjourned for the recess somewhat earlier than usual, in order that the builders may have full possession of the old premises with a view to entire reconstruction. The "James Forrest" lecture, by Prof. W. C. Unwin, F.R.S., will be delivered on May 2nd, and the annual general meeting on May 28th. These gatherings will be held by arrangement at the Royal United Service Institution.

A Long Span.—The *Frankfurter Zeitung* reports the following:—A telephone line was erected a little time ago between the villages of Quinten and Murg, and the line runs across the the Wallensee. The span across the lake is 2,400m. (1·49 miles). On one side the wire is fixed a point 360m. above the level of the lake, and on the other only 130m. The wire is 2mm. in diameter, and hangs at its lowest point within 40-50m. of the lake level. This span is claimed to be the longest in the world. Whether the wire will resist the storms and snow pressure remains to be seen. So far only spans of 1,100m. have been used in Switzerland.

Protected Cables.—We have received a communication from Messrs. Bourne and Grant, pointing out that in their opinion the "Kingdon" system of laying underground mains, described in our issue of the 19th inst., page 754, is covered by a patent acquired by the late Mr. Grant on February 2, 1895. The number of this patent is 2,730, and the claim is for "a protector for electric cables laid underground, substantially as described." The body of the specification describes a number of ∩-shaped covers for the cables, to obviate the damage liable to be caused by "workmen who may have to open the ground after the cables are laid."

Electric Conduit Explosions.—"Ill blows the wind that profits nobody." The recent scare with regard to explosions in electric conduits has set many an inventive mind to work to devise a suitable and sufficiently cheap material wherewith to fill the closed spaces which offer so many attractions to the waste produce of the gas companies. We were shown recently one of these patent messes, consisting of a mixture of paraffin and sand. This it is proposed to pour into the conduits when it has about the consistency of porridge, and allow it to solidify. Owing to the insulating properties of this material, it will enable the conduits for bare copper conductors to be made of considerably smaller cross-section than heretofore.

The American Bell Telephone Company.—The *Electrical World* gives a summary of the annual report of the American Bell Telephone Company for 1894, which shows a decrease in net earnings of some £160,000 as compared with the previous year, though the Company was able to pay £600,000 in dividends to its fortunate shareholders. The statistics given show the enormous extent to which the telephone talking has entered into daily life, the total number of calls, for instance, reaching 670,000,000 annually, or about 10 for every inhabitant of the United States. The number of calls for each subscriber averages 8½ daily, the cost per call being from 1d. to 5¼d., according to the character of the service. The report refers to the greater use by subscribers of their telephone service, which in the last six years has increased 40 per cent. The plan of charging telephone rentals according to the amount of service received is, we learn from the report, being generally adopted in the larger cities.

Expiring Patents.—To-day expires the Edison screw lamp socket, patent No. 1,802 of 1881, entitled "IMPROVEMENTS IN ELECTRIC LIGHTS, AND FITTINGS AND FIXTURES THEREFOR." The inventor was unable to explain himself with less than 22 drawings, and could not manage to keep down his claims to less than 28. The first of 28 claims reads as follows:—The combination with a lamp and a socket detachable from each other of controllable means for positively holding them together and means for automatically completing the necessary circuit connections through the lamp by the act of placing them together, substantially as set forth." On Sunday will expire Brush's well-known current governor patent, No. 1,835, of 1881, entitled, "IMPROVEMENTS IN CURRENT-GOVERNORS FOR DYNAMO-ELECTRIC MACHINES," and covering the historic carbon-regulator.

A Large Electric Locomotive.—In the March number of the *Transactions* of the American Institute of Electrical Engineers is a description by Dr. Cary T. Hutchinson of a large electric locomotive which has just been finished by the Baldwin Locomotive Works. This locomotive has eight drivers connected rigidly by side bars, making a wheel-base of 16ft., the length over all being about 30ft. The weight is 133,000lb., uniformly distributed on the eight drivers, giving 16,700lb. on each driver. There are four motors, one on each axle, the motors being built directly on the axle without springs of any kind between the armature and the axles. The machine has a capacity, on a four-hour test, of 1,000 H.P. at a speed of 35 miles per hour. The regulation is the series parallel. There is also a resistance intended for use on first position in starting. The lowest speed, without resistance, is about seven miles per hour. A test recently made at the Baldwin Locomotive Works showed an efficiency of more than 92 per cent. when operating 1,000 H.P. The motors are designed so that they will work without sparking with full current in the armature at one-half normal field strength. That is to say, they will operate at any speed from 35 miles per hour up to about 65 miles per hour at the same power, the drawbar pull varying inversely as the speed. At speeds below 35 miles per hour the drawbar pull is constant, the power, therefore, being directly proportional to the speed. The smoothness and absence of vibration was very noticeable in the test referred to. The entire machine was supported on four jacks, without bracings; when running with full torque, there was scarcely any shaking.

Electricity in St. Louis.—A report just issued by the secretary of the St. Louis Merchants' Exchange, gives some interesting particulars with regard to the use of electric light and power in St. Louis. The arc lighting is done by four companies, who operate about 4,500 lights of a nominal capacity of 2,000 candles each. The incandescent lighting is done by three companies, which now have approximately 175,000 lights of 16 c.p. connected. The electrical equipment of these several stations aggregates 20,000 H.P. The most important advancement to be expected in the immediate future is, we are informed, the placing of the major part of the wiring underground, which consummation it is expected will be reached within the next twelvemonth. St. Louis also ranks high in the distribution of electricity for power purposes. Three companies distribute an aggregate of about 4,000 H.P. throughout the city. Electricity has displaced steam in hundreds of small manufacturing establishments, and has recently come into extensive use for elevator work. In connection with street railways, nine companies operate some 275 miles of single track, running 500 motor cars and 600 trailers. There are eight power houses, with a total electrical equipment of about 23,000 H.P. These lines carried 65,000,000 passengers in 1894, a gain of about 8 per cent. over 1893. The electric railway companies employ about 4,000 men regularly. Considerable extensions will be made during the coming year. St. Louis has always been a centre of the carbon industry, and continues so at this day. The manufacture of incandescent lamps has also grown to be large and important. Recently the manufacture of alternating current motors, fans, and converters has been taken up, and is being actively pushed. St. Louis, we may add, has a population of about half a million.

Electric Pumping.—An interesting pumping plant for domestic and fire service has been installed at De Kalb, Ill. The water is pumped from a 10in. drilled well by a deep-well pump driven by a 30 H.P. motor. The water from this pump discharges into a reservoir near the pumping station, and from which it is pumped into the mains by two pumps, operated by motors. The mains are so laid that what water is not consumed during the time of pumping is carried to a standpipe from which it flows to the mains again when the pumps are idle. The pumps are of the triplex pattern, having three pistons 10in. in diameter, with 12in. stroke, and are directly connected to a 70 H.P. multipolar slow-speed motor with rawhide pinions. At 43 strokes per minute, the capacity of each pump is 500 gallons. For the domestic service the pumps work against a pressure of 60lb., but being designed for fire service, are capable of working against a pressure of 125lb. An automatic device for closing the standpipe connections from the mains is used in case of fire. The current to operate the motors is furnished by the De Kalb Electric Company, being carried from the power station to the pumping station, a distance of 700 yards. In the contract between the town and the De Kalb Electric Company, the latter assume all care and attention of the machinery in consideration of a price of 4 cents per 1,000 gallons pumped.

Science Banquet in Paris.—In honour of M. Berthelot, and as a demonstration of the power and progress of science in France, a banquet, says *Nature*, was held at Paris a few days ago. Nearly 800 guests were present, among them being M. Brisson, President of the Chamber of Deputies, and M. Poincaré, Minister of Public Instruction. Upon the invitation cards were printed the words, "Hommage à la science, source de l'affranchissement de la pensée." M. Poincaré made an eloquent speech in praise of the work done by the eminent Secretary of the Paris Academy of Sciences, and M. Berthelot, in his reply, dwelt at some length upon the beneficial influence of science on social and moral, as well as material, progress. Science, he said, had for its only guide the love of truth, and confidence in its final triumph. Proved under all circumstances, and strengthened every day by success, the scientific method had become the principal source of the moral and material progress of society. In fact, science was the source of all progress accomplished by the human race. Everyone knew that during this century science had conferred great benefits upon civilised peoples by the application of its results and laws to mechanical, chemical, and electrical industries. But M. Berthelot held that material progress was the least of the fruits of scientific work; he claimed for science the more extensive domains of the moral and social world, and vindicated the position taken up by him in his article on "Science et la Morale," which appeared in the *Revue de Paris*.

Argon.—The following interesting communication was recently made to the Académie des Sciences by M. Guntz:—Amongst the substances absorbing nitrogen, Lord Rayleigh and Professor Ramsey have chosen magnesium, owing to the facility with which this metal is procurable commercially, although its complete absorption of nitrogen is difficult to effect owing to the high temperature to which the magnesium must be brought to induce the two to combine. Lithium, which is easily prepared by electrolysis in the manner I have recently pointed out, combines, on the other hand, rapidly with nitrogen, and this at a temperature below dull red, as I have observed in an investigation which I am carrying out on the alloys of this metal. It is this property which enables one easily to show the presence of argon in atmospheric nitrogen, and even to obtain this gas. If we put an iron vessel containing lithium in a glass tube filled with atmospheric nitrogen, the whole being in connection with a manometer, and gently heat the iron vessel, the lithium combines incandescing with the nitrogen and a vacuum is produced in the apparatus, the pressure of the residual gas corresponding to about 10 millimetres of mercury. If the vessel be replenished with atmospheric nitrogen and heated afresh, the nitrogen is again absorbed, but apparently less completely, for the pressure of the residual gas is about 20 millimetres of mercury. If we repeat this experiment several times, one sees that the proportion of gas not absorbed by the lithium, a proportion which is measured by the vacuum obtained, increases at each experiment, and after the introduction of a sufficient volume of nitrogen, the tube is completely filled with argon. In order to show that this residue is due to the presence of argon, and not to the incomplete absorption of nitrogen by the lithium, the experiment may be repeated under the same conditions, but using nitrogen obtained from a chemical compound, such, for instance, as nitric oxide. It will then be seen that the 10 millimetre vacuum obtained at the commencement, remains sensibly the same after several fresh introductions of nitrogen obtained from nitric oxide. This experiment clearly brings out the difference between the nitrogen obtained from a chemical compound and that derived from the air, and shows that the latter contains a substance which is not absorbed by lithium, which substance is argon. Argon may be obtained and collected over mercury by passing a current of atmospheric nitrogen over a heated tube containing several iron vessels containing lithium.

An Interesting Electrolytic Phenomenon.—At a recent meeting of the Franklin Institute, Mr. C. J. Reed described a curious electrolytic phenomenon observed by him. Most metals, when used as positive electrodes in electrolysis, are, he remarked, either dissolved or corroded, producing metallic salts or oxides; but when used as negative electrodes, metals do not generally undergo such corrosion. While experimenting, however, on the oxidising effect of various electrolytes upon lead electrodes, Mr. Reed noticed, accidentally, that under certain circumstances, lead behaved towards some electrolytes in a peculiar manner, the only conditions required being very high electromotive force and current density. On passing an electric current through a solution of disodium-hydrogen phosphate, between electrodes of sheet lead, nothing unusual was noticed during the experiment. The solution had a very high resistance, and very little current passed even with a high electromotive force. At the close of the experiment, there being no switch in the circuit, the current was interrupted by lifting one of the electrodes out of the solution. It happened to be the negative electrode. At the instant of final contact between the electrolyte and the lowest point of the electrode, as it left the solution, what appeared to be a cloud of black smoke, or precipitate, which had suddenly formed in the solution, was noticed. On examining the cloud more particularly, and repeating the experiment several times, it was found that by exposing only a very small surface of the negative electrode to the solution, there was produced a large cloud of dark blue or lead-coloured precipitate, which rapidly sank in the solution and rendered it entirely opaque. It was then observed that the lead cathode was being rapidly eaten away, and that the precipitate was being produced at the expense of the lead. The precipitate was collected on a filter, washed with water and alcohol, and dried. It was found to be an impalpable powder resembling lead, and permanent in the air at ordinary temperatures. When rubbed in an agate mortar, it was reduced to a lustreless gummy mass, but did not assume a metallic appearance. Heated to the melting point of lead in the open air, it suddenly absorbed oxygen and formed yellow plumbic oxide, with incandescence. Heated in a glass tube in absence of oxygen, it melted to a globule of metallic lead. The surface of the lead cathode, after the experiment, was reduced to a point at the end, and presented a smooth, shiny surface, like polished lead. It was of the form one would expect to find a positive electrode of copper or other soluble metal. Other electrolytes were tried, and it was found that the lead precipitate could be produced in them.

Grooved Rails for Electric Railways.—Some investigations, says the *Engineer*, have recently been made to ascertain the most desirable shape for the groove to be used in the guard rails for curves on street railways, especially those operated electrically, the fundamental idea being that these grooves should be laid out corresponding to the lines of wear, so as to present from the start the largest possible wearing surface to the action of she wheels, in order to prolong the life of the rail. Two pair of wheels were carefully turned out of hard wood to an accurate scale of 3in. to 1ft., and with their axles—on which they were turned—secured to a strong frame representing the car truck, so that they could revolve freely but without any play. The frame was rigidly fastened in the centre to a stiff board extending at right angles with the truck, to what would be the centre of the curve. A pin accurately turned and fitting snugly in holes in the board, and holes in a wooden stand screwed to the floor, formed the centre proper. A large piece of drawing paper was stretched on a board, and on it were laid rail blanks without any groove, formed out of potters' clay, following the curves described by the wheels when allowed to move, guided by the board from the centre of the curve to whatever radius it was set. The wheels were then set upon the rail blanks and weighted until their flanges sank into the clay to their full depth, at which point the whole apparatus was arranged to be exactly level. The wheels having previously been varnished, were thoroughly oiled, so that the clay would not stick to them. The first pair of wheels was then revolved from the axle by hand, and thus the truck moved along the potters' clay, the flanges cutting their own grooves into it. The length of arc available having been traversed, the truck was lifted away, and if a perfect impression had been obtained short pieces were cut out of the various parts of the arcs of both the inner and outer rail, and particularly of those parts which had been traversed by the front wheels only or the hind wheels only, and those that had been passed over by both wheels, as comparison of them would show whether or not the truck stood exactly square with the radial line. These pieces were cut out so that the cut would also sever the paper underneath, and extending a short distance inside and outside, forming a strip on and by which the cut-out pieces could be slid away upon another board, and put away to dry and harden without handling the piece itself while yet soft, thereby avoiding possible distortion, except on the very ends by the cutting knife. As this latter was unavoidable, the pieces, after being thoroughly hardened, were sawed in half, so as to get at the central undistorted section, and the sawed surface ground smooth on a piece of slate, so as to present sharp lines. The shrinkage of the clay in drying could well be neglected, as actual measurement on a test piece showed that it would amount to little more than $\frac{1}{64}$in. in the full-size width of the groove. Rail makers and street railway officers claim that makers of street-car or tramcar wheels often exhibit no common sense in the proportioning of wheels, and there is consequently no uniformity of practice. The flanges, which should be carefully smoothed, are often left rough, causing much unnecessary wear on the rails. This same result is also produced by bad mounting of the axles in the frames. One line in Philadelphia has been carefully studied to find out the action of the wheels upon the curves, and by careful measurement of current it has been found that the proper shaping of the groove in the guard-rail has resulted in considerable economy and improvement in running.

ELECTROMAGNETIC THEORY.—LXVII.*

BY OLIVER HEAVISIDE.

(Continued from page 729.)

§ **258.** If the line is insulated at the far end B, instead of being earthed, as in § 256, other things remaining the same, namely, earth at the beginning A, where the impressed force e is situated, the change made in the waves is very easily settled. The initial wave (11) from A is the same as before, but it must now be reflected positively at B, or without reversal of the sign of the potential, in order that the current may be maintained zero. So the second wave V_2 differs from the old one of equation (12) in sign only, being now positive. This V_2 is reflected negatively at A. Therefore V_3 is negative, and since i tis reflected positively at B, V_4 must be negative too. This makes a cycle of signs. So we now have the following series:—

$$V = + + - - + + - - + + - - \&c.,$$

writing down only the signs of the waves, which are otherwise identically the same as in equation (15), where they make the arrangement $+ - + -$ &c.

Summing up as before, by the law of geometric series, we obtain

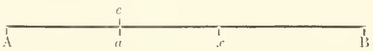
$$V = \frac{\epsilon^{-qx} + \epsilon^{-q(2l-x)}}{1 + \epsilon^{-2ql}} e = \frac{\cosh q(l-x)}{\cosh ql} e, \tag{22}$$

which is the condensed form of the solution. The final V is e all over, and the final C is zero, as is obvious. To test (22) generally, observe that it makes $V = e$ at $x = 0$, and $C = 0$ at $x = l$, which are the two terminal conditions.

§ **259.** When the impressed force is not at the terminal A, but is at some intermediate point, say at $x = a$, the case is a little more complicated, because there are two series of waves. The primary wave is double, going both ways, and each of its members suffers reflection at A and B. At an earth, the reflection of V is positive; at a disconnection it is negative. By means of these considerations it is easy to write down without further calculation the full solution in terms of the waves for any case in which the terminal conditions are earth or insulation, as two earths, or two insulations, or one earth and one insulation (two cases); and these solutions are fully realised algebraically by the functions $\epsilon^{-qx}1$ and $\epsilon^{-qx}q1$ when the impressed force acts steadily. As there is no difficulty in this process, it will be as well to take a more comprehensive case for illustration.

Let the terminal conditions be unstated except that it is given that if v is a wave incident at B, then βv is the reflected wave; and that if v is a wave incident at A, then αv is the reflected wave. Here α and β are the terminal operators defining the nature of the reflection, the coefficients of reflection, so to say.

Now let there be an impressed force e at $x = a$, and let us find its effect at a point x on the right side,



or between the impressed force and B. The wave from e going to the right is

$$v_1 = \epsilon^{-q(x-a)}\tfrac{1}{2}e. \tag{23}$$

In this put $x = l$ to obtain its value at B. Then multiply by β to obtain the value of the reflected wave v_2 at B. Finally, multiply by $\epsilon^{-q(l-x)}$ to obtain the value of the last at distance $l - x$ from β, that is, at x from A. The result is

$$v_2 = \epsilon^{-q(l-x)}\beta\epsilon^{-q(l-a)}\tfrac{1}{2}e = \beta\epsilon^{-q(2l-a-x)}\tfrac{1}{2}e, \tag{24}$$

which shows the second wave, going towards A.

Put $x = 0$ to get the value of v_2 at A. Then multiply by α to produce the value of the reflected wave v_3 at A. Finally, multiply by ϵ^{-qx} to get its value at x. The result is

$$v_3 = \epsilon^{-qx}\alpha\beta\epsilon^{-q(2l-a)}\tfrac{1}{2}e = \alpha\beta\epsilon^{-q(2l-a+x)}\tfrac{1}{2}e, \tag{25}$$

showing the third wave.

Put $x = l$ to get its value at B. Multiply by β to get value of the reflected wave v_4 at B. Then multiply by $\epsilon^{-q(l-x)}$ to get its value at x. The fourth wave is therefore

$$v_4 = \epsilon^{-q(l-x)}\beta\alpha\beta\epsilon^{-q(3l-a)}\tfrac{1}{2}e = \alpha\beta^2\epsilon^{-q(4l-a-x)}\tfrac{1}{2}e. \tag{26}$$

After this, it is the same over and over again. So we have the series

$$\left.\begin{aligned} v_1 &= \epsilon^{-q(x-a)}\tfrac{1}{2}e, & v_2 &= \beta\epsilon^{-2q(l-x)}v_1,\\ v_3 &= \alpha\epsilon^{-2qx}v_2, & v_4 &= \beta\epsilon^{-2q(l-x)}v_3,\\ v_5 &= \alpha\epsilon^{-2qx}v_4, & v_6 &= \beta\epsilon^{-2q(l-x)}v_5, \end{aligned}\right\} \tag{27}$$

and so on. The first wave is given explicitly, and the rest are obtained in succession by multiplying by one or the other of two factors in turn. So, by the law of geometric series, the sum of the v waves is

$$\Sigma v = \frac{v_1 + v_2}{1 - \alpha\beta\epsilon^{-2ql}} = \frac{\epsilon^{-q(x-a)}(1 + \beta\epsilon^{-2q(l-x)})}{1 - \alpha\beta\epsilon^{-2ql}}\tfrac{1}{2}e, \tag{28}$$

which represents the potential at x so far as it arises from the initial wave to the right.

But there is also the initial wave to the left to be considered. It is $-\epsilon^{-q(a-x)}\tfrac{1}{2}e$ between a and A; becomes $-\epsilon^{-qa}\tfrac{1}{2}e$ at A; generates the new wave $-\alpha\epsilon^{-qa}\tfrac{1}{2}e$ by reflection, which becomes $-\alpha\epsilon^{-q(a+x)}\tfrac{1}{2}e$ when it reaches x. After that, we have a succession of reflections at B and A precisely in the former manner. So, if this new set of waves be called w, we have

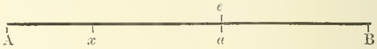
$$\left.\begin{aligned} w_1 &= -\alpha\epsilon^{-q(a+x)}\tfrac{1}{2}e, & w_2 &= \beta\epsilon^{-2q(l-x)}w_1,\\ w_3 &= \alpha\epsilon^{-2qx}w_2, & w_4 &= \beta\epsilon^{-2q(l-x)}w_3,\\ w_5 &= \alpha\epsilon^{-2qx}w_4, & w_6 &= \beta\epsilon^{-2q(l-x)}w_5, \end{aligned}\right\} \tag{29}$$

and so on. The total is

$$\Sigma w = -\frac{\alpha\epsilon^{-q(a+x)}(1 + \beta\epsilon^{-2q(l-x)})}{1 - \alpha\beta\epsilon^{-2ql}}\tfrac{1}{2}e, \tag{30}$$

showing the part of the potential at x due to the initial wave going to the left. The real potential is, therefore, the sum of the v's and w's.

But when the point x lies between A and the impressed force, the case is somewhat different. If we consider the



effect at x of the initial wave to the right, making allowance for the fact that it only gets to x by producing a reflected wave at B, we have the series of waves

$$\left.\begin{aligned} v_1 &= \beta\epsilon^{-q(2l-a-x)}\tfrac{1}{2}e, & v_2 &= \alpha\epsilon^{-2qx}v_1,\\ v_3 &= \beta\epsilon^{-2q(l-x)}v_2, & v_4 &= \alpha\epsilon^{-2qx}v_3, \end{aligned}\right\} \tag{31}$$

and so on, whose sum is

$$\Sigma v = \frac{\beta\epsilon^{-q(2l-a-x)}(1 + \alpha\epsilon^{-2qx})}{1 - \alpha\beta\epsilon^{-2ql}}\tfrac{1}{2}e. \tag{32}$$

Similarly, the initial wave to the left and its consequences are represented by the series

$$\left.\begin{aligned} w_1 &= -\epsilon^{-q(a-x)}\tfrac{1}{2}e, & w_2 &= \alpha\epsilon^{-2qx}w_1,\\ w_3 &= \beta\epsilon^{-2q(l-x)}w_2, & w_1 &= \alpha\epsilon^{-2qx}w_3, \end{aligned}\right\} \tag{33}$$

and so on, whose sum is

$$\Sigma w = -\frac{\epsilon^{-q(a-x)}(1 + \alpha\epsilon^{-2qx})}{1 - \alpha\beta\epsilon^{-2ql}}\tfrac{1}{2}e. \tag{34}$$

Finally, denote by V_1 the potential on the right side of e and by V_2 the potential on the left side. The former is the sum of (28) and (30), and the latter the sum of (32) and (34). That is to say,

$$V_1 = \frac{\epsilon^{qa} - \alpha\epsilon^{-qa}}{\epsilon^{ql} - \alpha\beta\epsilon^{-ql}}(\epsilon^{q(l-x)} + \beta\epsilon^{-q(l-x)})\tfrac{1}{2}e, \tag{35}$$

$$V_2 = -\frac{\epsilon^{qx} + \alpha\epsilon^{-qx}}{\epsilon^{ql} - \alpha\beta\epsilon^{-ql}}(\epsilon^{q(l-a)} - \beta\epsilon^{-q(l-a)})\tfrac{1}{2}e, \tag{36}$$

represent the complete solution in compact form, equivalent to the previous development in terms of waves.

§ **260.** There are several cases in which these solutions are reducible to the elementary waves of the kind before considered. These occur when α and β are $+1$ or -1, or zero, or constants lying between the limits -1 and $+1$. Under these circumstances the reflected waves are copies of the incident either full-sized or reduced, with or without reversal of sign.

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Thus, α or β being ± 1 makes four important cases.

(1.) Both ends earthed. The V waves are reflected negatively, so $\alpha = -1 = \beta$, and

$$\mathrm{V}_1 = +\frac{\cosh qa}{\operatorname{shin} ql} \operatorname{shin} q(l-x).e, \tag{37}$$

$$\mathrm{V}_2 = -\frac{\operatorname{shin} qx}{\operatorname{shin} ql} \cosh q(l-a).e. \tag{38}$$

(2.) Both ends cut. The V waves are reflected positively, so $\alpha = 1 = \beta$, and

$$\mathrm{V}_1 = +\frac{\operatorname{shin} qa}{\operatorname{shin} ql} \cosh q(l-x).e, \tag{39}$$

$$\mathrm{V}_2 = -\frac{\cosh qx}{\operatorname{shin} ql} \operatorname{shin} q(l-a).e. \tag{40}$$

(3.) Earth at A, and cut at B. Then $\alpha = -1$, $\beta = 1$, and

$$\mathrm{V}_1 = +\frac{\cosh qa}{\cosh ql} \cosh q(l-x).e, \tag{41}$$

$$\mathrm{V}_2 = -\frac{\operatorname{shin} qx}{\cosh ql} \operatorname{shin} q(l-a).e. \tag{42}$$

(4.) Earth at B, and cut at A. Here $\alpha = 1$, $\beta = -1$, and

$$\mathrm{V}_1 = +\frac{\operatorname{shin} qa}{\cosh ql} \operatorname{shin} q(l-x).e, \tag{43}$$

$$\mathrm{V}_2 = -\frac{\cosh qx}{\cosh ql} \cosh q(l-a).e. \tag{44}$$

These solutions and the more general cases may be easily converted to Fourier series, if required, by a method to be explained later. In the meantime it may be noted that the general solutions (35), (36) may be got by assuming

$$\mathrm{V}_1 = \epsilon^{qx}\mathrm{F} + \epsilon^{-qx}\mathrm{G}, \qquad \mathrm{V}_2 = \epsilon^{qx}\mathrm{H} + \epsilon^{-qx}\mathrm{I}, \tag{45}$$

and determining the four time functions by the two intermediate conditions

$$\mathrm{V}_1 - \mathrm{V}_2 = e, \qquad \mathrm{C}_1 = \mathrm{C}_2, \tag{46}$$

at $x = a$, and by two terminal conditions. In the case of equations (37) to (44) these terminal conditions are simply either $\mathrm{V} = 0$ or $\mathrm{C} = 0$ at A and B, as may be readily tested. What the terminal conditions are in general, in relation to the reflection coefficients α, β, will now be pointed out.

§ 261. The reflection coefficients are usually operators themselves. There is no difficulty in finding them. Let $\mathrm{V} = \mathrm{Z}_1\mathrm{C}$ at B. This says that Z_1 is the resistance operator of the terminal arrangement at B. Now let v_1 be a wave incident upon B, and v_2 be the reflected wave. Their sum is the real potential. So

$$v_1 + v_2 = \mathrm{Z}_1\mathrm{C}. \tag{47}$$

Also, we multiply by q/R to get the current belonging to v_1, and by $-q/\mathrm{R}$ to get that belonging to v_2, because the first is a positive and the second a negative wave, going to and coming from B respectively. So

$$q(v_1 - v_2) = \mathrm{RC}. \tag{48}$$

Eliminating C between (47), (48) by division, we get

$$\frac{v_1 - v_2}{v_1 + v_2} = \frac{\mathrm{R}}{q\mathrm{Z}_1}, \text{ therefore } \beta = \frac{v_2}{v_1} = \frac{\mathrm{Z}_1 - \mathrm{R}/q}{\mathrm{Z}_1 + \mathrm{R}/q}, \tag{49}$$

giving β in terms of Z_1.

Similarly, if Z_0 is the resistance operator of the terminal arrangement at A, we shall have

$$v_1 + v_2 = -\mathrm{Z}_0\mathrm{C}, \tag{50}$$

if v_1 is the incident and v_2 the reflected wave. Now v_1 is a negative wave, to be multiplied by $-\mathrm{R}/q$ to get the current to correspond, whilst v_2 is a positive wave, to be multiplied by R/q; so

$$-q(v_1 - v_2) = \mathrm{RC}. \tag{51}$$

Eliminating C, we obtain

$$\frac{v_1 - v_2}{v_1 + v_2} = \frac{\mathrm{R}}{q\mathrm{Z}_0}, \text{ therefore } \alpha = \frac{v_2}{v_1} = \frac{\mathrm{Z}_0 - \mathrm{R}/q}{\mathrm{Z}_0 + \mathrm{R}/q}, \tag{52}$$

giving α in terms of Z_0. Using these expressions for α and β in the solutions (35), (36), they are made completely at $x = 0$. The terminal conditions they satisfy are $\mathrm{V} = -\mathrm{Z}_0\mathrm{C}$ expressive and $\mathrm{V} = \mathrm{Z}_1\mathrm{C}$ at $x = l$.

§ 262. By inspection of (49), we see that β vanishes when $\mathrm{Z}_1 = \mathrm{R}/q$. This is because R/q is the resistance operator of an infinitely long cable line. To say that it equals Z_1, asserts that the cable either does not stop at β, but goes on to infinity; or else that if it does stop, there is a terminal arrangement which is exactly equivalent to the infinitely long continuation, so far as the real cable itself is concerned.

In this case $\beta = 0$ reduces (35) (36) to

$$\mathrm{V}_1 = (\epsilon^{qa} - \alpha\epsilon^{-qa})\epsilon^{-qx}\tfrac{1}{2}e, \tag{53}$$

$$\mathrm{V}_2 = -(\epsilon^{qx} + \alpha\epsilon^{-qx})\epsilon^{-qa}\tfrac{1}{2}e, \tag{54}$$

showing two waves only, for there is no reflection at B, and therefore can be but one reflection at A.

Again, if $\mathrm{Z}_0 = \mathrm{R}/q$ then $\alpha = 0$. There is no reflection at A, because either the cable is continued past A indefinitely, or else there is a terminal arrangement copying the continuation. We now have

$$\mathrm{V}_1 = \epsilon^{qa}(\epsilon^{-qx} + \beta\epsilon^{-q(2l-x)})\tfrac{1}{2}e, \tag{55}$$

$$\mathrm{V}_2 = -\epsilon^{qx}(\epsilon^{-qa} - \beta\epsilon^{-q(2l-a})\tfrac{1}{2}e, \tag{56}$$

showing two waves again, the reflection being at B.

Finally, if $\mathrm{R}/q = \mathrm{Z}_0 = \mathrm{Z}_1$, both α and β vanish, and we reduce to

$$\mathrm{V}_1 = \epsilon^{-q(x-a)}\tfrac{1}{2}e, \tag{57}$$

$$\mathrm{V}_2 = -\epsilon^{-q(a-x)}\tfrac{1}{2}e, \tag{58}$$

which are simply the primary waves from the source, without subsequent interference.

It will be observed that the expressions for α, β contain q, involving $p^{\frac{1}{2}}$. In order, therefore, to have the coefficients freed from $p^{\frac{1}{2}}$ (besides in the previous ways), we must introduce $p^{\frac{1}{2}}$ in Z_1 and Z_0. Say, for example,

$$\mathrm{Z}_0 = \left(\frac{\mathrm{R}_0}{\mathrm{S}_0 p}\right)^{\frac{1}{2}}, \qquad \mathrm{Z}_1 = \left(\frac{\mathrm{R}_1}{\mathrm{S}_1 p}\right)^{\frac{1}{2}}. \tag{59}$$

These mean that the cable A B is put between two other cables of different types; of the type R_0, S_0 on the left of A, and of the type R_1, S_1 on the right of B. The differentiator p then disappears from α and β, which reduce to

$$\alpha = \frac{(\mathrm{R}_0/\mathrm{S}_0)^{\frac{1}{2}} - (\mathrm{R}/\mathrm{S})^{\frac{1}{2}}}{(\mathrm{R}_0/\mathrm{S}_0)^{\frac{1}{2}} + (\mathrm{R}/\mathrm{S})^{\frac{1}{2}}}, \qquad \beta = \frac{(\mathrm{R}_1/\mathrm{S}_1)^{\frac{1}{2}} - (\mathrm{R}/\mathrm{S})^{\frac{1}{2}}}{(\mathrm{R}_1/\mathrm{S}_1)^{\frac{1}{2}} + (\mathrm{R}/\mathrm{S})^{\frac{1}{2}}}. \tag{60}$$

These are constants, and may evidently have any values between (and including) -1 and $+1$. We can get rid of the reflection at A by having $\mathrm{R}_0/\mathrm{S}_0 = \mathrm{R}/\mathrm{S}$, and of that at B by $\mathrm{R}_1/\mathrm{S}_1 = \mathrm{R}/\mathrm{S}$. This is somewhat more general than the previous way of having continuations of the same type as the real line. If we do not abolish the reflections, the whole series of waves summed up in (35), (36) are in action, only with α and β constants instead of, as in the general case, operators containing p.

§ 263. In conection with the preceding, the other kind of source should be mentioned. The treatment is similar when the source at $x = a$ is not impressed force, which creates a discontinuity in the potential, though not in the current, but is a source of current, creating a discontinuity in the current, though not in the potential. Thus, let h be the strength of a source of current at $x = a$ (say led to the cable by an auxiliary wire), then the current in the line increases by the amount h in passing from left to right past the source. This case has been already briefly considered (§ 250). The primary waves are

$$c_1 = \epsilon^{-q(x-a)}\tfrac{1}{2}h, \qquad \text{on the right,} \tag{61}$$

$$c_2 = -\epsilon^{-q(a-x)}\tfrac{1}{2}h, \qquad \text{on the left,} \tag{62}$$

and the potentials to correspond are

$$v_1 = \epsilon^{-q(x-a)}\frac{\mathrm{R}h}{2q}, \qquad \text{on the right,} \tag{63}$$

$$v_2 = \epsilon^{-q(a-x)}\frac{\mathrm{R}h}{2q}, \qquad \text{on the left.} \tag{64}$$

When h is steady or impulsive we have already indicated the results. The point at present in question is the extension to include terminal influences. Have the same reflection coefficients as above, and apply them to the present case. The initial wave to the right is made the same as in § 259, equation (23), by substituting $\mathrm{R}h/q$ for e, whilst the initial wave to the left is made the same by writing Rh/q for $-e$. There is no other difference. So we may employ the previous results fully. In particular, the solutions (35), (36) become

$$V_1 = \frac{\epsilon^{qa} + \alpha\epsilon^{-qa}}{\epsilon^{ql} - \alpha\beta\epsilon^{-ql}} \left(\epsilon^{q(l-x)} + \beta\epsilon^{-q(l-x)}\right)\frac{hR}{2q}, \qquad (65)$$

$$V_2 = \frac{\epsilon^{qx} + \alpha\epsilon^{-qx}}{\epsilon^{ql} - \alpha\beta\epsilon^{-ql}} \left(\epsilon^{q(l-a)} + \beta\epsilon^{-q(l-a)}\right)\frac{hR}{2q}, \qquad (66)$$

which express the potentials V_1 on the right side and V_2 on the left side of the source h. Test that

$$V_1 = V_2, \qquad \text{and} \qquad -\frac{dV_1}{dx} + \frac{dV_2}{dx} = Rh, \qquad (67)$$

at $x = a$.

Take $h = pQ$ when the source is impulsive. Then (65), (66) represent the potential due to a charge Q which is initially all at the point $x = a$, as modified by the terminal influences. The conversion to a Fourier series of this result leads to the expansion of an arbitrary function in all sorts of Fourier series, not merely the periodic case which rigourists have tried so hard to demonstrate, but to the numberless other expansions which occur naturally in the physics of the matter, associated with different forms of the coefficients α, β regarded as functions of p. It is no easy matter from the restricted rigorous mathematical point of view to answer the question, Why should an arbitrary function be capable of expansion in such or such a series? But from the physical point of view, the question is rather, Why shouldn't it? This matter, however, must come later.

CORRECTIONS.—§ 243, equations (30), (31), delete $e-$; § 244, equation (35), insert π as a factor after $=$, and read $\underline{|3}$ for 3 in second line.

(To be continued.)

A MAGNETIC TESTER FOR MEASURING HYSTERESIS IN SHEET IRON.*

BY PROF. EWING, F.R.S.

Makers of transformers are now generally alive to the paramount importance, from the point of view of all-day efficiency, of using iron in which the hysteresis losses are small. The need, however, is felt of some simple means by which this quality can be readily determined. Tests made by the ballistic and other methods have shown that different samples of iron may exhibit extraordinarily wide differences in regard to hysteresis. The author has found, for example, in the course of his own tests of iron supplied for transformers, a range of nearly three to one in the hysteresis of good and bad samples. It is unnecessary to point out how much the all-day efficiency of a transformer working under ordinary conditions will be affected if the sheet iron used in its construction has three times as much hysteresis as it need have. Again, experience shows that even in one batch of plates, of the same rolling, so much difference is apt to exist between one plate and another as to make the testing of a single sample furnish a poor guide to the average quality of the batch. Even in a single plate samples cut from different parts show marked differences in hysteresis. The author has noticed as much as 15 per cent. variation in samples taken from the four corners of a plate not quite 2ft. square, the material of which was of very excellent quality. It is well known that different analyses of the nearly pure iron of which such plates are rolled exhibit corresponding variations. The impurities appear to be unequally distributed; and, further, it is not unlikely that the irregularities which are found in the magnetic quality depend in part on slight differences in the treatment as regards annealing. Whatever their cause, there can be no doubt that they exist, and their existence makes the result of a single test often somewhat fallacious. What is wanted is a sufficiently large number of tests, in any one batch of iron, to allow a fair average to be estimated for the quality of the batch.

To make this possible, a simple and expeditious method of testing is imperative. The ballistic method, although unimpeachable on the score of accuracy, is anything but expeditious, and can scarcely be called simple. The value of the hysteresis is arrived at by first observing the relation of the induction B to the magnetising force H for a considerable number of points in each of a series of cyclic processes of magnetisation, then drawing the B H curve for each of these cycles, and measuring the enclosed area. The operation requires some skill and experience, and a good deal of patience. The same criticism applies to other methods of finding the hysteresis by first finding the relation of magnetism to magnetising force (as, for instance, by the permeameter or by the author's magnetic curve tracer). It must be borne in mind that in the testing of transformer iron the permeability is a quite secondary matter. What is of primary importance is the hysteresis, and high permeability is not necessarily or invariably found associated with small hysteresis. In the testing of sheet iron by the ballistic method the finding of the relation of B to H is a step in the process; it is not the object of the test.

These considerations have led the author to devise an apparatus which measures the hysteresis directly, by a single operation, and in a manner sufficiently simple to allow the test to be applied to numerous specimens without much expenditure of time, trouble, or iron. The basis of the instrument is the mechanical measurement of the work done in causing reversals of magnetism to take place in the iron under examination. Such measurements have been made before as a laboratory experiment and under special conditions. Thus, Mr. L. R. Wilberforce and the author, two or three years ago, endeavoured to determine the hysteresis of a cylinder of iron when rotated in a strong magnetic field, by measuring the couple required to keep it slowly turning. And a method of the same general character has been employed with complete success by Mr. F. G. Baily to investigate the disappearance of hysteresis which takes place in such a cylinder when the field is made sufficiently strong—a matter of great interest in connection with the molecular theory of magnetism. In the machine now brought forward as a practical tester for workshop use the same mechanical principle is involved. The process of reversal, however, resembles that which occurs in a transformer rather than in a dynamo; the induction is caused to have practically the same value in all samples, and that a value appropriate from the transformer point of view; the sample is cut in a very simple form, and is arranged to be readily inserted and removed. The magnetism is reversed by turning a handle, and the result is given by the position of a pointer on a scale.

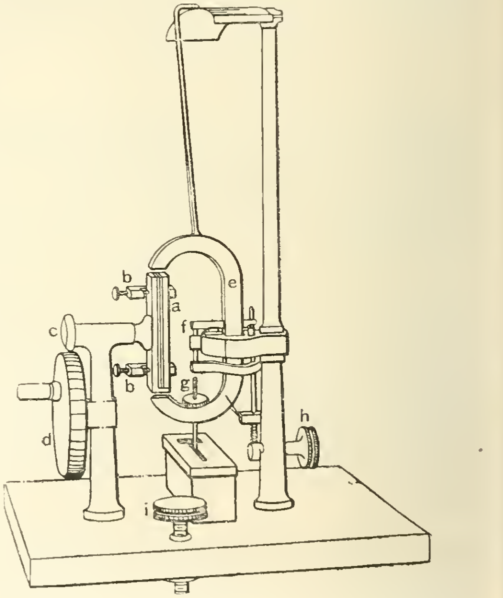

FIG. 1.

Fig. 1 is a drawing and Fig. 1*a* is a perpective view of the instrument now exhibited, the form of which has been reached after a good deal of experiment. The iron to be tested is cut or stamped in the form of strips, which are 3in. long and five-eighths of an inch wide in this instance. The number of these pieces that is taken to compose the sample depends on the thickness of the sheet: six or seven pieces will in general be sufficient for the usual gauges of transformer iron, and a smaller number if the material tested is the thicker sheet used in dynamo armatures. The bundle of pieces forming the sample is placed in a carrier, *a*, and is covered with a vulcanite washer and secured by two clamps, *b b*. The carrier is made to rotate by means of the friction pulley, *c*, and driving wheel,

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[*] Paper read before the Institution of Electrical Engineers, April 25th.

d. This causes the sample to revolve between the poles of the permanent magnet, *e*, with the effect that its magnetism is periodically reversed. The work done in reversing the magnetism, in consequence of hysteresis, causes a mechanical moment to be exerted by the revolving sample upon the magnet; and the magnet, being supported on a knife-edge at *f* in line with the axis of the carrier, tends to follow the sample and is deflected through an angle which serves to measure the work expended. Since a definite amount of work is done per reversal, whatever the frequency (so long as that is not so high as to make a sensible addition to the work by inducing currents), the deflection of the field-magnet is independent of the speed at which the carrier revolves, and no special care has to be taken to turn the handle at a uniform rate. If the rate is very slow the magnet will show each individual impulse which it receives as the ends of the sample pass its poles, but when the speed is sufficiently raised these impulses blend into a steady deflection; and the speed may be further augmented to the extent of doubling it, or more, without making the deflection change. It is only at higher speeds still that the effects of induced currents become apparent. The deflection is observed by means of a pointer and scale above the magnet. The swinging of the magnet is checked by means of a dash-pot below, consisting of a vane, or spade, moving in a box filled with oil. The stability is adjusted to give any required degree of sensitiveness, by means of the weight *g*, which travels as a nut upon a screw fixed to the magnet, and serves to raise or lower the centre of gravity of the oscillating system. The magnet swings about a knife-edge working in an agate trough, and a lifting arrangement like that of a balance is provided, operated by the handle *h* to save the knife-edge from unnecessary wear or injury. The pointer is set to zero in the middle of the scale by means of a nut which runs on a screw projecting sideways from the middle of the magnet, and a more delicate adjustment of the zero may be effected by means of the levelling screw *i*. In operating, the observer inserts the sample and secures it by the clamps, then begins to turn the handle and lets the magnet down on its knife-edge. After reading the deflection of the pointer to one side he reverses the direction of rotation, reads the deflection to the other side, and takes the sum of the two readings as the total deflection. The deflection is proportional, or very approximately proportional, to the hysteresis of the iron, even when samples widely different in quality are compared.

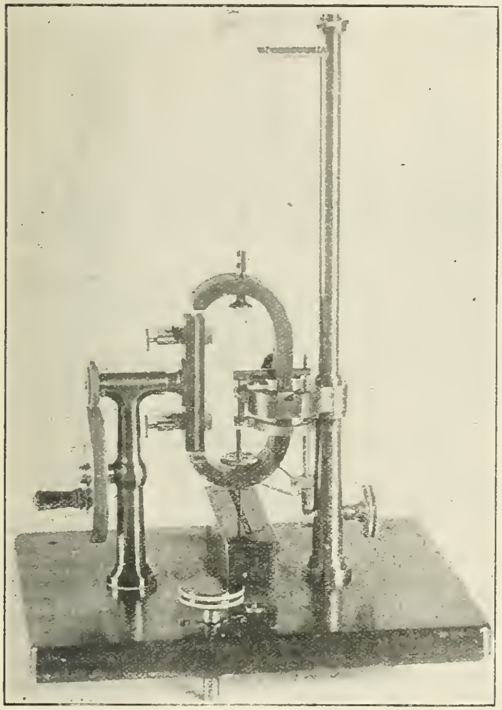


Fig. 1*a*.

To secure that this shall be so, a considerable air space is left between the magnet poles and the ends of the sample, with the result that such variations of permeability as are liable to be met with in different samples are almost without influence upon the total induction through the iron. The author has examined the induction by means of a search coil wound round the sample, and has found it to be practically the same in the best and worst specimens of transformer iron. The dimensions and strength of the field-magnet are so proportioned, with reference to the section of the sample and to the extent of the air gaps, as to make the induction have a value fairly representative of transformer work. In the instrument shown, the induction is about 4,000 C.G.S. units with the normal size of test sample. By increasing or reducing the area of section of the sample, the intensity of the induction is reduced or increased. Within reasonable limits, however, any value of this intensity may be adopted in testing, for it is known from the results of ordinary ballistic tests that curves drawn to show the relation of the hysteresis loss to B preserve their relative positions through a wide range of values of B. In other words, the relative amounts of hysteresis in different samples do not change, or scarcely change, when the iron is more strongly or less strongly magnetised. This, of course, follows from the fact that a formula of the type originally suggested by Mr. Steinmetz,

$$\text{Hysteresis loss} = c\,B^n,$$

is practically applicable, c and n being constants, within limits which are more than sufficiently wide to include the inductions used in transformers.

In cutting the pieces which are to make up the sample care has to be taken to make the length always the same, otherwise the air gaps, and consequently the induction, will vary irregularly. The carrier is formed so that it serves as a length gauge; and to facilitate the preparation of the samples a supplementary gauge is furnished, in the form of a clamp of hardened steel, in which the strips are readily filed to the exact length after being cut a trifle too long. The width of the pieces requires no particular care.

The author was under the expectation that it would be necessary, in making an accurate comparison of quality between different specimens, to give the sample the same weight in each case, in order to make it have the same cross-section. He finds, however, that no nice adjustment of the weight is required, provided advantage is taken of a property which will be most easily explained by citing an experiment made with the tester.

The experiment in question shows the effect of varying the section of the iron by varying the number of strips which make up the sample. Eleven strips of thin transformer iron were taken, each 3in. long by ⅝in. wide, cut from the same plate. These were all used to form the sample in the first instance; then one was removed, and the remaining ten were tested, then nine, and so on, until finally the sample under test consisted of a single strip. The following are the scale readings for this, and also for another exactly similar experiment, which was made with a different specimen of transformer iron, of a poorer quality than the first. The two specimens are distinguished as A and B:—

Number of strips in sample.	Scale readings of magnetic tester.	
	(Specimen A.)	(Specimen B.)
11	72	118
10	71	117½
9	70	117
8	69½	116½
7	69	116⅓
6	69	117
5	69	120
4	71	124
3	75	132
2	85	142
1	69	130

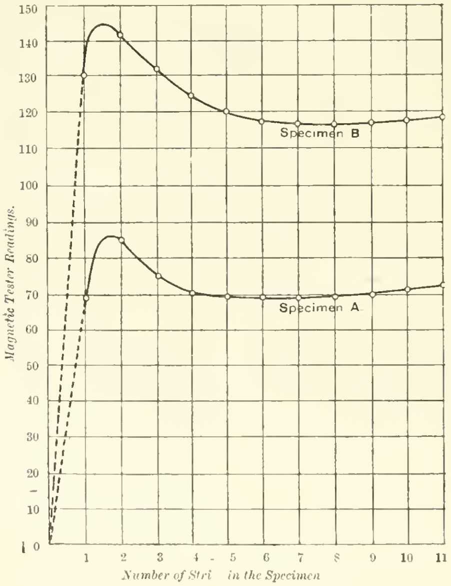
These results are also shown in the curves of Fig. 2. It will be seen that both curves have the same general character, and that the scale readings of the tester pass a very flat minimum when about seven pieces form the sample. Whether six, seven, or eight pieces be used, there is no material difference in the readings. Precisely similar results are given by other specimens. Hence, if a weight is chosen equal to that of seven pieces of this material as a general standard, it will suffice, in preparing other samples for test, to select that number of strips which will give a weight approximating even roughly to the standard weight. The nearest whole number of strips will do, and it is not necessary to cut a narrow or wide strip to make up the exact weight.

When only two or three strips of this thin iron are taken the work expended in reversing the magnetism of the bundle is increased. The total induction through the sample is somewhat diminished; but the intensity is increased, and this more than compensates for the smaller volume of iron that is being operated on. It is only when the sample is reduced to a single piece that the saturation of the iron prevents B from increasing sufficiently to continue this effect, and there is then a sharp fall in the curve.

These considerations have led to the use of samples the aggregate thickness of which is equal to that of six or seven of these transformer plates. In testing armature plates the same weight is approximated to by taking a smaller number of pieces. It is scarcely necessary to add that solid pieces, or bundles of wire, may be tested as well as sheet iron.

Calibration.—An extensive series of experiments has been made in order to determine to what degree of accuracy the readings of this magnetic tester correspond to the hysteresis losses as found by ballistic tests for various samples of iron. For this purpose it was necessary to test each identical sample in as nearly as might be the same state, first ballistically, and then in the new tester. In view of the variations which are observed between one part of a plate and another, the author did not feel that it would be satisfactory to use separate pieces for the ballistic observations and for the observations to be made with the tester. After some consideration he adopted the following two plans:—

In the first place, the ballistic tests were made on rings, each consisting of a long strip cut to the width subsequently wanted in the magnetic tester, namely, $\frac{5}{8}$in. This was bent into a ring, the ends just overlapping. After bending, the ring was annealed in a gas flame to get rid of the hardness produced by the bending. This is a most essential step, for in good iron the process of coiling into a ring, even of large diameter, hardens the metal very perceptibly, and increases the hysteresis. Then the ring was tested ballistically, a sufficient number of cycles being taken to allow a curve to be drawn showing the relation of the hysteresis loss, or $\int H\,d\,I$, to B, from B = 2,000 to B = 8,000 or so. The same thing was done with each ring. Then the rings were uncoiled and cut up into 3in. lengths for the tester, and the pieces were straightened and annealed to get rid of the hardness due to this straining. The whole number of pieces into which each ring had been cut were then dealt out into packs of six (or five, or seven, according to the thickness of the material), and these packs were shuffled until repeated trials in the tester showed that every pack gave nearly the same scale reading. The mean scale reading for the several packs obtained from each ring was then taken as a mean applicable to that ring. Here it was assumed that the first and second annealings might be held to bring the material into the same physical state.



To guard against any uncertainty on this point, four additional trials were made, using a different procedure. Long strips were again cut, but each of them was tested ballistically in its original straight form in a solenoid with open ends, the induction coil being wound over the central region only. Each strip was 36in. long and $\frac{5}{8}$in. wide, and a single strip was used in each test. The general effect of the free ends is to shear over the B–H diagram, but not to alter the enclosed area. Enough areas were measured to determine, as before, the curve of $\int H\,d\,I$ and B for each strip. The strips were then cut up into pieces for the tester, which were treated as in the former case. In this procedure there was no annealing.

By these two means seven standard samples in all were produced, of quality ranging from exceptionally good to exceptionally bad. The magnetic tester readings for these were taken, using approximately equal weights to form the sample in each case. In the following table the tester readings are given alongside of the value of the hysteresis loss ($\int H\,d\,I$) as determined ballistically for an induction, B, of 4,000 units for each of the seven specimens. Numbers I., II. and III. were those tested ballistically in the ring form; the others were tested in the form of straight strips.

Comparison of Magnetic Tester Readings with the Hysteresis Loss determined by Ballistic Tests.

No. of specimen.	Magnetic tester scale readings.	Hysteresis loss by ballistic tests. Ergs per c.cm.
I.	60	640
II.	81	890
III.	124½	1,420
IV.	70	750
V.	125½	1,430
VI.	136	1,580
VII.	184	2,120

The same results are shown graphically in Fig. 3. It will be seen that they accord well with one another, and that the scale reading of the magnetic tester is nearly proportional to the hysteresis loss. A straight line drawn from the origin among the observed points lies sufficiently near all of them to allow the assumption to be made, so far as workshop testing is concerned, that the deflection in the tester, when multiplied by a factor depending on the sensitiveness of the instrument, is a practical measure of the hysteresis.

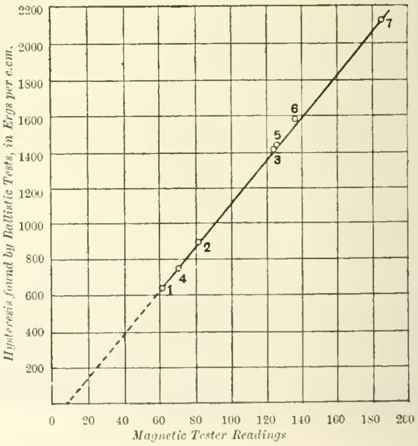


FIG. 3.

More exactly, however, the locus of the points is seen to be a straight line passing not quite through the origin. This may be partly due to the fact that the induction produced in the tester is not absolutely so high in the bad as in the good iron. In all probability, however, it is mainly due to this—that as the sample revolves some small amount of work is done in periodically changing the distribution of magnetism in the field-magnet itself, in addition to the work that is done in reversing the magnetism of the sample. Any work expended within the field-magnet would contribute to the deflection, and would exist even if the sample (while retaining its permeability) were entirely destitute of hysteresis. Hence the line may be expected to pass a little to the right of the origin, as it is actually found to do.

It is intended to furnish with each instrument two standard samples of iron, along with a table stating their hysteresis as found by reference to ballistic experiments (in ergs per cubic centimetre, and also in watts per pound, at an assigned frequency). In proceeding to test other samples the operator will first note the deflection given by each of his standard pieces, and then, by simple proportion, or by aid of a diagram, he may go on to interpret in absolute measure the deflection observed with any specimen. This will make his results independent of any loss of strength on the part of the field-magnet, or of any changes he may find it convenient to make in the sensibility of the instrument.

The hysteresis of the standard samples is stated for B = 4,000. To find the hysteresis for any other induction it is only necessary to use the following table of factors, which has been deduced by the author as a general mean from ballistic tests of many samples :

Induction B.	Relative amount of hysteresis.	Induction B.	Relative amount of hysteresis.
2,000	0·33	5,000	1·41
2,500	0·47	6,000	1·39
3,000	0·63	7,000	2·41
4,000	1·00	8,000	3·00

Other forms of the instrument can be constructed by making the field revolve while the sample is pivoted, so that the sample deflects; by placing the axis vertical instead of horizontal, with a control furnished by a spring or by bifilar suspension ; by using a weighted arm or a torsion head to measure the deflecting couple, instead of observing the deflection by a pointer on a scale ; and so forth. But the author believes that the form now exhibited will be found both accurate and handy in general use.

He hopes it may contribute indirectly to the betterment of the iron used for magnetic purposes, by making it easy for a purchaser of iron or a purchaser of transformers to specify a maximum of hysteresis, and to see that he gets what he specifies. A notable improvement in the quality of sheet-iron in this respect has been going on during the last few years, and it is now practicable to get iron which a short time ago would have been pronounced impossibly good. But it would be easy to quote tests showing that some iron of relatively very poor quality still finds its way into armature and transformer cores. The author's aim has been to put into the hands of those who are practically concerned with magnetic hysteresis, whether as makers of plates, builders of transformers, or engineers of alternate-current supply stations, an apparatus in which testing is reduced to its simplest terms, where each test consumes no more than a few square inches of the sheet, where the preparation and testing of the sample take only a few minutes of time, and the operation consists in turning a handle and reading how good or bad the iron is from the position of a pointer on a scale.

STATISTICS OF ELECTRIC SUPPLY STATIONS IN GERMANY.

The *Elektrotechnische Zeitschrift* of April 4th contains some interesting figures with regard to the present state of the electrical supply business in Germany. A glance at Table I. shows that the continuous-current system leads by a long way. It is represented by 81 per cent. of the total number of stations, and by 78 per cent. of the total output. Table II. shows that steam is the principal motive power employed, this agency being employed by more than half the stations, and being responsible for some 81 per cent. of the total output. Water power is comparatively little used, and gas still less. Grouping the stations by size, more than one-half have only an output of under 100 kilowatts, about 40 can be called of medium size, and only 20 are really large stations. The 148 stations are distributed over 135 towns. There are in all, connected up to the supply mains, nearly half a million 50-watt lamps, over 12,000 10-ampere arc lamps, and motors to the extent of 5,635 H.P.

Table I.

System.	No. of stations.	Output of dynamos (kilowatts).	Capacity of batteries.	Total capacity of station.
Continuous current with accumulators	80	14,388	4,459	18,847
Continuous current without accumulators	40	11,621	...	11,621
Alternating current	15	4,208	..	4,208
Three-phase system	8	2,858	...	2,858
Combination systems :—				
Three-phase and continuous current	2	646	32	678
Alternating current (generated) continuous current (distributed)	1	99	98	197
Continuous and alternating current...............	2	76	...	76
Total..........	148	33,896	4,589	38,485

Table II.

Motive power.	Number of stations.	Total output of dynamos (kilowt.)
Steam....................................	80	27,290
Water....................................	44	3,938
Gas................	5	265
Compressed air........	1	14
Electric motors	3	126
Combinations:—		
Water and steam	11	893
Water and gas...	1	30
Steam and gas	3	1,451
Total.......	148	33,897

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, April 26th.

Royal Institution.

9 p.m. Evening Discourse. "The Effects of Electric Currents in Iron on its Magnetisation," by Dr. John Hopkinson, F.R.S.

Physical Society.

5 p.m. Meeting at Burlington House. The following Papers will be read : (1) "A Theory of the Synchronous Motor," by W. G. Rhodwell ; (2) "Note on a Single Graphic Interpretation of the Determinantal Relation of Dynamics," by G. H. Bryan.

Institution of Mechanical Engineers.

7:30 p.m. Ordinary Meeting at the Royal United Service Institution, Whitehall. Prof. Roberts-Austen's Report, and reading of other Papers.

MONDAY, April 29th.

Society of Arts.

8 p.m. Cantor Lecture, "Recent American Methods and Appliances Employed in the Metallurgy of Copper, Lead, Gold and Silver," by James Douglas.

TUESDAY, April 30th.

Royal Institution.

3 p.m. Afternoon Lecture. "Alternating and Interrupted Electric Currents," by Prof. Forbes, F.R.S.

WEDNESDAY, May 1st.

Society of Arts.

8 p.m. Ordinary Meeting. The following Paper will be read: "Deviations of the Compass," by Prof. A. W. Reinold, F.R.S.

Royal Institution.

5 p.m. Annual Meeting.

THURSDAY, May 2nd.

Royal Institution.

3 p.m. Afternoon Lecture. "The Liquefaction of Gases," by Prof. Dewar, F.R.S.

Institution of Civil Engineers.

8 p.m. The third "James Forrest" Lecture at the Royal United Service Institution, Whitehall. Subject : "The Development of the Experimental Study of Heat Motors," by Prof. W. C. Unwin, F.R.S.

FRIDAY, May 3rd.

Institution of Electrical Engineers.

8 p.m. Students' Meeting. The following Paper will be read : "Single-Phase Alternate-Current Motors," by A. C. Eborali.

Jungfrau Electric Railway.—The plans for the generating stations in connection with this mountain railway are now completed, and are before the Town Councils of Gündlischwand and Lauterbrunnen for consideration. As motive power the water of the "weissen Lütschine" will be used. The required amount of water is 5,000 litres (1,100 gallons) per second, and as, after careful tests, the supply of the stream in summer months was found to be from 2,200 to 33,000 gallons per second, no fear is entertained of the water supply running short. To take the greatest advantage of the water power, two generating plants are proposed, namely, an upper one, with a head of 115ft., and a lower one, with 220ft. The former plant will consist of four 470-H.P. horizontal turbo-dynamos and two 35-H.P. turbo-exciters. The lower plant will be considerably larger, and will comprise four 1,000-H.P. turbo dynamos and two smaller ones for the exciters. The total output of both generating sattions will be 4,400 H.P.

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All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as evidence of good faith. No notice whatever will be taken of anonymous communications.*

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SPECIAL NOTICE.

The present number of "THE ELECTRICIAN" *completes Vol. XXXIV. With next week's Number will be issued (Gratis) the Index to the Volume.*

Owing to the growth of the electrical and allied industries the demands for space in "THE ELECTRICIAN" are, for the greater part of the year, so pressing that a permanent increase in the size of the journal has become necessary. To meet the increased cost involved by this step, and by other improvements, such as heavier paper and more numerous illustrations, the price of "THE ELECTRICIAN" will, from this issue, be advanced to **6d.** *Hitherto this sum has been charged when the number has contained a Supplement, and, as the industries grow, these may be more frequently necessary; but the practice of charging extra for Supplement numbers as issued will be discontinued.*

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EARTHING THE MIDDLE WIRE.

The programme of the Institution of Electrical Engineers has this session been a tolerably varied one. There have been Papers on electric traction, on dynamo design, on magnetism, on electro-metallurgy, on the telephone switchboard, on railway electric lighting. One or two topics, however, which but for an occasional airing in the columns of the technical journals would never see the light of day, are apparently taboo, notwithstanding that wherever two or three electrical engineers are gathered together to indulge in a quiet professional talk one or the other of these topics is sure to crop up. No doubt the vagaries of alternators when running in parallel, jerry house-wiring, and the advisability of earthing the neutral of a three-wire system, are "delicate questions"; they touch the pecuniary interests of manufacturers, the tender susceptibilities of dynamo designers, the confidence of the public in the electric light. But since it is generally agreed that these matters are of considerable interest and importance, we shall certainly sooner or later have to give up discussing them *in camerá*, and harden their delicate constitutions by a little wholesome publicity.

Take, for instance, the grave question of the earthing of the middle wire of a three-wire system. In another column will be found a valuable Report on the subject drawn up under the authority of the Verband Deutscher Elektrotechniker, and signed by Mr. Gisbert Kapp. This Report, together with some remarks made in the course of a Paper recently read before the Berlin Elektrotechnischer Verein by Dr. Kallmann, electrical engineer in the Berlin Municipality, show that our German friends, at any rate, are not afraid to come out into the open and debate the *pros* and *cons* of one of the knottiest problems of electric supply. The Report is the outcome of a dispute between the German Post Office and the Altenburg Town Council, who wanted to earth their middle wire. The Association, over which Mr. Kapp presides, was called in to settle the dispute, and summed up strongly in favour of the plan of earthing. Not less favourable are the remarks of Dr. Kallmann. In this country, on the contrary, there is, so far as we can ascertain, a somewhat strong prejudice against this course, no two successive individuals, however, agreeing in what they apprehend will be the consequences; but as two of a trade seldom do agree, too much emphasis should not be laid on this sad lack of harmony among the prophets of evil.

The arguments of the advocates of earthing have, it must be admitted, a very convincing appearance; no doubt those on the other side would be equally so, could their supporters be prevailed upon to give the electrical community the benefit of their experience and meditations. An earthed neutral, it is said, affords a means of immediately discovering and therefore of repairing leaks, should they occur on the outside or inside network: both in the streets and in the houses the fuses will go. Further, the thorough earthing of the middle wire will tend to concentrate what we may term the area of roaming of leakage currents, and that effect, together with the speedy action of the fuses, will tend to diminish the number and the duration of telegraphic and telephonic disturbances. Again, with the neutral earthed the positive potential to earth is only one-half what it is with the middle wire insulated. These, it might be reasonably objected, are mere neat *a priori* arguments. But "facts are stubborn things," and here, to back up their argumentation, the advocates of earthing have Dr. Kallmann's statement that in the autumn of last year the municipal authorities of Berlin, in the interests of the public safety, required the connection of the middle wire to earth.

On the other hand, the Board of Trade, which is burdened with the immense responsibility of safeguarding the public security, the Post Office, the National Telephone Company, and the fire offices, may very well agree to differ with this sanguine view of things. Earthing the neutral, the opponents of the idea may say, doubtless *tends* to reduce the resistance between a faulty outer and earth; but will the fuses actually go with all the obliging promptitude prophesied? And even assuming the fuses will consent to oblige, is not this fuse-blowing indoors and out somewhat too heroic a remedy; is not this alleged impossibility of maintaining a decent insulation on a large three-wire system a lamentable confession of weakness; are we quite sure that what is all very well for a triple-concentric system of cables out of doors, and for a double-concentric system indoors, is without danger when we have bare copper in culverts outside and rubber-insulated wires in modern casing inside; and what about the possibility of electrolytic troubles?

Now it is just because there is so much to be *said* on one side and so much to be feared on the other, that we think that a frank and free discussion of a matter that sooner or later will surely have to be settled definitely one way or the other, would conduce to the general advantage. At present we have one English central station manager stating that since the conversion of his network into a three-wire system Providence or somebody else has been sufficiently kind to keep the neutral at the same potential as earth, and the advantage of this is so much appreciated that when the Unknown ceases to help him, artificial automatic arrangements continue to act instead; and another equally competent, equally experienced engineer offering almost unqualified opposition to the earthing of the neutral. No advocate of earthing would be bold enough to recommend it as an universal panacea, but as the Report of the Verband aptly remarks, it only remains to choose the system in which, firstly, faults are less often to be expected, and, secondly, when such occur the resulting disturbances are quickest put right. "Of two evils the less is always to be chosen."

REVIEWS.

An Introduction to the Theory of Electricity, with Numerous Examples. By L. Cumming, M.A. Fourth Edition. London: Macmillan and Co. 1894.)

Since its first appearance, in 1876, this work has filled an important place and proved itself of no little value as an academical treatise or college text-book. The facts of electrical science can only be discovered upon an experimental basis; but there are, among the less fundamental facts, many which can be directly deduced from certain simple experimental data or from certain mathematical suppositions. For example, a whole series of theorems about condensers, distributed charges, &c., may be built upon the generalised theory of potential—which is simply *à priori*—together with the law of attraction between two point-charges; or, again, an experimental premise like Ohm's law may be wielded to assist in the deduction of endless theorems about electrical circuits. The student has only to be sure about his premises, and then he need care about nothing, save that he is provided with writing material and the mathematical text-book which Mr. Cumming has written.

It seems to us, however, that this method of acquiring an introduction to the theory of electricity is more useful as a mental exercise, as mixed mathematics, as logic, in fact, than as a stepping-stone to the real modern ideas about that theory. It savours too much of the old school which laid much stress upon that invaluable implement, deductive logic; and which attached relatively small importance to experimental investigation. Let us not be misunderstood. We are very far from saying that Mr. Cumming deprecates experimental study; we only wish to point out that the student whose introduction to modern electrical studies is based upon deductive theorems, the premises of which are largely academical, is very likely to fall into the error of supposing that the science owes little to experiment, or to anything else but pure mathematical reasoning, for its further advancement. Viewed in this light, the title of the work before us is, we think, misleading; it would have been better to have styled it mathematical exercises in electrical science, or something of that sort; to have made it clearer, in fact, that the book is but a text-book on one branch of mixed mathematics.

When this treatise first made its appearance it was orthodox to describe electrostatic and electromagnetic phenomena in terms of the imaginary substances positive and negative electricity, and north and south magnetism. We fear that a great deal of the original method of treatment still clings to this book. It is surprising to find in any modern work, claiming to furnish an introduction to electrical theory, such a crude and obsolete explanation of the source of contact electrification in the theory of the voltaic cell, as that "the opposed electricities so separated will, for the most part, be heaped up on either side of the plane of separation"—yet this occurs on page 153. Altogether, we find too much about "electricity" in the chapters on electrical phenomena, and too much about "magnetic matter" in the chapters on magnetism.

Problems and Solutions in Elementary Electricity and Magnetism. By W. Slingo and A. Brooker. (London: Longmans, Green and Co. 1895.)

This little book consists of the examination papers in elementary electricity and magnetism, set by the Science and Art Department between 1885 and 1894, with suitable illustrated answers, and a number of unanswered original questions for exercise on the part of the student. Having restricted themselves to these examination papers, it is, of course, not the authors' fault that practically none of the questions answered are mathematical or arithmetical. Every science teacher knows the value of a problem class; and he can also appreciate a work which lightens his labour in finding problems for such a class. But opinions are divided as to the value of the question-and-answer method of teaching merely descriptive information.

The chief aim of the authors has evidently been to teach the student how to answer questions; but the method they have adopted may very possibly serve a further purpose. The attention of the student is more emphatically directed to the *point* of the information when it is preceded by a question than when it is given in the usual text-book form. We speak of beginners only; for there is nothing conceivable more tedious and wearisome than that those who do possess the faculty of seeing the point for themselves should be instructed *à la* "Mrs. Markham's History."

Steel Works Analysis. By J. O. Arnold. (London: Whittaker and Co. 1895.)

This work, which takes its place in Messrs. Whittaker's well-known and valuable "Specialists' Series," is designed as a practical treatise for the use of students who are preparing themselves for the post of analyst in steel works. As the author, who was formerly chief chemist at the Sheffield Steel and Iron Works, rightly says: "Analysts deficient in . . . . the principles of chemical analysis, can claim to rank only with skilled artisans; in chemical analysis the head and the hands should always work together." Acting upon this principle, the author has made his book something more than a cut-and-dried guide to testing, and has carefully embodied a judicious amount of theory and explanatory remarks. In order to render the work easy of reference, the theory and the practice have been placed, so to speak, in separate compartments or paragraphs, each suitably headed. This makes the book handy in the laboratory, at the same time that it is satisfying in the library.

The ground covered in this treatise is sufficiently extensive, and is not restricted to the analysis of iron and steel in process of manufacture. For example, such matters as the determination of the evaporative power and thermal value of coal, and the analysis of boiler water, receive their fair share of consideration. The author rather curtly dismisses the subject of the "determination of temporary hardness" of water, the method he recommends being specified as follows: "The total hardness – the permanent hardness = the temporary hardness." We beg respectfully to submit that this is simple arithmetic, and not chemical analysis. In many cases in boiler practice one wants to know what the temporary hardness is likely to be, and one would like a more direct method of determining it than the formula supplied by Mr. Arnold. We may mention that, on receiving this book, we turned with some curiosity to the index to see if the author had anything to say about magnet steel and iron; but perhaps we had no right to expect anything on this subject, as the time has hardly yet arrived for the chemical properties of magnet iron and steel to occupy the attention of steel works' chemists, although a diligent collection of data by them should prove not only of commercial but also of scientific value. The absence of information on this point cannot at present fairly be considered a defect, although dynamo makers, no doubt, would very much like to see the matter competently dealt with. Before many years have elapsed, it will form, we venture to think, an essential branch of steel works analysis. We can heartily recommend this book to such of our readers as are interested in the subjects with which it deals]

PROPAGATION OF MAGNETISATION IN IRON.

In *The Electrician*, February 22 and March 1, 1895, we reprinted a very full abstract of the Paper on "Propagation of Magnetisation of Iron as Affected by the Electric Currents in the Iron," which was read before the Royal Society by Dr. Hopkinson and Mr. E. Wilson. Since the reading of that Paper the authors have carried their researches to further extent with modified apparatus, and the results of their subsequent researches have been embodied in a Paper which was read before the Institution of Electrical Engineers last February. The general conclusions to which these later researches have led do not materially differ from the previous ones, but as the apparatus employed was better calculated to give satisfactory results than that used in former experiments, it is advisable to say something about it, and to give our readers the accompanying illustrations of it.

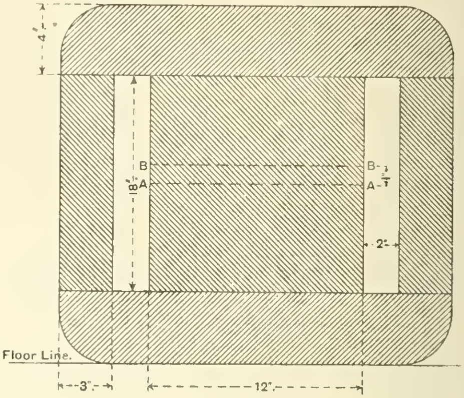

Fig. 1.

It may be remembered that the authors first of all employed a form of embedded coil winding, which introduced disturbing effects on the induction in the iron. These troubles have been eliminated by means of the tunnelled core of the magnet shown in Figs. 1 and 2. The former of these figures shows a vertical section through the magnet, the magnetising coils (not shown) being placed in the annular space between the inner core and the outer cylindrical shell. A horizontal section, on A A, of the inner core is shown in Fig. 2. This shows the tunnelled passages through the iron, whereby the exploring loops and coils were introduced into the mass of the core. It will be seen that the intersection of the tunnels forms a number of rectangular elements of the core at varying depths. By threading insulated wires through these tunnels, and looping them round one or the other of these rectangular elements of the section, that particular element may be explored, and when any particular loop is connected to a ballistic galvanometer, and a magnetising current is started in the field coils, the growth of the magnetic induction in the particular element of the section under consideration will be indicated by the throw of the ballistic galvanometer.

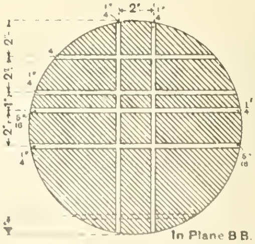

Fig. 2. Section on A A

THE USE OF ELECTRICITY FOR COOKING AND HEATING.*

BY R. E. CROMPTON.

Up to the present time, the utilisation of electrical energy, laid on now so universally in our houses for lighting purposes, for the further purposes of heating and cooking, has been regarded by the public, and even by many who have technical knowledge, as impracticable, and certainly as too costly, to be seriously adopted. It will be my object this evening to show you that far from this being the case, heating and cooking by electricity has now advanced to a highly practical and useful stage. No doubt these erroneous impressions have arisen chiefly from the fact that the advocates of electric lighting have from the first dinned into the ears of the public that one of the chief advantages of electric lighting is that by it light is furnished without heat; even those who put it more precisely showed that a 10-c.p. gas jet heated the air of a living room 13 times more than a 10 c.p. electric glow lamp; and it was the knowledge of these facts that prevented electrical engineers from carefully examining the problems connected with electrical heating. However, at very early periods, Siemens showed that where intense heat is required to be concentrated in a small space, the electric arc forms a very convenient furnace, and, in many cases, actually possesses economical advantages. The principle was practically adopted by Cowles for his earlier furnaces for reducing aluminium, and has been also used for electrical welding by the Bernardos process.

But for the production of the heat we require for warming rooms or for cooking food, little or nothing was done until about four years ago, for although Lane Fox was the first to point out, in his 1878 patent, that electrical heating could be satisfactorily carried out by placing the food or other materials to be heated in a vessel surrounded by a coil of insulated wire, through which a current should be passed, nothing appears to have been attempted until about four years ago Carpenter, in America, so far developed Lane Fox's ideas as to take out a patent for manufacturing electrical heating apparatus by attaching these resistance wires to the surface of cast-iron plates by an enamelling process, and a considerable amount of apparatus was manufactured by him in America on this principle; some of this was forwarded to England, and was shown at work by Messrs. Crompton and Co., at the Crystal Palace Exhibition in 1891.

In practice it was then found that, although Carpenter had done sufficient to show that electric heating could be usefully employed, yet that the apparatus at that time was not sufficiently durable to be of practical value. A number of serious defects made themselves evident, principally connected with the enamelling process; the enamel was found to crack, and the surface of the wire used was thus exposed to the oxidising action of the air. This action rapidly destroyed the wire, and thus broke the circuit. It occurred to us that this difficulty might be surmounted if sufficient time were spent on a research into the nature of the metals best suited to stand the frequent heatings and coolings to which the apparatus is subject, and which at the same time would have a coefficient of linear expansion so nearly the same as that of the enamels used, and of the plates to which the wire is attached by these enamels, that the tendency to crack, which is caused by unequal expansion, would be overcome. After a long course of experiments we found that several of the nickel steel alloys, varying in composition from pure nickel to others containing quite a large proportion of steel, were well suited for the purpose, and in all respects were far superior to the German silver alloys which had been used in America. We also found that if we substituted for the homogeneous enamel used by Carpenter, a composite enamel consisting of two or more layers, the lower one being of the hardest and most refractory character, we were able to obtain very satisfactory results. We have been able to use an enamel consisting almost entirely of silica for the ground-work; this fuses only at an exceedingly high temperature almost approaching the welding point of wrought iron. We devised special machinery to artificially roughen the surface of the plates to which this first coat of enamel is to be applied, and we thus insure that the layer of enamel between the wire and the plate, to which it is attached, is never even softened at the temperatures reached by our apparatus in ordinary working. We apply our nickel steel wire in the form of a waved or crimped ribbon. This crimping is carried out by a special machine devised for the purpose.

This crimped ribbon is mounted on the surface of a "transfer plate," afterwards to be described, and it is from it transferred to the surface of the first coat of enamel, which has been already raised to a temperature sufficient to soften it but not to melt it. We then cover the first enamel and the wire with powdered enamel of a more easily fusible nature, and we then raise the temperature of a whole to a sufficient degree to enable the second enamel to melt down and incorporate itself with the upper surface of the first coat of enamel, at the same time completely covering and insulating our wires. This process is one which has required much study and considerable manual dexterity on the part of the workmen, but once it was perfected it gave excellent results; it allows the wire to be heated to any degree desirable for ordinary heating or cooking operations, without any fear of the enamel cracking so as to allow of access of air to the wire.

Not the least part of our difficulties was the preparation of the crimped wire and the designing of the transfer plates above referred to. We found that if we attempted to crimp the wire or arrange it in wavy patterns by hand, that the wire was always liable to become thinner at each of the bends, and consequently the electrical resistance at these points was higher, and the heat developed greater than that of the points intermediate between the bends. To avoid this, we had to devise a crimping machine, which crimped or corrugated the wire in such a manner as to avoid altering it cross-section. This machine takes the wire from a reel, crimps it, and delivers it in any desired pattern on to the surface of the transfer plates.

The transfer plates consist of a metal plate, to the back of which are attached a number of electro-magnets, in such a manner that when the crimped steel wire has been laid on its plate, in any desired pattern or form, by exciting the electro-magnets, they hold the wire and retain it firmly in position on the surface of the plate until it is desired to transfer it to the heated surface of the enamel; this can be done instantaneously by breaking the exciting circuit, so that the wire no longer adheres to the transfer plate. We have other methods of rapid transfer, but it is unnecessary to take up your time by describing them here, as the above method is fairly representative of the others. By the above-described method we are able to apply the wire in somewhat complicated patterns to the surface of any metal plate, and to insulate it therefrom in a very thorough and permanent manner by our compound enamel. The only other difficulties which have arisen in connection with the enamel have been those due to unequal expansion and contraction of the terminals at the ends of the wire. At first we had some difficulty in arranging these so that the enamel did not crack, and allow the terminals to be burnt or oxidised at the point at which the wire leaves the enamel.

The simplest form of apparatus in which we heat a plate by a current passing through a wire enamelled to its surface, is that which we call a heater. It is a cylindrical plate mounted on short legs, to the underside of which wire is applied and fixed by the enamel, the upper side being ground flat and polished. Such a heater can be put to many useful purposes; it can be used as a radiator of heat or as a means of heating dishes on the breakfast table, or for the purpose of drying linen or for warming or drying any article which it is inconvenient or dangerous to place near the fire. It can also be used for cooking purposes if the food is placed on flat dishes or pans, care being taken that the lower surface of the pan comes into close contact with the upper surface of the heater; but, although cooking *can* be carried out in this manner, we do not recommend the use of separate heaters, as there is always a loss from the lower surfaces of the pans not making sufficiently good contact with the upper surface of the heater, and we therefore prefer to insure this contact by making the heating-plate form part of the kettle, saucepan, frying-pan, or other similar culinary utensil.

In the course of our experiments to determine the best and most efficient arrangements of our apparatus we met with great difficulties in what would appear a comparatively simple matter—the measuring of the temperatures we obtained. We found that the ordinary mercurial thermometer, however carefully it may be made, is not suitable for accurately indicating the temperature of the heated surfaces, as it really indicates the temperature of a stratum of air near to the heated surface instead of that of the surface itself. After trying Calender's improved form of the Siemens electric pyrometer we eventually adopted for our measurements of temperature my own form of platinum thermometer, a description of which may interest you at this stage. This platinum thermometer, which measures temperature by showing the increase in resistance due to the rise in temperature of a delicate coil or platinum spiral placed in close contact with the heated surface, is made and used as follows: The spiral consists of a thin strip of platinum only two-thousandths of an inch thick by one twenty-fifth of an inch wide; a sufficient length of this strip to have about 5 ohms resistance at the temperature of 0°C. is wound in a form of double spiral on to a strip of mica sheet about half-an-inch wide by 4in. long; this is enclosed and held between two similar sheets of mica fastened together at their edges by a sewing of very fine platinum wire. The total thickness of the spiral and its covering is not greatly in excess of that of a sheet of paper, so that the whole of the spiral can be brought within a distance of one-hundredth of an inch from the surface to be measured. It is arranged on an electrical circuit in series with a standard resistance made of manganin. The standard made of this alloy has practically no change in resistance due to change of temperature, *i.e.*, within the limits of air temperature change of an ordinary room or laboratory. Both platinum spiral and the standard manganin resistance are provided with couplings or terminal screws, by which any desired number of platinum spirals may be coupled in series with the manganin standard. A very small constant current from an accumulator cell is passed through the whole of them. Each of the platinum spirals, as well as the manganin standard, is provided with a pair of potential terminals, and at the time of first calibration they are carefully adjusted, so that the potential difference measured on a potentiometer is exactly equal. When the platinum spirals are plunged in melting ice and the manganin resistance is at the ordinary laboratory, it is convenient to balance them at this point at 1,000 on the potentionmeter scale. The platinum spirals are then exposed to the temperature of boiling water in a hypsometer, and if the platinum employed be pure, the potential difference of the platinum spirals, when now compared with that of the standard, will be as 1,362 to 1,000. If this portion of the potentiometer scale between 1,000 and 1,362 be divided into 100 parts, each of these will be equal to 1°C. It is evident that any desired number of temperature readings may be taken by employing a corresponding number of platinum spirals, and comparing them in turn with a standard. It is obvious that this method of taking temperatures presents many advantages over the employment of ordinary thermometers, as when these have to be used for taking temperatures of ovens or of the interior parts of meat, or of other food, the act of removing the thermometers to take the reading introduces errors of considerable magnitude, whereas, with the arrangement I have just described, it is possible to take accurate readings, practically simultaneously, of the temperature in various parts of the oven or other apparatus, and of various parts of a joint of meat, and in this way a great many interesting facts respecting cooking have come to light. By these means we have been able to measure, with a high degree of accuracy, the amount of electrical energy that is required for various forms of heating and cooking apparatus, and the following four tables give a fair idea of the cost of heating of surfaces required, first for roasting, or baking, or frying; the second table gives the cost of heating surfaces to a lower temperature, such as is required for warming the air of a room, or for airing linen, or similar purposes. Tables III. and IV. give the cost of the energy required for boiling water in small quantities, and are interesting, as they show that even when we are using electricity in the manner in which it compares least favourably with solid fuel, *i.e.*, for the boiling of water, we can, with an ordinary electrical kettle, switch on the current and obtain a cup of tea at a cost of less than a farthing for a single cup, or half a farthing per cup, if several are required. Although these tables show the amount and cost of electrical energy required to raise various kinds of heating surfaces to a certain temperature, something more than this is necessary to enable you to form an opinion of the value of heating and cooking by electricity from the point of view of economy.

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* Paper read before the Society of Arts, Wednesday, April 24th.

Table I.—*Showing energy required to raise a heater plate from 50°F. to 400°F. in half an hour.*

Time.	Energy in B.O.T. units.	Cost at 4d. per unit.	Temperature, Fah. scale.
0	0	0	50deg.
10min.	0·116	0·46d.	257deg.
14min.	0·164	0·67d.	332deg.
21min.	0·248	1·0d.	357deg.
30min.	0·404	1·61d.	400deg.

Table II.—*Shows the energy required for a radiator plate, such as we use for heating the air of a room.*

Time.	Energy in B.O.T. units.	Cost at 4d. per unit.	Temperature, Fah. scale.
0	0	0	50deg.
10min.	0·091	0·364d.	171deg.
30min.	0·277	1·1d.	240deg.
40min.	0·350	1·4d.	257deg.
50min.	0·430	1·72d.	261deg.
60min.	0·500	2·0d.	264deg.

Table III.—*Shows the energy required for boiling 1lb. of water in a tea-table kettle.*

Time.	Energy in B.O.T. units.	Cost at 4d. per unit.	Temperature, Fah. scale.
0	0	0	50deg.
10min.	0·075	0·32d.	212deg.

Table IV.—*Shows energy required by a smaller kettle containing ¾lb. of water, i.e., sufficient for two cups of tea.*

Time.	Energy in B.O.T. units.	Cost at 4d. per unit.	Temperature, Fah. scale.
0	0	0	50deg.
12min.	0·051	0·2d.	212deg.

When the subject is first mentioned even to a skilled engineer, his first idea is that in almost every case electric heating must be too expensive to become general. He knows the wastefulness of steam generating plant is such that not more than 6 per cent. of the heat energy in the fuel can be distributed to the consumer in the form of electrical energy, and he is not to be blamed if he concludes from this that there is no chance of using the reconverted heat from this energy, in competition with the heat which the consumer can obtain direct from burning the fuel itself. But the fact is that all these opinions are based on an insufficient knowledge of the economy—or rather extraordinary want of economy of cooking—as carried on at present by the ordinary kitchen grate. Now that we can actually measure the heat that is required, and carry on cooking operations, we are astonished at the smallness of the results obtained by present methods. The percentage of the heat units of the coal burnt in our kitchens which is actually utilised in cooking the food is in all private houses, and in most hotels and clubs, so ridiculously small that I should hardly be believed if I quoted you the figures which we have obtained; it is not too much to say that in many cases not more than 2 per cent. is utilised. This enormous waste is due to the fact that with the sole exception of boiling and stewing all the remaining operations of cookery depend on the radiation of heat to the substance to be cooked. Take, for instance, the process of grilling a chop; consider how much coke has to be burnt before a bed of glowing coke fit for the purpose is obtained, and after the clear grilling fire is in order, consider that 70 per cent. goes up the chimney, 16 per cent. is radiated into the room, or employed in roasting the cook, male or female, as the case may be, it is not difficult to understand that the chop itself does not receive more than 2 per cent. of the total heat-units. On the other hand, with a properly-arranged griller, heated by electrical means, fully 65 per cent. of the heat energy in the electricity is utilised in the meat. Take, again, the case of the ordinary oven attached to the kitchener of a small private house. The oven may be used, on an average, three hours a day, but if solid fuel is used the oven must be heated continuously from the time that the kitchen fire is alight in the morning until late at night, so that in this case the heat usefully radiated from the sides of the oven to bake, to roast, or brown the food within it, generally amounts to a very trifling percentage of the fuel used.

The comparison with gas cooking, although not so striking as when solid fuel is used, is still very favourable to electricity, for, although in the case of the gas oven, considerable economy results from the gas being used only at the time that the oven is required for cooking, yet in this case the heat is communicated to the food by radiation from gas flames, so that it is necessary that a current of air must continuously pass through the oven in order to ventilate it, and carry away the products of combustion. This ventilating current also carried away with it at least 80 per cent. of the heat units obtained by burning the gas.

The electrical oven consists of a rectangular box, having double sides at bottom, top, back, and front; the inner surfaces of the inner plates are the electric radiators, and the space between them and the outer plates is filled with a non-conducting material; the door closes practically airtight, no ventilating current of air is necessary, thus all waste of heat being prevented. In this case, when the oven is filled with food, more than 90 per cent. of the heat energy can be utilised, and thus, although possibly 5 to 6 per cent. only of the heat energy of the fuel is present in the electrical energy—90 per cent. of this—or 4½ per cent. of the whole energy actually goes into the food, and thus the electrical oven is practically twice as economical as any other oven, whether heated by solid fuel or by gas.

Thus far I have dwelt at some length on the economical question: it is time to say something on the questions of the convenience and of the superior results which can be obtained by the electrical means. I have already spoken of the large loss by radiation which occurs when solid fuel is used, or to a less extent when gas fuel is used; this has the great inconvenience of injuring the quality of food that is being prepared in the kitchen, of keeping the cooks in a heated and unpleasantly perspiring condition, and I might enlarge considerably on this point. The electrically-worked kitchen may be kept as cool as a dairy if it be desired, and the effects on the quality of the cooking, and on the health and tempers of the staff, must be experienced before it can be fully appreciated. I have also mentioned, in the case of the gas oven, the necessity for allowing ventilating currents of air to pass over the surfaces which are cooking.

These currents of air dry up and harden and take away the flavour of the outer portions of the meat; any connoisseur can detect this in the case of joints cooked in a gas oven. With the electrical cooking the absence of such ventilating currents and the stillness of the air prevents the above-described drying and hardening action; the meat is found to be tender and juicy right up to the extreme outer surface; it is browned only to a sufficient extent to please the eye and the palate. Again, the facility for regulating the temperature to any degree of nicety, which we can give with any of the electrical cookers or ovens, is being highly appreciated in the higher walks of the culinary art. Most skilled cooks will tell you that it takes much experience to satisfactorily manage an ordinary oven so as to bake or brown pastry or sweetmeats, and always give a uniform result. When these skilled cooks use electrical apparatus for the first time they almost invariably say—a child could learn the ways of this oven in a few hours, and produce as good results with it, with absolute certainty, as I could with an ordinary oven after I had known it and learnt its ways for years.

All users of electric light are interested in the development of electric heating and cooking. You all of you have been told that the cost of electrical supply may be greatly reduced, if it can be utilised during the daytime for other purposes in addition to lighting. Although the day may come—and I feel certain will come—that electricity will be used for power purposes within our homes to an extent undreamt of at the present time, yet such development must be necessarily of slow growth. We must be educated to the point of using power for many occupations and pursuits which have yet to be invented; but the day of electric cooking is not far distant. There is no reason why in a few years to come quite a majority of the users of electric light should not do all cooking operations of the nature of roasting, baking, stewing, frying, by electrical means—perhaps still employing solid fuel for boiling purposes only, and this in connection with a suitable furnace for supplying the whole of the hot water required for a household.

Time does not allow me to go into very many interesting matters connected with electric welding, brazing, soldering, roasting of ores, drying of paints, and many other industrial operations in which electrical heating can be advantageously employed. I am also unable to do more than state the bare fact that the managers of several theatres—notably the Vaudeville—have found that electric radiators form a most convenient, safe, and economical method of heating the auditorium of a theatre. During the late severe frost these radiators were found to be a great convenience in large shop fronts to prevent the lowering of the temperature, and hence the freezing of the moisture on the plate-glass, which otherwise obscured the contents of the windows.

SAFETY PRECAUTIONS IN CONNECTION WITH UNDERGROUND MAINS IN BERLIN.

A lengthy Paper was read recently before the Berlin Electrotechnical Society by Dr. Martin Kallmann, municipal electrician of Berlin, dealing with administrative and safety regulations for electrical distribution by the Berliner Elektricitäts Werke in that city. The author, having discussed the working of the three-wire direct-current system as carried out by means of lead-covered iron-armoured cables during the past ten years, referred to the precautions to be taken to ensure safety. The following is a brief abstract in so far as the latter is concerned:—

The principal function from the point of view of technical safety is left to the fuses provided in every street and service box. It must, however, not be forgotten that the street fuses rarely come into operation. With short-circuits and earths in the houses, the fuses there will mostly blow. If, however, an earth takes place in the street it is impossible to rely upon the prompt working of the cable safety devices at the moment of danger. A relatively small current strength only is necessary, especially in the earth, to produce a very important thermal effect by the formation of arcs. In any case, earths of several hundreds of amperes are infrequent, and, as a rule, other circuits in the neighbourhood of the arc are included in the latter before the intensity reaches such a height. Even then one cannot yet safely depend upon the blowing of the fuses in the case of large cables. If one places any value upon pressure measurements and automatic fault indicators, the provision of several test wires in the main feeders is to be recommended. The use of safety fuses of such a large cross-section as not to be blown by any single dynamo in use, in case the full load of the latter should pass through the fuses, is not judicious. It may be mentioned that no lead fuses are inserted in the neutral conductors of the Berlin street network.

The direct electrical safety devices used in Berlin comprise automatically operating signalling appliances which indicate in the central station any interruption immediately on its taking place. Two apparatus of this kind have been introduced during the past two years. The construction of these is based upon the utilisation of the testing wires in nearly all cables, and which, connected to a signal relay, give warning at the generating station not only of direct mechanical injury to the cable, but also indicate the entrance of water in the street boxes, and the occurrence of insulation faults. This method of control, which was described in a previous Paper,* has proved to be an important factor of safety in regard to cable interruptions. Apart from this special controlling appliance, there are several indirect safety contrivances. Among these is the method of supply by means of storage batteries. Another circumstance which contributes towards the condition of safety is the absence of fuses in the neutral street conductors, the former being replaced by simple copper connecting pieces. It is admitted that a good insulation of all poles in a large three-wire system cannot be entirely maintained, whilst the superiority of a middle-wire earth as compared with an outer conductor earth is not disputed. As soon as one pole is earthed, as, for instance, the middle wire, fuses for this pole are superfluous and troublesome. There is practically no justification for calculating the fuses of the middle wire, which at most is half as heavy as the outer conductor, to a correspondingly small cross-section. The middle wire has only to serve as a compensator. In the case of a short-circuit or a heavy load on one side it would be unnecessary to provide fuses also in the middle wire, as in an extreme case of this character the fuses in the outers would be sufficient.

The police regulations in Berlin still prohibit the laying of bare conductors. Nevertheless, a permanent neutral earth exists in the network. In the autumn of last year the authorities, in the interests of public safety, required the connection of the middle wire to earth, the solid metallic connection of the armouring of all cables to the neutral pole being regarded as desirable. Whether the neutral wire is now actually laid uninsulated or not, the connection at short distances of the cable armouring with the neutral pole affords the best security for the prevention of an extension of an earth. On damage to an outer conductor, the disturbing effects would almost exclusively be restricted to the fault or to some neighbouring cable, since the lead and iron armour of each cable represents the negative pole, and thus the earth is a complete short circuit between the cable core and its lead and iron covering. The disturbing effect in this way remains almost entirely of an internal nature; the current strength increases within the shortest time to a maximum, and the lead fuse of the faulty outer conductor comes into operation. As a result, the extent of the interruption is not only local, but its duration is considerably reduced. The probable diminution in the disturbances in telephone wires through this method has previously been mentioned; but the connection of all cable armouring with the neutral pole may also remove the danger of fire. The cables are insulated from the pipes and other metallic masses in the streets. The insulation is effected by laying the cables parallel at distances apart of 30cm. and 15cm. at crossings. When this distance is unattainable, the cables are arranged in glazed earthenware covers or pipes. It is evident that by the adoption of this protective method, not only is the network of pipes better safeguarded against immediate damage from the effects of combustion in the case of earths, but the participation of these masses of iron in the distribution of current when earths arise is considerably reduced if not entirely prevented. It will only be at those places at which the neutral pole is intimately connected with the network of pipes that the safe passage of current will take place.

Dealing with mechanical protective measures, there is the question of preventing explosions. Those due to electrolysis through water entering the boxes can be prevented by the careful maintenance of the rubber layers protecting the tops of the boxes. A further safeguard lies in the automatic indication of the entrance of water or moisture in the boxes by the use of the before-mentioned controlling device. Moreover, the air space should be reduced as much as possible; oil insulation seems not to have been everywhere applied. With regard to explosions due to coal-gas and air, the hollow spaces in the streets in connection with the Berlin network have been reduced to a minimum. Where, however, such has not been possible, adequate ventilation by means of openings, which require special care in frosty weather, have been provided. The protection of cables from mechanical injury by covering them over with stones, iron plates, &c., is too troublesome and costly. In some towns the cables have partly been covered with ∩ iron. The armour of the cables can of itself only in a limited measure prevent damage. A sufficient protection should be provided for all cables by some covering if the cables are not laid at a depth exceeding 50 centimetres. Important feeders laid together should be similarly protected, even if placed at a depth of 70 centimetres. Impregnated wooden planks are suitable for the protective covering, as iron plates would increase the danger of leakage. The suggestions made have the approval of the authorities of Berlin.

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* See *The Electrician*, Vol. XXXI., May 26, 1893.

THE ADMISSIBILITY OF AN EARTHED MIDDLE CONDUCTOR.

The Town Council of Altenburg recently solicited the advice of the Verband Deutscher Elektrotechniker on the question whether a bare middle conductor, or earthed middle conductor, as we should call it, was admissible for the projected central lighting station. The contractors for the station, the Allgemeine Elektricitäts Gesellschaft, had proposed to distribute the current, using a bare middle conductor; but, as the Post Office officials raised objections, the Town Council appealed to the Verband, and on their advice allowed the use of the bare conductor. With the permission of the Town Council of Altenburg and the Allgemeine Elektricitäts Gesellschaft, the decision of the Verband has been made public.

After reciting the documents which were under review, the Report goes on as follows:—

As the objections of the Post Office officials of Leipsic do not specially refer to the three-wire system, but solely to the use of a bare middle conductor, we may take it that the question we have to decide upon is—whether a system of distribution with an insulated, or one with a bare middle conductor, causes less disturbance in the working of the telegraph or telephone. We have then to distinguish between the normal condition of the conductors, where the insulation everywhere is of the best possible, and the abnormal condition where leaks have arisen in one or more places.

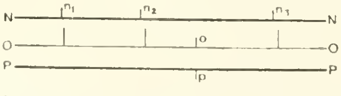
It is a well-known fact, that with two equally well insulated conductors, the negative shows, as time goes on, the lowest insulation, and that this may go on till it leaks to earth. By using an insulated middle conductor, the negative conductor shows so much the worse insulation, and the leaks occur mostly in the houses. When using a bare middle conductor, such leaks can also arise but not remain, because, on account of the earth contacts of the middle conductor, the fuses in the respective outer conductors go, and thus expose the faulty points. These must then be made good before the light can be again obtained.

The use, therefore, of a bare middle conductor gives a means of at once discovering the bad points in the insulation, and therefore of being able to repair them.

As things are now, in an installation of several thousand lamps, a systematic control of the insulation is not possible (except in the case of the automatic working of the fuses by using a bare middle conductor). One has to take into account, when using an insulated middle conductor, of the possibility of more or less perfect earths, arising at different points in course of time in the negative lead.

As long as the insulation of both leads remains good, this condition can only cause disturbances in the telephone wires, owing to the current leakage from one weak point to another, which depends on the difference of potential in the particular points of the negative outer lead. As this difference of potential usually does not exceed 2 volts, the earth currents cannot be great. However, the earth currents in this case are greater than those caused by using a bare middle conductor, as these latter are caused, not by a fall of potential of 2 volts, but of only a part of 1 volt.

The comparison is much to the disadvantage of the insulated middle conductor, when, from any cause, leaks occur in it or the outer positive lead. In the accompanying figure, N N, O O, P P represent respectively the negative outer conductor, the middle conductor, and the positive outer conductor. They are drawn for simplicity straight, but one must remember they are laid along streets, &c. The letters, n_1, n_2, n_3, denote house connections and the insulation has become defective with time. If now we get a leak through any cause, such as cutting of insulation at o in the middle conductor, or p in the positive lead, then we have a current from o or p to all the three faulty places (n_1, n_2, and n_3). The points o and p may be far away from the points n_1, n_2, &c., and if there are near to those points, telephone connections with earth plates, part of the current will go through the telephone wires and apparatus. One must also notice that if the points n do not cause dead earths, the current may be sufficient to disturb the telephone working, but not sufficient to blow the fuses. In such cases one remains in ignorance where the weak spots are until a systematic examination of the cables is carried out. This disturbance does not automatically cease through fusing of the cut-outs, but continues until the weak spots are found and removed from the cable network.



If now the middle conductor be laid on the earth, and faults exist in the insulation of the outer conductors, we should have earths, but the disturbances caused by them would be of much shorter duration, and more especially so the greater the number of earths on the middle conductor. If it were possible to have the middle conductor laid altogether on the earth, the currents caused by faults in the insulation would take, for the most part, the nearest way from the fault to the middle conductor, and only use the earth to carry the full short-circuit current, where the middle conductor did not reach. As the cut-outs would immediately fuse, the current created would last only a very small time, and could not create any lasting disturbance as is possible when using an insulated middle conductor.

The simple laying of the conductor on the earth is not sufficient to give perfect earth contacts, as in some cases there is insulation, even if small, between the middle conductor and the dry ground. In order to obtain the above ideal condition, we should recommend an artificial connection of the middle conductor to the armour covering of the outer lead, at intervals of 20 metres, by means of cross-wires.

It now remains to be seen how far in normal working, *i.e.*, when there are no great faults in the outer leads, the use of a bare middle conductor to prevent disturbances in the telephone wires is beneficial. Disturbing earth currents can only be created when there is a difference of potential in different points of the middle conductor, and thus we must see how large this potential difference may be in a properly laid network. The potential difference depends on the conductivity and load of the middle conductor. The greater the first and smaller the latter, the smaller is the potential difference, and consequently the earth current. The difference of load between each half of the circuit in Berlin is at most 2 per cent. of the maximum load, so that the middle conductor carries at most 2 per cent. of the whole current. If it were possible to make the two halves of the conductors balance as well as in Berlin, one can easily see that the middle lead would only have a small current to carry. In order to get a good balance, house connections with more than 10 lamps should be worked from both sides of the network. This we hardly think possible in a small town like Altenburg, so that our decision will not be based on results obtained in Berlin, but rather in Gera, as the tramway and central station are similar to those planned for Altenburg. The Gera Tramway Company have supplied us with load curves, from which we shall be able to obtain an estimate for the load to be expected on the middle conductor in Altenberg.

We may observe that these curves are equivalent to a maximum load of 1,000 lamps burning at the same time, whilst the network in Altenburg is reckoned for 2,600 lamps. If we consider the Berlin result of 2 per cent. too favourable for Altenberg, then we may also expect the result in Altenburg will be better than in the smaller installation of Gera. In the latter case, the load curves show for four days, viz., December 23, 1893, May 31, 1894, September 2, 1894, and October 1, 1894, that the maximum load on the middle lead was 47 amperes, nearly 12 per cent. of the absolute maximum load of the outer conductors, which was on December 23, 1893, 400 amperes. We have, therefore, 2 per cent for the Berlin installation, 12 per cent. for the Gera; and, as Altenburg is between the two, we have taken approximately 10 per cent. for the load on the middle conductor in the latter case. The middle conductors in Altenburg have been calculated on a pretty liberal scale. We have taken as cross-section of the middle conductor in Altenburg 70 per cent. of that of the outer conductors, and can thus estimate what will be the greatest difference of potential between any two places on the middle lead. The network of conductors is calculated for the usual fall of 2 volts. If the middle conductor carries the whole current, the fall of potential would be 2·85 volts; but as the middle conductor carries only one-tenth of the current, the fall of potential is only 0·285 volts. In Gera the maximum load on the middle conductor occurs when the absolute load is very small, viz., in the daytime. Now, in Altenburg the day supply is to be taken from a battery of accumulators, so that at the time of the maximum loading of the middle lead the current is taken from the battery, and under these conditions is perfectly steady, so that the difference of potential in different points of the middle lead undergoes only slow and slight changes. The maximum value of this voltage of 0·285 volts is so small that it cannot cause the indicators to fall by a lasting current in the telephonic wires, or influence the plainness of the transmission. A disturbance of the so-called "connection controller" for such a small telephonic installation as that in Altenburg is not to be feared. If with a bare middle lead the earth be really used in a marked degree to carry current, as the Post Office officials in Leipsic are afraid, then electrolytic action should take place, and the middle conductor would in time be destroyed. The installation at Gera was laid down in the summer of 1891, and in the winter of 1892 when Herr Baehker, engineer to the Allgemeine Elektricitäts Gesellschaft, had the middle conductor dug up, it was quite unattacked.

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* From the *Elektrotechnische Zeitschrift* of March 14th.

According to information obtained from the Gera Tramway Company, disturbances in the telephonic working have only very rarely occurred. According to information from the Kaiserl. Deutschen Oberpost Direktion in Hamburg, on October 5, 1894, to the Stadtbauamt of Altenburg, the bare middle lead has caused repeated disturbances. We inquired from the manager of the Hamburg central station, and have obtained the following answers:

1. In Hamburg itself not bare, but insulated middle conductors are used.
2. The negative conductor lies on the ground.
3. In Altona and St. Pauli, where bare middle conductors are used, disturbances of the telephone have not often occurred.

We are of the opinion that in neither case can disturbances of the telephone, by faults occurring in the insulation, be altogether avoided, and that it only remains to choose the system in which, firstly, faults are less often to be expected, and, second, when such occur, the resulting disturbances are quickest put right. In both instances the use of bare middle conductors seem the best as—

(1.) The potential of the positive conductor to earth is only half what it is when insulated middle conductors are used, and the energy wasted in cases of earths is reduced to a fourth.

(2.) Any insulation faults occurring are automatically made known by the fusing of the cut-outs.

(3.) The disturbances caused in the telephone by faults of insulation are quickly stopped.

We have, therefore, arrived at this result—that the use of a bare middle conductor for the Altenburg electric lighting installation, as much for safety in working the central station as for preventing disturbances in the working of the telephones, is better than the use of an insulated middle lead.

The report is signed by Herrn Slaby and Gisbert Kapp.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *April 12, 1895.*

Death of George M. Phelps.—Mr. George M. Phelps, principal owner of the *Electrical Engineer*, died yesterday after a short illness at the age of 52. Mr. Phelps was one of the most genial and popular members of the American electrical fraternity, and a leader in everything relating to the social side of professional life. He was the guiding spirit of the New York Electric Club during its existence, and an indefatigable worker in the interest of the American Institute of Electrical Engineers, of which he was annually elected treasurer for a number of years, and had been renominated for another term of office at the last meeting of the Council.

Massachusetts Central Stations and Electric Street Ways. The annual reports of the Massachusetts Commissioners of Electric Lighting and Street Railways are not reassuring as to the present financial state of the electric supply and electric railway industries in that State, and there is reason to believe that the conditions are no better elsewhere throughout the country, and probably are even still more unfavourable. Of 59 lighting stations but 19 paid over 6 per cent. in dividends, and 35 declared no dividends, and but 30 of 68 street railways paid dividends. The most unfavourable feature, however, is the almost total absence of any provision for the future in the way of a depreciation or reserve fund. While some of the larger companies paying dividends seem to be commencing to create such a fund, there seems to be no real recognition of its importance even among these, as the amount varies greatly, and in few cases bears any apparent relation to the investments. On the other hand, the deterioration of street railway plants is alarmingly rapid, while most of the central stations are handicapped by the possession of inferior machinery that will soon have to be replaced if they are to be kept in operation. One may feel safe in predicting that before many years most of our electric supply and railway plants will pass into other hands through bankruptcy or other liquidation proceedings. They will then be renovated and placed on a paying basis, for in almost every instance at present the absence of returns can be traced to over-capitalisation and uneconomical equipment and management, or to these several causes jointly. Even now the situation has been grasped by some capitalists, who are sharply on the look-out for this class of investment, and many plants have already passed into their hands and been profitably reorganised.

Steam v. Electric Railways.—In several parts of the States the Courts have been laying down the principle that electric railways cannot extend their lines beyond urban limits without coming under the limitations prescribed for steam railways. The important consequences of this principle are that interurban roads cannot enjoy franchises of highways, but must purchase their right of way, and that they are bound by the same restrictions as steam railways with respect to paralleling existing lines of the latter.

PARIS NOTES.

(FROM OUR OWN CORRESPONDENT.)

PARIS, *April 22, 1895.*

Exhibition of the Société de Physique.—The annual exhibition of the Société de Physique took place on Tuesday and Wednesday, April 16th and 17th, in the buildings of the Société d'Encouragement. Amongst other novelties, I may mention a 2-ampere arc lamp on the Cance-Brianne system, which may be expected to have an extensive use in the near future in competition with the "Auer" lamp. M. J. Carpentier exhibited a standard electrometer, constructed according to instructions given by MM. Abraham and J. Lemoine, and designed for very high potentials; a galvanometer of very high sensitiveness, somewhat on the lines of the Thomson galvanometer of Mr. Weis's invention; manganin resistances of 0·1 ohm carrying 100 amperes; a new portable wattmeter intended for the testing of meters; also a fine set of enlarged views of the Mont Blanc panorama, taken with M. Carpentier's "photojumelle." M. V. Chabaud showed platinum tubes welded directly to glass, put out of shape or torn by pressure, but with the welding still firm. M. Digeon exhibited a "hysterisimeter" of M. Marcel Deprez based on the torque brought about by the attraction of the sheet-iron discs by turning electro-magnets rapidly. MM. Gaiffe et Cie. installed a high-frequency plant intended for electro-medical purposes; this plant was composed of a small gas motor of $\frac{1}{3}$ H.P., and a small dynamo mounted on an elastic platform, charging a storage battery actuating a Rhumkorff coil, the currents of which were transformed in high-frequency currents by means of a condenser and a solenoid. All these instruments were constructed according to instructions of MM. D'Arsonval and Abdank-Abakanowicz. M. Janet showed his method of alternating-current electro-chemical inscription, and MM. Sautter, Harlé et Cie exhibited the "lumen-meter" of M. André Blondel. On Friday the members of the Société de Physique were invited to visit the works of MM. Weyher et Richemond, owners in France of the Brown-Boveri patents, and were shown the conditions of working of two-phase and three-phase dynamos established in their factory.

CORRESPONDENCE.

ENGINE GOVERNING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your issue of this week contained an article by Mr. G. Addenbrooke on the subject of the governing of steam engines when driving dynamos. Therein he advocates the regulation of the voltage of a compound dynamo by the governor of the engine instead of by a resistance in the shunt. This arrangement may be very good for a single unit of plant, as a voltmeter connected across the dynamo terminals would enable the engine attendant to adjust the governor as required.

With two or more units running in parallel, however, I would ask how he proposes to deal with the regulation. In such a case how is the *engine* attendant to know how the load is divided, and which engine governor requires adjusting? Surely the *switchboard* attendant is the proper person to regulate the voltage. A glance at the ammeters in circuit with the dynamos would show how the load is divided, and with the shunt resistances close at hand both current and voltage can be varied to suit requirements.—Yours, &c.,

W. C. Goodchild, Resident Engineer.

Electrical Department, Midland Railway, Leicester Station,
April 13, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am obliged by the proof of Mr. Goodchild's letter anent my last article. If Mr. Goodchild had read my article carefully and particularly, and the two former ones, I think he would not have been under the necessity of taking up your space. In the first place, I did not advocate the running of compound dynamos in parallel; I merely spoke of a compound dynamo in one instance, as it happened to be coupled to the engine on which the governing experiments were tried.

The remainder of his letter seems to me a good argument for the system I was advocating where dynamos are running in parallel. He says: "How is the engine-driver to know how the load is divided?" This, I know, is the state of things at present in most places; but I would ask Mr. Goodchild, How is an engine-driver to drive engines to the best advantage if he does not know what work they are doing?

In my case the dynamo ammeters and voltmeters would be situated near the engine driving each, and under observation of the driver, who would then know exactly what he was doing. He would also know the extra voltage required as the load increased, and therefore could keep his engines properly loaded, and adjust them as required to the best advantage.

The duty of the switchboard attendant is to look after the circuits in a central station, and he should not have his attention divided by having to superintend running engines also, a duty for which he is often unfitted.

He will have a main voltmeter and ammeter on the omnibus bars, so that he can judge the state of matters, and he can, of course, signal to the driver. With this arrangement the use of resistances can be almost dispensed with.—Yours, &c.,

G. L. Addenbrooke.

Wolverhampton, April 23, 1895.

LEGAL INTELLIGENCE.

Oppenheimer v. Kelly (Wright and Claughton interpleading).

In the City of London Court on Tuesday, before Mr. Commissioner Kerr, an action was tried in which the plaintiff (of the International Electric Company) had obtained judgment for an amount against the defendant (receiver of the debenture-holders in Poole and White, Limited); but when execution was levied the goods were claimed by Wright and Claughton and one Ellis (the defendant's successor as receiver for debenture-holders), and their claim was now tried. Plaintiff's counsel said the judgment was recovered against Kelly as the receiver of Poole and White (Limited). It was apparently a personal judgment. The claimants were the trustees for debenture-holders under a deed by which Poole and White (Limited) had assigned their property to them. Subsequently there were second debentures issued, and the holders appeared to have appointed Kelly as their receiver. Kelly entered into possession on behalf of the second debenture-holders. Then there was a winding-up order made against Poole and White (Limited), and a liquidator was appointed. In January of this year the present claimants appointed Ellis as their receiver, and he entered into possession. In the meantime Kelly had been carrying on the business. He had been supplied with goods by the plaintiff. They proposed to take in execution goods belonging to the Company, or which did belong to the Company, but were the property of the first mortgage debenture-holders. Counsel for the execution creditors said they did not propose to take any of the property of the Company. They proposed to take the property which was not the property of the Company, and was not included in the property of the first mortgage debentures, but the plaintiff disputed this. As, however, he was unable to prove his case without the evidence of the officer who seized the goods, and as this person was absent, the claim was barred, with costs.

BOOKS RECEIVED.

"Journal of the Institution of Electrical Engineers." Edited by F. H. Webb. (London: E. and F. N. Spon. Price, 3s.)

"Motive Powers and their Practical Selection." By Reginald Bolton. (London: Messrs. Longmans and Co. Price, 6s.6d. nett.)

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NOW READY.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Although about 100 pages are added to the book, no addition is made to the price, which is 7s. 6d., post free 8s. 3d., abroad 9s.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices:—*

Laboratory Notes and Forms.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A Large-Sheet Table, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s.—each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"Electro-Chemistry."—This useful work, by Dr. G. Gore, is still on sale, the price being 2s., post free.

"The Work of Hertz."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. net., is now ready.

"Electrical Engineering Formulæ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"Drum Armatures and Commutators."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson, price 6s. 6d., post free.

"The Electrician."—A special notice concerning certain changes in the price, &c., of this journal (commencing with the new volume on May 3rd) will be found on page 790.

Tenders Invited.—The Corporation of Londonderry invite tenders for the supply of electric light carbons for one year from June 1st next. Tenders must be sent in to Mr. R. N. Chambers, Town Clerk, The Guildhall, Londonderry, not later than May 1st.

——— The Brighton Corporation invite tenders for the supply and erection of boilers at the Corporation Electricity Works, North-road. Specifications and particulars may be obtained at the office of the town clerk, Mr. F. J. Tillstone, and tenders, addressed to him, must be in by May 13th. Our advertisement columns contain further details.

——— The Brighton Corporation also invite tenders for the supply of india-rubber lead-covered armoured cables. Specfications may be obtained of Mr. F. J. Tillstone, town clerk, and tenders, addressed to him at the Town Hall, must be in by May 13th. Some further particulars appear in our advertisement columns.

——— The Brighton Corporation also invite tenders for the supply and erection of arc lamps, switches, &c. Specifications and particulars may be obtained of the town clerk, Mr. F. J. Tillstone, and tenders, addressed to him, must be in by May 27th. Some further particulars will be found in our advertisement columns.

——— The Directors of the Brighton and Rottingdean Sea View Electric Tramroad Company invite tenders for the supply and maintenance of accumulators, full particulars of which can be obtained on application to Mr. Magnus Volk, Madeira-road, Brighton. Some further information is given in our advertisement pages.

——— The Portsmouth Corporation invite tenders for wiring the Corporation stables and the fire brigade station, Landport. Tenders, addressed to Mr. Alex. Hellard, town clerk, must be in by the 29th inst.

——— The Vestry of Shoreditch (London, E.C.) invite tenders for the erection of a dust destructor, furnaces, boilers, &c., capable of dealing with 20,000 tons of refuse per annum, and of producing the quantity of steam specified in the conditions required for electric lighting and other purposes. Specification and sketch-plan and other information can be obtained from Messrs. Kincaid, Waller and Manville, the engineers to the Vestry, 29, Great George-street, Westminster, S.W., and tenders must be sent in to Mr. H. Mansfield Robinson, solicitor and Vestry clerk, by 4 p.m. on Monday, May 20th. Some further particulars as to the conditions of the contract, &c., will be found in our advertisement columns.

——— The Great Indian Peninsula Railway Company invite tenders for telegraph wire, brass sheets, and other stores. Tenders, addressed to the secretary, Mr. F. L. Soare, 48, Copthall-avenue, London, E.C., must be in by May 2nd.

Sale by Auction.—Particulars are given in our advertisement columns of the sale, under an order of the High Court, of the business of electrical engineers carried on at the Borough Mills, Bradford, under the style of Andrews and Preece (Limited), together with the plant, machinery, tools, stock-in-trade, patent rights, &c. Particulars, conditions of sale, &c., may be obtained of Mr. James Duff, the Receiver, 2, Mann's-court, Kirkgate, Bradford; of Messrs. Walker and Rowe, solicitors, 8, Bucklersbury, London, E.C.; or Mr. F. Walker, solicitor, Halifax. Tenders have to be sent in to Mr. Duff by May 22nd.

Vacant Appointment.—The Governors of the South-West London Polytechnic, Manresa-road, S.W., invite applications for the appointment of Head Master of the department of Mechanical Engineering, at a salary of £250 per annum. Some further information is given in our advertisement columns, and applications must be made not later than Monday the 29th inst.

——— The Vestry of St. John, Hampstead, are prepared to receive applications for the post of electrical engineer for their central electricity station. Applications must be sent in by May 2nd. Some further particulars are given in our advertisement columns.

Dividend.—A supplementary dividend of 2s. 8¾d. in the £, in the bankruptcy of Moses Humm, electrician, of 8, Westbourne-road, Forest Hill, S.E., is now payable at the office of the Official Receiver, 24, Railway-approach, London, S.E.

Removal.—Messrs. Callender's Bitumen Telegraph and Waterproof Company (Limited) notify that owing to the great increase in their business it has been found necessary to remove to larger premises, and the Company's offices are now situated at 90, Cannon-street, London, E.C., close to the South-Eastern and Metropolitan Railway stations. Mr. Theodor Petersen has been appointed Assistant Manager to Mr. T. O. Callender, and Mr. W. Douglas Reid, who for 10 years past has been connected with the Company and its outside works, has been appointed Resident Engineer for the home district. Mr. F. A. Pocklington has charge of the Liverpool district, with offices at Oldham-place, Renshaw-street, Liverpool; Mr. George Barnard has charge of the South Midlands and West of England district, with offices at 58, Water-street, Birmingham; Mr. Burton takes the North Midland district, with offices at Lichfield-street, Wolverhampton, and Talbot-street, Nottingham; and Mr. W. Moir has charge of the Scotch business, with offices at 28, Charlotte-street, Ayr, N.B. The Company's London telephone number has been changed from 4,485 to 15,133.

Bankruptcy.—Mr. Frederick Gittins, of Liverpool, has been appointed trustee in the estate of Edward J. Bayly, electrical engineer, 2, Selborne-street, Liverpool, who was recently adjudicated a bankrupt.

——— The estate of John Scott, sole partner in the firm of D. and G. Graham, electrical engineers, of 140, Douglas-street, Glasgow, has been sequestrated. The election of trustee and commissioners will take place at the Faculty Hall, Glasgow, on May 2nd, at 12. The agent is Mr. J. Law Crawford, W.S., Glasgow.

Liquidation.—Notice is given that Mr. George Stapylton Barnes has been appointed Official Receiver in the winding-up of Martiny (Limited). The first meeting of creditors will be held at 33, Carey-street, Lincoln's Inn, London, W.C., on May 1st, at 11 o'clock, and of contributories at 12 o'clock.

——— The creditors and shareholders of the Ford-Lloyd Manufacturing Company met on Wednesday at 33, Carey-street, W.C., when Mr. G. S. Barnes, Official Receiver, stated that the failure of the Company (which was established in June, 1893, with the sole right to dispose of the invention known as the E.S. Dry Battery) was attributed to the want of sufficient capital to work the business. The accounts filed show unsecured debts £977, liabilities on bills discounted £927, loans on debentures £3,000, preferential claims £120. The assets, valued at £1,631, were fully charged to secure the loans on debentures. The case has been left in the hands of the Official Receiver.

Easton, Anderson and Goolden (Limited).—This Company have opened branch offices at Bank-buildings, St. Mary-street, Cardiff, for the purpose of bringing their electric mining machinery and other manufactures into more extended use in South Wales. This branch will be for some time under the superintendence of Mr. Llewellyn B. Atkinson, one of the Directors of the Company, who will reside at Cardiff to take charge of the Company's operations in South Wales. The firm's new shops at Erith (to which the plant, &c., from their dynamo factory at Woodfield Works has been removed) are now in full operation, and a number of important electrical and other contracts are in progress.

Catalogue.—The Electrical Engineering Company, of Minneapolis, U.S.A., have sent us a copy of their Catalogue, No. 3. Accustomed as we are to big things in the catalogue way from America, the book under review heads the list. Including the index, nearly 300 large octavo pages are filled with illustrations, prices and particulars of an infinite variety of apparatus, instruments and accessories for electric light and power work. Many of the illustrations are familiar in these combination catalogues.

Aberdeen.—The municipal buildings are now lighted throughout by electricity, more than 200 lamps, arc and incandescent, being employed. The light, so far, has given great satisfaction, and in the famous Town Hall the portraits show to great advantage. The fittings in polished and lacquered brass are of special design.

African Telegraphs.—The telegraph line along the course of the Beira railway, which has been completed to Salisbury, is to be continued to Umtali. The Mozambique Company have a telegraph line in course of construction from the coast to the Beira Railway Company's terminus, Fontesville. This line is continued by the Beira Company to Chimoi, and when these lines are finished telegraphic communication by the east coast will be completed throughout the Mozambique Company's territory.

Aluminium.—An English company is, it is reported, establishing works near Odde, in Western Norway, for the production of aluminium.

Assault and Alleged Slander.—Owing to the unfortunate dispute between officials of the Bury (Lancs.) Corporation and Mr. Wynne, the Corporation's late electrical engineer, an action was brought for slander and assault by Mr. Wynne and heard before Mr. Justice Hawkins this week at Bury. It will be remembered that Mr. Wynne was summarily dismissed from the Corporation's service, but was successful in an action for wrongful dismissal, in which action the counsel for the Corporation stated that no reflection whatever was meant upon Mr. Wynne's competency or character. The present action was the outcome of an assault, which consisted in the summary ejection of the plaintiff from the Corporation premises, and after a lengthy hearing, the jury, after an hour's deliberation, found for the defendants on the counts for slander and malicious conspiracy, but with respect to the assault by the Town Clerk, found for the plaintiff with 40s. damages. His lordship gave judgment for the defendants.

Ayr.—It is stated that several gentlemen well-known in Ayr and district have under consideration a proposal for the construction of an electric tramway from Prestwick and Ayr to Burns' Cottage and Monument.

Ballaarat (Victoria).—This enterprising town is now supplied with the electric light by the Ballaarat Electric Supply Company. There are already erected about 50 powerful arcs and some 500 incandescents for the lighting of business premises. The work has been carried out under the superintendence of Mr. J. A. Dawson, electrical engineer to the School of Mines, on behalf of the electric lighting company, and Mr. H. Harrison has acted in the matter on behalf of the Crompton Electric Supply Company of Australia. It is already under consideration to materially augment the plant, the light having proved very popular.

Bath.—With regard to the decision of the Urban Sanitary Authority to proceed with their application for an electric lighting Provisional Order, which was referred to in our last issue, it has further been decided that the Electric Light Committee be empowered to take every step necessary to obtain an Order, including, if considered advisable, the sending of a deputation to London to place the matter fully before the Board of Trade. In reply to an objection by Mr. Tonkin, that the Board of Trade were evidently under the impression that the Corporation wished to have the local electric lighting company completely at their mercy, Mr. Radway stated that in their license the company had the right to go to arbitration.

Bordeaux Exhibition.—It is now officially announced that the Bordeaux International Exhibition will be opened on May 4th, and intending exhibitors are reminded that if their exhibits are not received in due time the Exhibition authorities will consider themselves at liberty to otherwise dispose of the space allotted.

Bedford.—The question of the lighting of the Shire Hall by electricity has been discussed by the Bedfordshire Police Authority, but, owing to the cost of wiring and fittings (£79. 3s. 3d.), the matter has been postponed for 12 months.

Brighton.—The Electric Lighting Committee recommend the Corporation to contribute a sum of £250 per annum from the electricity works account as a contribution towards the expenses of the rate collection. The Corporation has approved the recommendation.

Church Lighting.—The parish church of St. Edward's, Cambridge, is to be lighted electrically.

Commission of Sewers (London, E.C.).—At the meeting of the Commissioners on Tuesday, the Clerk read a letter from the Comptroller (Mr. Brand) asking that Mr. Voysey (the electric light inspector) should be allowed to act as consulting electrical engineer to the Corporation at a nominal sum ; but the consideration of the matter was postponed.

Cricket.—The Westminster Electric Cricket Club send us a list of their fixtures for the season 1895. The club's grounds are at Denmark Hill, and several interesting matches have already been arranged.

Dewsbury.—The report of the Lighting and Water Committee has been presented to the Town Council, in which gratification is expressed at the increased consumption of electric current and also of gas. It has been decided to instruct the electrical engineer to furnish the Lighting Committee with an estimate of the cost of fitting up the new municipal buildings for the electric light.

Durban (South Africa).—At a recent meeting of the Town Council, the Finance Committee presented a report recommending the issue of a loan of £100,000 for the purposes of lighting the town by electricity, the construction of a promenade, &c. The question is being dealt with in committee of the whole Council, and, as opinion is divided on the electric lighting portion of the scheme, some time may elapse before the subject is finally dealt with.

Fareham.—It will be remembered that the District Council recently determined to take counsel's opinion as to their legal position with regard to the purchase of the undertaking of the Fareham Electric Light Company. Mr. A. M. Channell, Q.C., and Mr. A. Glen, to whom the matter has been referred, state in their "Opinion" that there has been a breach of the agreement by the District Council, as to Clause 13, under which the Local Board agreed to use their best endeavours to obtain sanction from the Local Government Board for the transfer of the Company's undertakings, but that there has been no breach of the agreement so far as the actual purchase is concerned, as it was conditional upon the approval and sanction of the Local Government Board being actually given. Counsel are of opinion that the Council may properly defend an action, and recommend the payment of a small sum into Court with a denial of liability. A heated discussion took place upon the subject at the last meeting of the Council, and it was ultimately decided to defend the action brought against it by the Fareham Company.

Great Northern and City Railway.—Before Mr. Campion, one of the examiners of private Bills, the petition for an additional provision in the Extension of Time Bill of this Company was considered on Tuesday. The petition states that the Great Northern Company have decided to alter their Finsbury-park station to enable the trains of the City line to run into that station instead of Drayton-park, as originally proposed, and as it was desirable that the same locomotive power should be used, sanction was asked to use steam as the motive power on the City line, in addition to or in substitution of electricity as at present authorised. The Metropolitan Railway Company objected that the Standing Orders had not been complied with, as the notices for the Bill did not include the substitution of steam as one of its objects, and the Examiner upheld this contention. The question has now to be dealt with by the Standing Orders Committee.

Hampstead (London, N.W.).—The Vestry have received a letter from the London and Hampstead Battery Company suggesting that a scheme for the mutual advantage of the Vestry and the Company might be arranged, by which the latter would transfer to the Vestry the work now being carried out by them on the north side of Finchley-road, the Vestry transferring to the Company that portion of their Provisional Order covering the southern portion of the road. The matter is receiving the attention of the Lighting Committee.

Hayfield (Yorks.).—At a recent meeting of electors of Hayfield to consider the question of adopting the Lighting and Watching Act, Mr. Slack, Chairman of the Parish Council, who presided, said that the Council had not as yet decided whether to light the village with gas or electricity, but a committee was investigating the matter. It was unanimously decided to adopt the Act, and to call for £120 to meet expenses.

Holborn Restaurant.—We have received a copy of a tastefully illustrated *brochure* describing the ins and outs of the Holborn Restaurant, London, W.C. There is an effective full-page illustration of the dynamo room, and it looks as though there is electric power enough to cook plenty of "viands," as well as to flood the spacious halls with light.

Indian Directory.—The useful Directory published by the proprietors of the *Indian Textile Journal* is now ready, and in addition to matter of interest to those engaged in the textile manufactures, the book contains a quantity of information which will be found of more general use. One article is entitled "Electrical Industry in India," and gives an all too brief account of the electrical work going on in our great dependency. A map supplement shows those points in the country where engineering and metal works are established, and a quantity of information relating to the Merchandise Marks Act, Boiler Inspection Act, &c., is also given. The published price, in paper covers, is 7s., in cloth covers, 8s.

Kingston, Jamaica.—It is stated that the Gas Commissioners are about to utilise the waters of Constant Spring, situate six miles from the town, for power purposes for an electric lighting undertaking. It is estimated that water can be stored equivalent to 600 h.p. The local tramway company, having decided to use electricity for their line, the scheme of the Gas Commissioners is likely to receive the support of this important customer. As usual opposition is threatened by the local gas company on the ground that their pipes are likely to suffer from leakage, &c. Objections are also probable from the water company. These objections would, of course (the *Journal of Gas Lighting* naively remarks), be removed by the Commissioners deciding to use gas as the motive power.

Lectures.—Mr. H. B. Ransom's lecture at the Croydon County Polytechnic on "The Mechanical Principles of Electrical Engineering" last week proved interesting to a large audience. It was the last lecture of a special course. The mechanical testing of materials was described, with views of the testing machines used at University College, London. A number of other interesting subjects were covered by the lecture.

Liverpool.—At the meeting of the Special Lighting Committee of the City Council last week, it was mentioned that Sir Frederick Bramwell had been requested to act as expert in the joint interests of the Company and the Corporation, and to examine the accounts of the Company. Mr. Richard Barrow (controller to the Corporation and auditor) has also been requested by the Committee to verify the figures. Until these reports have been presented the further negotiations remain in abeyance.

Llandudno.—The District Council have received a letter from the Electric Tramways Company notifying that notwithstanding the adverse result of the recent poll of the ratepayers, the Company intended promoting a Provisional Order for the construction of their works, but were prepared, in order to obtain the consent of the Council to make certain modifications. A deputation from the Company waited upon the Council, and explained the modifications they were willing to introduce. With regard to electric lighting, the Company proposed to supply the Council with current at cost price. It was stated that the promoters had already spent more than £2,000, and were therefore not disposed to abandon their scheme. It was, however, ultimately decided that the Council abide by the decision of the ratepayers, decline to reopen the question, and take all necessary steps to oppose the Company's scheme.

Medical Electrical Institute (Limited).—Meetings of creditors and shareholders in this failure have been held before Mr. C. J Stewart, Official Receiver, at which the oft-told history of the concern and its predecessor, the Medical Battery Company (Limited), were detailed. After the break-up of the older concern, business was commenced in 1894 by the "new Company." Advertisements were inserted in various newspapers upon a considerable scale in the hope that the public demand for the medical and electrical appliances sold by the company would greatly increase, it appearing that the former prosperity of the Company was in a large measure due to a system of extensive advertising. In that hope, however, the Board were disappointed, as the advertisements did not apparently produce sufficient business to pay expenses. This is very satisfactory, and is evidence that the electro-quackery business is played out

Mexico.—On April 2, 1896, an Exhibition of Industries and Fine Arts is to be opened in the City of Mexico. The buildings are to cover an area of about 600 acres if the intentions of the promoters are carried out. A considerable space is to be devoted to electrical exhibits. Already a journal is established to put before the public the merits of the Exhibition, which appears to be promoted from San Francisco.

Morecambe.—At a recent meeting of the District Council a letter was read from the Morecambe Electric Light and Power Company stating that they were willing to dispose of their undertaking to the Council on certain conditions. The letter has been referred to a specially appointed committee for consideration, and a sub-committee appointed to interview the management of the Company on the matter.

Newcastle-on-Tyne.—It is proposed to instal the electric light in the Town Hall at an estimated cost of £470.

Rothesay.—At a special meeting last week the Town Council again referred back to the committee who are dealing with the matter the question of lighting the harbour and a portion of the Esplanade by electricity for a supplementary report. Complaints continue to be made of the very inferior quality of the gas supplied for the public lighting.——At a special meeting of the Harbour Trust, on Monday, a minute recommending that the Pier be lit electrically, at an estimated cost of over £1,000, was remitted to a committee for consideration and report. It was stated that there would be some opposition to the scheme unless the Esplanade and other parts of the town were included. The power is to be obtained from a 30-H.P. turbine, the water to be obtained from Lochfad. The annual cost of the scheme is estimated at £280, as against £150, the present charge for gas.

Salford.—The lighting of four out of the six new sheds at Salford Docks has now been satisfactorily completed. Two of the sheds have been lighted by Messrs. Bennett and Druce, of Preston, with 200 lights.

Shanghai.—Some time ago the municipal authorities of Shanghai purchased the undertaking of the local electric lighting company, which at the time was supplying current equivalent to 8 2,000 c.p. for arc lighting and about 2,000 8-c.p. incandescents. Some opposition to the scheme was experienced, but a recent statement by the Chairman of the annual meeting of ratepayers shows that the municipality were justified in their enterprise. The success of the purchase has whetted the appetites of several of the leading citizens, and an energetic effort is to be made to abolish gas, regarding the quality of which strenuous complaints are made.

Stafford.—At the monthly meeting of the Town Council on Tuesday, in moving the adoption of the report of the Electric Lighting Committee, Mr. W. H. Peach said that the work of laying the electric light cables would be started in a few days, and that orders for the supply of current were coming in in a very satisfactory manner.

St. Pancras (London, N.W.).—At their meeting last week, after dealing with the report of the Electric Lighting Committee, which was referred to in our last issue, the Vestry discussed a recommendation of the Committee as follows :—

> "That, on the completion of the works at present in hand at King's-road station and elsewhere, the services of the consulting engineer be dispensed with, and that the Vestry appoint a chief electrical engineer, competent to manage the whole of the Vestry's generating and distributing stations and mains, and to design and carry out all extensions and new works ; and that the salary attached to the office be £600 per annum."

With regard to this resolution the Committee report :—

> "In consequence of several explosions that have taken place in districts where the Vestry's electrical mains are laid, investigations have been made as to the cause, and as to the best means to be taken to prevent a recurrence of them in future. In the course of the inquiry your Committee became aware of serious difficulties involved in the dual responsibility exercised by Prof. Robinson, the consulting engineer, and Mr. Baron, the chief engineer ; and this method of working having proved very unsatisfactory, your Committee are unanimously of opinion, after much deliberation, that the time has now arrived when the best interests of the Vestry will be served by the appointment of a chief electrical engineer."

Mr. Purchese, who is Chairman of the Works Committee, pointed out that Prof. Robinson had been appointed to a position of great importance at the early stage of the Vestry's electric lighting scheme, and he thought the Vestry ought to be provided with information as to the cause of the friction between their consulting and chief engineer. Mr. Sweet, Chairman of the Electric Lighting Committee, said Prof. Robinson had completed the work for which he had been engaged, and the proposed appointment of an engineer to take entire charge of the electric light undertaking would mean a great saving. Mr. Wetenhall thought that in justice to Prof. Robinson the members ought to be made acquainted with the facts of the case, as, in his opinion, there was something hushed up. An amendment was subsequently moved that the Committee's recommendation be referred back, but this amendment was lost. An amendment, moved by Mr. Boden, that the earlier portion of the resolution should be omitted, and that it should commence from the words "that the Vestry appoint," &c., was approved, and afterwards passed as a substantive motion.

Wimbledon.—The District Council have decided to accept the offer of Mr. A. H. Preece to report on the best means and cost of lighting the streets of Wimbledon electrically for a fee of £50. Mr. Preece is to be asked to submit alternative schemes.

Worcester.—Mr. F. H. Tulloch, Local Government Board Inspector, held an inquiry last week at Worcester into the application of the City Council for sanction to borrow £20,230 for electric lighting purposes. It was stated that sanction had already been obtained by the Council to borrow £41,000, and the present loan was required for additional work and extras, particulars of which were given by the City Surveyor. There was no opposition.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

March 27, 1895.

6,318. A. G. Waterhouse. London. New and useful improvements in the method of transmitting electric currents to electric railway cars.

6,319. A. G. Waterhouse. London. New and useful improvements in electric-current meters.

6,320. A. G. Waterhouse. London. New and useful improvements in thermostat and electric switches or circuit brakes.

6,351. W. M. Mordey and S. P. Thompson. London. Improvements in dynamo-electric machines.

March 28, 1895.

6,390. J. Peel. London. Improvements in the method of and in apparatus for electrically lighting miners' safety lamps.

6,391. A. Ballance and C. E. A. Fitz-Maurice. London. Improvements in the method of and apparatus for switching on and off electric currents for electric lighting and other suitable purposes.

6,403. J. A. Kingdon. London. Improvements and connected with the means of protecting electric conductors.

6,416. F. W. Ball and J. H. Winter. London. Improvements in ceiling roses for electric light fittings.*

6,430. J. F. Cummings and W. C. Vawkey. London. Improvements in conduits for electrical conductors.*

March 29, 1895.

6,455. W. Thomson (Baron Kelvin). Glasgow. Improvements in apparatus for indicating and recording electric supply.

6,473. G. Hermet. London. An improved composition applicable as a substitute for natural cork and for other purposes, such as an electrical insulating material.

6,494. E. Fuchs and M. Fuchs. London. Improvements in and connected with electric alarm-clocks or alarm systems.

6,509. R. Greville Williams. London. Improvements in apparatus for electrically effecting the reproduction at a distance of graphic matter or designs matter, printed, stencilled, photographed, or otherwise produced.

March 30, 1895.

1,536. J. T. Nibleit. London. Improvements in apparatus for producing electrical effects on the stage.

6,545. G. Davenport. London. An improved electric arc lamp for optical lanterns and other purposes.

6,546. S. D. Williams. Newport, Mon, Improved application of telegraph and telephone circuits.

6,557. S. V. Evans. Manchester. Improved apparatus applicable to the working of electric or lime light for theatrical purposes.

6,565. H. Tee. London. Improvements connected with the electrolytic production of alkali and chloride from sodium chloride solution and other substances.

6,575. A. W. Bennett. London. Improvements in apparatus for charging portable electrical accumulators or batteries.

6,586. A. Price. Birkenhead. Electric pneumatic action for organs.

April 1, 1895.

6,622. A. J. Howard. Taunton. Improved mechanism for feeding the carbons in an electric arc lamp.

6,630 R. J. Urquhart. Manchester. Improvements in automatic exchange systems and apparatus for telephonic and other electrical communication. (W. Decker, United States.)

6 649. F. Terrey. London. A system in connection with electric burglar alarms and other apparatus to which it is applicable.

6,652. A. Duffek and B. Holub. London. Improvements in the construction of electric accumulator plates.*

6,654. M. Kotyra. London. Improvements in telephone transmitters.

6,657. G. Lyons and H. Bevis. London. Improvements in holders for incandescence electric lamps for stage and like purposes.

6,674. G. Benischke. London. Improvements in asynchronous alternating current motors.

6,681. J. M. Cronin. London. Improvements in or relating to electric switches or circuit controllers. (Date applied for under Patents, &c., Act, 1883, Sec. 103, 22nd September, 1894, being date of application in United States.)*

April 2, 1895.

6,756. A. J. Boult. London. An improved mode of connecting the parts of a telephone apparatus. (P. Rubbidge, Australia.)*

6,781. The Edison and Swan United Electric Light Company (Ltd.) and C. F. Proctor. London. A socket for electric glow-lamps.*

6,788. R. K. Boyle. London. Improvements in or connected with apparatus for recording and reproducing telephonic messages.

6,791. P. R. Jackson and Co. (Limited), J. S. Lewis, and G. Kemp. London. Improvements in enclosed electric mining switches.

April 3, 1895.

6,893. H. H. Lake. London. Improvements in electrical signalling apparatus for marine purposes. (B. A. Fiske. United States.)*

April 4, 1895.

6,908. H. Richardson. Lichfield. Improvements in electric weighing apparatus.

6,934. H. W. Handcock and A. H. Dykes. London. An improvement in electric glow-lamps.

6,935. S. G. Dutton. London. Improvements in and connected with junction boxes for electric cables and the like.

6,952. E. G. Rudén and K. L. Norén. London. A new or improved electrically opened and closed gas burner.

April 5, 1895.

7,009. J. Finlayson. Glasgow. Improvements in dynamo electric machines.

7,041. J. Wohl. London. A protecting cover for telegraph posts.

April 6, 1895.

7,075. T. Fletcher, W. Russell, and Fletcher, Russell & Co. (Limited). Manchester. Improvements in and connected with electric cooking and heating grills and similar apparatus.

7,086. G. W. Russell, Jun., and A. V. Officer. London. Automatic electric switch.

7,107. J. Brockie. London. Improvements in working electric arc lamps and apparatus therefor.

7,108. O. Imray. London. Improvements in the purification of saccharine juices by electrolytic treatment, and means employed for that purpose. (La Société Anonyme Raffinerie, Say, France.)*

April 8, 1895.

7,142. Manchester Edison Swan Company (Limited), A. Still, and E. W. Cowan. Manchester. Improvements in regulating transformers for alternating currents.*

7,147. J. Graham. London. Improvements in telephone receivers.

7,152. J. V. Faber. Birmingham. Improvements in the mode of and means for writing by telegraphy which he terms the pantelegraph.*

7,191. H. J. Fisher. London. Improvements in electric arc lamps.

April 9, 1895.

7,245. J. H. Guest. London. Improvements in electric railways.*

7,278. C. H. Gray. London. Improvements in or relating to electric conductors.

April 10, 1895.

7,310. H. J. Rogers. Watford. Improved means and apparatus for raising, lowering, and traversing arc lamps used for photographic and other purposes.

7,315. W. J. S. Barber-Starkey. Manchester. Improvements in and connected with electrical storage batteries.

7,319. T. Fletcher, W. Russell, and Fletcher, Russell and Co. (Limited). Manchester. Improvements in and relating to electrical hot plates.

7364 J. Wetter. London. Improvements in the electrolytic manufacture of alkali-chlorates. (The Elektrizitats Aktiengesellschaft vormals, Schuckert and Co., Germany.)

April 11, 1895.

7,445. D. E. Hewlett. London. Improvements in accumulators.

7,458. C. Kellner. London. Improvements in the electrolysis of metallic salts.

April 13, 1895.

7,504. G. Ferrari and R. Arno. London. Improvements in and relating to the distribution of alternating currents.

7,525. W. Gissling. Long Eaton. An electrical jacquard apparatus for use in curtain lace machines and fancy looms.

7,548. Siemens Bros. and Co. (Limited). London. An electric safety switch. (Messrs. Siemens and Halske, Germany.)*

April 16, 1895.

7,584. J. H. Rider and J. Pilling. Bolton. Improvements in methods of electric distribution.

7,600. W. Rowbotham, H. Levetus, and S. J. Levetus. Birmingham. Improvements in and relating to primary batteries.

7,625. D. M. Rothenberger, C. A. Inglis, and E. D. Reilly. London. Improvements in electric wire insulators.*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

5,631. Preston and Gill. Electric lighting of trains, &c.

5,650. Pearson. Thermometric circuit closer.

6,497. Hermite and Others. Electrolysing chloride solutions.

6,975. Smith and Wright. Battery plates or electrodes.

8,292. Liardet. Charging secondary batteries.

8,3[illegible]7. Lake (Antwerp Telephone and Electrical Works). Telephone switches.

8,350. Leigh (Vohwinkel). Electric batteries.

8,823. Dearlove. Transmitting signals through telegraph lines.

8,972. Griffin. Secondary batteries.

9,123. Maxim. Electric railways.

10,331. Behr. Electric tram and rail vehicles.

10,515. Fleming. Dynamo-brushes.

14,245. Scott. Electrical distribution.

15,403. Krützfeldt. Telephones and microphones.

1895.

1,446. Schoenmehl and Platt. Galvanic batteries.

1,526. Mathers. Electric conduit.

3,095. Hey and Parsons. Electrical exchange systems.

3,134. Hempel and Maerker. Telephonic connections.

COMPANIES' MEETINGS AND REPORTS.

◆

Metropolitan Electric Supply Company (Limited).

The eighth ordinary general meeting of this Company was held on Wednesday at Winchester House, Old Broad-street, under the presidency of Sir John Pender, G.C.M.G., M.P.

The SECRETARY (Mr. E. Cunliffe Owen, C.M.G.) having read the notice calling the meeting, the report of the Directors was taken as read.

The CHAIRMAN then said: Before asking you to adopt the report I will, as usual, make a few remarks on the working of the business in the past year. It will be most convenient to deal first with that portion of the accounts which show the growth of our undertaking. From the capital account you will have seen that we have expended in connection with our works of construction a total sum of £42,999 in the year. Of this amount about £30,000 have been spent on mains, transformers, connections, and meters. This represents the ordinary extension of our business in supplying the new customers who have been connected to our system, as well as making provision for future customers in our various districts. So long as customers continue to increase at their present rate and the areas occupied by us have to be filled up with the necessary network of mains, this expenditure must continue to grow, while every addition means the growth of profitable business to the Company. The other items of capital expenditure requiring notice are, buildings £1,832, machinery £7,995 and compensation £2,703. Dealing with these in the order named, the first item is due to works for the completion of the new foundations at our Manchester-square station to which I referred last year, and also to expenditure at our Amberley-road station at Paddington in providing for the reception of additional plant to enable us to keep pace with the needs of the district. The second item (machinery) is due to new plant, which has been erected at Manchester-square station to meet the circumstances under which we have been placed in connection with the actions brought against us for vibration. This seems a fitting place for referring to the difficulties we have encountered in this matter difficulties which have required our most earnest care, and which have taxed the skill and energies of our staff to overcome, and we are much indebted to my old friend, Lord Kelvin, to Prof. Kennedy, and to many others for the assistance they have rendered to us in the matter. Some considerable time was necessarily occupied in carrying out the remedial measures, and it was found impossible to avoid litigation, which took the form of actions for injunctions to restrain the Company from carrying on their works in such a way as to cause a nuisance. There were practically three of these actions, for though a fourth was commenced very recently, it was soon discontinued, and the plaintiff had to bear his own costs; and though there is still a small question about alleged noise with the plaintiff in another of the actions, so far as vibration is concerned, all the actions have been disposed of. We therefore may, I think, regard our difficulties as practically overcome at Manchester-square, for of the three outstanding actions in one case the plaintiffs admit that there is no vibration; in the second, no steps have been taken for about a year, so I think we may assume they have arrived at the same conclusion; while in the remaining action it only remains to ascertain what damage the plaintiffs have suffered directly attributable to the vibration. It was, of course, impossible for us to carry out the remedial works, involving, as they did, alterations of foundations and changes of machinery, without serious expense and great difficulty in maintaining a constant and regular supply. Moreover, our working expenses show a large increase in consequence of our other stations having been called upon to assist the Manchester-square works almost daily during the alterations. I ought to explain that the machinery which was thrown out of use from the above causes is doing excellent work elsewhere, so that we are now possessed of additional plant which it would have been in any case necessary to obtain to cope with our largely increasing output. You will, I think, now quite realise the nature of the third of the items, namely, "Compensation," to which I have directed your attention in the capital account. It relates entirely to payments made in connection with these law suits. The capital expenditure during the year naturally involved the provision of funds to meet it, and in dealing with this question the Board considered that they ought to able to borrow on better terms than 5 per cent. In the result a First Mortgage Debenture Stock at 4½ per cent. was created to the extent of £250,000, of which amount £150,000 was issued last July at 105, that being the rate at which the old debentures had to be redeemed. This stock now stood about 120, giving a good indication of the position they had in the financial world. With the proceeds the whole of the old debentures have been paid off, and the net premiums have been carried to the depreciation fund. You will notice that I have said net premiums, as there were expenses of issue to be paid and interest to be provided for during the period which had to elapse before the whole of the old debentures could be called in under the terms on which they were created. Of the balance of £50,000 which was left, we had £21,000 still in hand at the end of the year, but it will before long be necessary to make a further issue to keep pace with our rapid expansion of business. I now ask you to turn to the revenue account, which shows a steady increase, being £16,150 more than in 1893, and an increase of £7,000 in the gross profit. This increase, satisfactory though it is, would have been larger, had it not been for a somewhat heavy increase in working expenditure, partly owing to the higher price we had to pay for coal, but also to a very large extent in consequence of the peculiar difficulties which the litigation to which I have already referred forced upon us. These difficulties, having been successfully overcome, as we believe, will not again trouble us. I ought also to point out that, as mentioned in the report, the Board found it absolutely necessary to make certain reductions in favour of large consumers of current. While up to the present time we have been able to maintain our standard price at 7¼d. per unit, a reduction is made after a certain fixed minimum has been reached. This reduction has been largely taken advantage of by our more important customers, especially during the winter quarters: but while our receipts have been materially affected thereby, the encouragement which this system of charging gives to use our current is beneficial, as having a tendency to increase our day load. I would also remind you that in one portion of our district competition has to be met. The final result, as shown in the net revenue account, is that, after writing off the usual £1,000 from the preliminary expenses, and setting aside a further £8,000 to depreciation, there remains a balance of £15,909, out of which the Board propose to pay a dividend of 6s. per share, carrying forward £939 to the next account. Referring to the amount written off for depreciation, and to the auditors' note upon the subject, I ought to say that the Board do not in any way commit themselves to an opinion as to what amount should be written off on this account. They recognise the fact that electric lighting is a business which is at present new and undeveloped, and as such cannot be judged altogether by the experience of other businesses. While the knowledge which is being gained year by year may show at some future time that the amount set aside is insufficient, it may, on the other hand, be found that it has been larger than is actually necessary. Having regard to the interests of the present shareholders, who have taken all the risk of the establishment of the undertaking, the Board have thought, after the most careful consideration, that an appropriation for the purpose in question, increasing with the Company's income and practically proportional to that income, will most justly and reasonably meet all the requirements of the case. Now, gentlemen, I have been careful to put all these statements on paper, because it is necessary that you should have a very accurate and careful account of the proceedings in connection with our business during the year. I may say that I have only received one letter complaining rather that the dividend was smaller than the writer had expected. On the other hand, I have received a letter which states that the writer highly approves of the policy which guided the Board in declaring only a moderate dividend. I daresay I am speaking to many who are rather disappointed, and I am myself disappointed that our dividend is not larger; but when I see the causes accounting for this, which come before me daily, I am satisfied that we are pursuing a sound policy in building up the business, as we are doing, upon a thoroughly sound basis. I may mention that when we originated this business we were under the impression distinctly—showing how uncertain these things are—that at least £1 per light would be gathered from our customers. I remember being taken to task by a gentleman connected with another company, who said that I had undervalued the revenue, and that I ought to have taken the amount at 25s. I may, however, tell you that if we had got per light what we originally anticipated we should receive when we first issued our prospectus, we should be paying you a very different dividend to-day from that which we are proposing. The average amount we receive for our light is 8s. 5¼d., and you can understand that that is a very marked difference compared with £1, which we thought we should receive. Still, I am not disappointed, because I see the growth of the concern, and that the demand for the light is a continual and steady one. You see that by this diagram, the red line showing the increase that has taken place. I will give it to you, however, in figures, which you will no doubt be able to understand just as well. We have to-day 224,829 lights, and we have applications for 10,000 more, and, as far as I can see, we can, with our present machinery, go on up to about 300,000 lights. One reason for our not paying as large a dividend as is paid by one or two of the existing companies is that we have a much larger area than they. We have to lay down mains over a very considerable space, as shown by this map. When we begin to get along them a full demand for our lights, then the Company will begin, with no increase of expense, to reap what they are sowing at the present time. I therefore look to our dividend steadily increasing, for the demand is increasing, and I think we are building up this business on such a solid foundation that those who are in it now will have no cause to regret their association with us. We originally expected to supply current in the more central portions of the West-end, but the Board of Trade has the power, of course, to make the allotments, and we were obliged to take the allotments which were made to us. We are, however, hopeful that we shall be able to develop our areas satisfactorily, though the work will extend over a greater period of time. Still, when we get it thoroughly established, and the demand for the electric light, the popularity of which is daily increasing, is such as to occupy the mains we have laid down, I think I shall be able to make matters look brighter than they do to-day. I cannot tell you the trouble and worry we have had in connection with this question of vibration. We have been attacked on all sides about it. Many people expected to get something out of us, and many believed that their property was being injured by the vibration caused by our works. We have been forced to go into this matter, but we have done so in the most careful way possible. The result has been that I think we have got such improvements introduced into our machinery that our present power answers our purpose better than the original power. I may say, too, that altogether we expect to obtain results through the troubles which we have experienced which will eventually be very beneficial to the Company. In regard to the reserve fund: as I have told you, this is a new business. We want to be perfectly safe in what we are doing in regard to depreciation, and, so far as I can make out, we are on the safe side. I see our very careful auditor here. In these days every man is called to account for words he utters on an occasion of this kind, and, in connection with the auditor's certificate, I think he was rather anxious to show that this being a new business, while the amount we have placed aside for depreciation was considerable, yet that it was an uncertain amount until we had something like 20 years' experience of the working of our machinery. By that time it will be a question whether we have a debit or a credit. I sincerely hope that the improvements lately introduced will show that we are putting aside sufficient to meet all depreciation. I will pay the compliment to our engineer and the executive of our system of saying that we have a thoroughly efficient staff, and we have very proper and efficient discipline among that staff. The complaints we have had have been comparatively few, and the relations between ourselves and our customers are extremely satisfactory. The reduction in our charge to which I have alluded affects us very considerably, but where there is competition it has to be met. I think the day will come when it will be understood that it will be advantageous not to press competition as is done at the present time, and I hope that when we get to understand our business better, we shall be in a more favourable position to come to an understanding with the various companies who are all working in the same direction as ourselves, and I am glad to find that the other companies do look upon us rather as an example than otherwise in the way our business is conducted. I daresay that some of you may have heard that our Chief Engineer has been called upon and invited to give his services to another important company. I value the services of our engineer greatly; I value the work he has done for us because it has been done in a quiet, systematic way. We therefore came to an arrangement with the other company to which I have referred that while we retained the services of our engineer, we would allow him to assist them also, and to give them the benefit of his experience. Without going further into detail to-day, I think I may sum up by saying that we stand well with our customers and well with the public, and we ought to stand well with our shareholders, for while the dividend is not large, it is based on the soundest business principles which can be applied. There is nothing strained, and you have the prospect of a steadily increasing income; for, as I have already said, our business is steadily improving. It must therefore result that our income will grow in the future, and I hope that the expenses will not grow in the same proportion. He then moved the adoption of the report and the accounts and the declaration of the dividend recommended, payable on May 2nd, adding: I hope that next time I meet you we shall be able to issue our dividend warrants on the same evening as the meeting, because even a week's delay in the payment of a dividend is probably a longer delay than is desirable.

Admiral Sir GEORGE H. RICHARDS, K.C.B., F.R.S., seconded the motion.

Mr. YOUNG congratulated the Directors on the diminution in the management expenses as compared with what they were a year ago, and on the increase of £16,150 in the revenue having been obtained at an increase of only £419 in the management expenses. The coal bill was, however, a very large one still. In their report the Directors stated that "considerable difficulty was experienced in maintaining the public supply while the alterations were in progress" (the alterations in connection with the works at Manchester-square), and he desired to know whether the Chairman could state roughly what the expenditure had been owing to the vibration. He assumed that this expenditure was not included in the item of £2,703 mentioned in the capital account as "expenses relating to compensation for damage."

The CHAIRMAN stated that the item of compensation was altogether distinct from the expenses attending the vibration, but it was useless for him to mention any speculative figure in answer to the question asked by Mr. Young. They were treating all these things, as men of business, upon sound business principles. He might say, in further reply to Mr. Young, that they were so situated in regard to their installations that they had to use the best smokeless steam coal. This Company's stations, too, were very much inland, and they had not the advantage which some of the other companies had of laying down their coal cheaply.

Mr. WALLER asked for some further information regarding the contemplated competition between the Strand Company and this Company as regarded the supply of the Strand district.

The CHAIRMAN said that it would not do for him to mention what what was going on in connection with this matter, except that it was receiving careful attention.

Mr. JOHN NEWTON complained of the qualification in the certificate given by the auditors, who stated that the accounts were correct "subject to the sufficiency of the charge for depreciation." He contended that a company in its early stages, if it were spending an ample sum in maintaining all machinery and property effectively, was satisfying all reasonable requirements as regarded depreciation, especially in a case like that of this Company, where the business was rapidly extending. He thought that auditors generally were assuming a responsibility which did not attach to them as regarded the question of depreciation, and the qualified certificate which so many of them now gave was calculated to damage the interests of the company concerned, and to place such company in the category of investments which people might think they had better not go into.

The CHAIRMAN said he thought it possible that if Mr. Newton, who was a very good accountant himself, were in Mr. Griffiths' place he would do very much what Mr. Griffiths had done. Mr. Griffiths was appointed by the body of shareholders, and what had been said by his firm in their certificate had been said, no doubt, as they thought, in the interests of the shareholders. The Directors, however, he believed, took very much the same view as Mr. Newton. Mr. Griffiths was the representative, not of the Directors, but of the shareholders, and he had no objection to what had been stated by the auditors. He (the Chairman) did not know that the depreciation, as far as they had gone, was as marked as one might suppose it to be; but they had the money in hand, and he thought that Mr. Newton would agree with him that it was a very good thing to have a good standby, either in the form of a reserve fund or a depreciation fund.

Mr. JOHN GRIFFITHS said that Mr. Newton might be assured that his firm would not do anything which would be prejudicial to the Company. The reason for drawing up their certificate as they had done was this—that they had no certain knowledge up to the present time of what the depreciation was; and he believed the shareholders, as a body, would think that the auditors had acted wrongly if they had not drawn attention to the fact.

Mr. CRIPPS said he was not entirely satisfied with the dividend, and he thought that the management expenses were high. He inquired whether the time had not arrived when they might have half-yearly meetings, or, at all events, half-yearly dividends.

The CHAIRMAN, in reply, said that if they had half-yearly meetings it would add very considerably to their expenses, which he desired to see kept down. He thought the suggestion regarding the payment of an interim dividend was reasonable, and when the time was opportune for doing so, he would be only too glad to recommend his Board to pay interim dividends. He then put the motion, and it was carried unanimously.

Resolutions were afterwards passed re-electing the retiring Directors, Admiral Sir G. H. Richards, K.C.B., Sir Eyre Massey Shaw, K.C.B., and Mr. John B. Verity, and the auditors, Messrs. Deloitte, Dever, Griffiths and Co.

The CHAIRMAN said that when he first became Chairman of the Company he laid down the rule that chartered accountants should inspect their accounts, and that the Directors should have nothing whatever to do in preparing the accounts in any way.

A cordial vote of thanks to the Chairman and Directors was then passed.

The CHAIRMAN briefly acknowledged the vote, and the proceedings terminated.

County of London and Brush Provincial Electric Lighting Company (Limited).

The annual general meeting of this Company was held at the City Terminus Hotel, Cannon-street, on Monday, under the presidency of the Right Hon. D. R. Plunket, Q.C., M.P.

The SECRETARY (Mr. B. Broadhurst) having read the notice calling the meeting, the report of the Directors was taken as read.

The CHAIRMAN then said: Gentlemen, this is really the first annual report which we have had to submit to you in the history of this Company. I have the honour of asking you now to adopt it, proposing this resolution on behalf of my brother Directors as well as of myself. It is true that last autumn we submitted to you a statement, but that was rather of a preliminary nature, and the present report now gives the results of the first nine months working. I hope you will agree with me—you who have studied the report and accounts—that the position in which we find ourselves after such a very brief experience is an eminently satisfactory one. In the first place, looking at it from a financial point of view—which is, after all, most important to us as shareholders, and also for our customers—you see that in the profit and loss account, after providing for all the usual charges and writing off the preliminary expenses in connection with the Canterbury Company, the negotiations with which did not produce any substantial result (these expenses, however, only amounted to about £300), we are able to submit to you a profit—a very small profit I admit, but still it is a satisfactory circumstance that we are able to show even a small profit on the operations of the Company at the end of only twelve months' working. The capital expenditure is proportionately rather heavy, but this is not a matter of regret when you consider the purposes to which that expenditure has been applied; in fact, we are only sorry that we have not had opportunities up to the present time of making a larger number of investments of the same kind. There is another circumstance which I think—looking at the matter still from a financial point of view—we may regard with peculiar satisfaction. A short time ago we found it necessary to apply to the public for money for the purpose of meeting expenses upon contracts we had already entered into, and also for the purpose of paying for shares in certain companies over which we thereby acquired a controlling influence; and when we made an issue of 10,000 Preference shares of £10 each, they were immediately taken up and subscribed for many times over, the Ordinary shares issued at the same time being also well subscribed for. I think that all these circumstances are symptoms which we may fairly claim establish the satisfactory position of our Company at the present time, and I think it is not only satisfactory to ourselves that we should find ourselves in this position, but I think it may also afford an additional inducement to private persons who may think of taking electric supply from us; and I think it ought also to be an encouragement and give confidence to many other companies which, not having had such a fortunate experience in their early careers as we have had so far, may now desire to retrieve their position by alliance with us. You may rest assured that the Directors will take care that the basis of such alliances would in every case be thoroughly safe in your interests. As you know, we have already had some experience in matters of this kind; but before I refer to our experience in acquiring a controlling influence over existing companies, let me say a word or two as to the present condition of the Company in regard to those enterprises which are within the circuit of the County of London. No doubt, we have been met with some delay in this business, mainly owing to objections taken by the London County Council and other Local Authorities to our proposals—not, I beg you to observe, from any faults they have detected in the system of electric lighting we submitted to them, but on account of unfortunate circumstances which have lately happened in connection with the operations of other companies. Thus the Board of Trade have for the moment yielded to the objections taken by the County Council and other Local Authorities in order that they might fully possess themselves of all the circumstances of the case before giving their consent. I do not think we can very seriously complain of that, however, because, no doubt, a certain amount of distrust and even apprehension has been excited in the public mind by unfortunate accidents which have occurred elsewhere; but I wish you to understand that those accidents have not occurred in connection with any system similar to that which we propose as to street boxes. But still this accounts for the delay which has so far occurred. I think it is a satisfactory circumstance—especially in reference to the report which, you may have seen, was made last week by Major Cardew, the very careful and able representative of the Board of Trade, as the result of his inquiry into accidents which have occurred with the electric lighting in London—that our excellent engineer, Mr. Lawson, assures me that the system he is prepared to submit—which he has for some time past been contemplating, and is, in fact, now carrying out—will not be open to the objections stated in Major Cardew's report, and will meet all the requirements which he has set forth. You may rest assured, therefore—and the public also—that we shall be able before very long to carry out the latest requirements for electric lighting with safety to the public and advantage to yourselves. In fact, I am glad to say that we have obtained the consent of the Local Authorities in the district of St. Luke's and Clerkenwell to the extent that we have been able to lay our pipes and mains through that district, and to make our arrangement for street boxes. I believe that all those matters are satisfactorily arranged in that district. As you know, also, we have commenced the building of the power station which we propose to establish at the City-road basin of the Regent's Canal. We hope that that will be completed in sufficient time, as we state in our report, to supply current from that station by the end of September, and thus we shall be ready for the period of year when the days are short and the nights are long. Then, as to Wandsworth, our operations have been held back a little awaiting the publication of the regulations of the Board of Trade, but we have good reason to believe that those regulations will now be immediately issued. We have been fortunate enough to acquire, meantime, a large supply of pipes at prices which compare very favourably with those now ruling in that business, and we are now ready to commence laying them and to complete our roadwork there at an early date. As you know, we have acquired a site for our power station on the southern banks of the Thames for the Wandsworth district. The plans for the station are already well advanced, and tenders will be invited as soon as possible for the construction of the buildings. We have also now obtained the consent of the Local Authority in the district of St. Olave's, Southwark. That is an important district, containing the two London Bridge stations and railway approach, and it will be a very favourable operation for us, because that district adjoins the district of St. George the Martyr, where we have already obtained a Provisional Order, and we shall be able to work the two districts from one generating station. I hope we shall be able by this concentration of operations to work that station on economical conditions. I think I have now dealt with all our operations in the County of London. Turning to enterprises which have engaged our attention outside the County of London, I will first deal with the Bournemouth Company. A year ago, as you know, we acquired from the Brush Company their interest in the Bournemouth Electric Lighting Company, and I am glad to tell you that the improvement of our position in that quarter has since that time been very remarkable indeed. There has been a great increase in the number of consumers there—so great an increase that it is represented by an addition, I think, of 4,500 8-candle-power lamps, making 19,000 altogether up to the end of last year. Of course we have had to incur some additional expenditure in order to undertake this increased service, but this has been done in a way that any further demand on us can be economically met. I may mention, as an illustration of the advantageous circumstances under which the proceedings of this Company are conducted, that within the first three months of the present year there has been an increase of, I think, 20 per cent. in the current supplied as compared with the amount supplied this time last year, and at the same time Mr. Lawson informs me that by more economical arrangements of the plant there has been a considerable decrease in the expense of coal per unit of supply. We have not nearly come to an end, I hope, of our development of the Bournemouth Company's operations; and it is estimated that whereas at the present time the capital outlay per 8-candle lamp power light we supply there is represented by about £2. 15s., as the development of our business goes on and we attain, as we hope before long to attain, a business represented by 40,000 8-candle-power lamps, the capital cost per lamp will be reduced from £2. 15s. to £2. 5s. With respect to Dover, the building of the generating station and of the offices connected with it is completed. We have a very fine station and set of offices there, and we have acquired an interest which will, I believe, turn out to be a very valuable one. Up to the present the whole of the plant has not been delivered; but with such plant as we have there, we are already supplying the light to the sea front of the town. We have also laid our mains all through the business part of the town, and with very little additional expense we shall be able to lay them through the residential part of the town also. I may say that last week I had the pleasure of meeting Sir William Crundall, our very popular and energetic Chairman of the Dover Company, and Mr. Bagshawe, on the spot. I went over the whole of our arrangements there with those gentlemen, and I think you may feel very comfortable that, with their wise and able assistance, we shall be able to make our enterprise at Dover a very profitable one. With regard to Windermere, we have so far succeeded in obtaining the consent of all the Local Authorities, excepting two, to our obtaining the Provisional Order we desire for that district. We have obtained the consent of seven of the Local Authorities out of nine, and I hope that before long the two outstanding will see the advantage of joining with the others in taking the electric light from us. We can offer it to them on very moderate terms by reason of the advantage we have in using the water supply of the outflow of the river Leven. Coming to Richmond, in Surrey, which is the last investment we have made, I may say that when we were drafting this report, the negotiations, which had been for some time in progress, were practically completed, and they have now been actually completed. We have acquired at Richmond an excellent generating station, supplied with admirable plant, and we have obtained an interest in a going concern which already supplies over 4,400 lights in the town, and as with a small additional expenditure double the number can be supplied, I believe that our investment in this direction will turn out to be a very favourable one. I do not think that anybody who goes through that picturesque town can fail to see the large number of fine houses and first-class shops, as well as large hotels and other business premises it contains, and I think its handsome streets and terraces would considerably gain in appearance if electric lighting were introduced into them. I can very easily understand that the people of Richmond have hesitated up to the present to make application for the electric light from the existing Company on account of the various difficulties in which it was unfortunately involved, but now that that Company stands on a perfectly firm financial basis, I hope that the demand for the light will become more brisk when the people there find that they can rely confidently on obtaining the permanent and satisfactory completion of any contracts which they may enter into with us. On the part of the Company I can promise that we shall be ready to meet half way customers who may desire to take current from us by, if necessary, additional mains, carrying electricity into districts at present not served by the concern, and giving all other facilities which can be reasonably asked of us. I may say as to the Richmond station that, having very carefully gone through it and it surroundings only last week, I am very sanguine that we shall find that this our latest investment will turn out to be very profitable. I have only to add, as regards the matter of electric traction as applied to tramways, that we have had proposals from one or two directions on this subject, and we are of opinion that there is probably considerable scope for the development of such electrical enterprise in this country. We are carefully considering this matter. Up to the present we have had no offer with which we have thought it well to close, but we shall be ready carefully and favourably to consider any further offers which may be made to us. I now beg to propose

"*That the report of the Directors and statement of accounts to December 31, 1894, now presented to the shareholders, be received, and that the same be hereby adopted.*"

The DEPUTY-CHAIRMAN (Mr. J. B. Braithwaite, jun.) seconded the motion.

Mr. CASH inquired whether a quotation had yet been obtained from the Stock Exchange for the Ordinary and Preference shares of the Company, which, they had been informed, had been applied for. The Chairman had touched very lightly on the very small amount of profit made last year, and if there was any further information or hopes which could be held out to the shareholders in connection with this matter, he thought it would be satisfactory to them. The fractional amount of £300 profit for the year had been the subject of remark.

The CHAIRMAN, in reply, stated that a little delay always occurred in connection with the obtaining of a quotation on the Stock Exchange, but the papers were going in on the following day, and they hoped they would receive a quotation without further delay. As regarded the question of profit, he took a more favourable view of the result than Mr. Cash did; and he doubted very much whether any other electric lighting company in the kingdom had been able so soon to make any profit at all. The fact was that the greater part of their time so far had been spent in preparations. His own feeling was that they would be able next year to present an even more satisfactory result of their operations. The resolution was then unanimously adopted.

The DEPUTY-CHAIRMAN afterwards proposed the re election of the retiring Directors, the Right Hon. D. R. Plunket and Mr. F. W. Reynolds. They had, he said, heard the lucid and clear explanation of the Company's affairs which had been made by the Chairman, and they would have gathered from this the interest taken by the right hon. gentleman in the prosperity of the Company. With regard to Mr. Reynolds, he had worked with that gentleman for some years as a colleague in connection with electric lighting, and he knew of no one who took a deeper interest in this question that Mr. Reynolds, who also had considerable practical knowledge of it.

Mr. SMART seconded the motion, which was unanimously carried.

Mr. Robert H. March (chartered accountant) was afterwards re-elected auditor to the Company.

Mr. HERRING stated that it had been intended, when this Company was started, that the remuneration of the Directors should be on the same footing as that of the City of London Electric Lighting Company, that is to say, beginning at £1,000 for the first year, and rising by £300 a year until a maximum of £3,000 was reached, and that it was by error that provision was made in the Articles for the first year only at £1,000 with no arrangement for subsequent increase. He therefore proposed that the meeting should then agree to an alteration of the Articles of Association in the sense above indicated. After some discussion it was determined that the subject should be adjourned until next general meeting, when it was understood Mr. Herring would again bring forward his motion.

A vote of thanks, proposed by Mr. SMART and seconded by Mr. CASH, was carried unanimously, and briefly acknowledged by the Chairman. The proceedings then terminated.

Great Northern Telegraph Company.

The following abridged report of the general meeting, held at Copenhagen on the 20th inst., is issued:—

Mr. F. Zahle presided, and in the absence of the Chairman of the Company, the Managing Director, Commodore E. SUENSON, R.N., rendered an account of the working of the Company during the year 1894. He said the year 1894 had seen the celebration of the twenty-fifth anniversary of the formation of the Company, and, old as some of their cables were, their condition was still satisfactory, thanks to the care taken to renew and strengthen defective portions. During the past year six of the cables in Europe have been subject to 13 interruptions, and in the Far East there have been nine interruptions of five of the cables. The cable steamer "H. C. Orsted" has been employed on active service for 115 days; the "Store Nordiske" for 127 days. The Wladiwostock line, which runs through Russia and Siberia, connecting their European with their Far East cables, had worked less satisfactorily than usual, and various suggestions for the improvement of the service were now under consideration. The Board had reason to hope that these suggestions would be carried out, it being in the interest of Russia herself to improve matters on account of the Siberian Railway, which will follow the track of the telegraph line, and greatly increase the importance of the latter. Amongst the technical improvements of the year should be mentioned the introduction of duplex working between two of the most important telegraphic centres of the Company's European system, viz., the stations at Newcastle and Gothenburg. In this connection it may also be mentioned that in these two stations the electric light was introduced some years ago in place of gas. The result has been so satisfactory that electric lighting has since been established in the offices at London, Aberdeen, and Shanghai. On January 1, 1895, the three Scandinavian Telegraph Administrations opened a new overhead line for direct transmission between Copenhagen and Christiania. This line would deprive the Company of a large proportion of the traffic over the Danish-Norwegian cable, which was already rather unremunerative. There was, however, no reason to complain, as the direct service between the two capitals is a distinct advantage to the public. The new building for the Central Administration of the Company at Copenhagen was completed in time for the celebration of their twenty-fifth anniversary. This celebration was fully justified by the circumstances, seeing that, notwithstanding many difficulties, serious competition, and mishaps of various kinds, the Company had succeeded in carrying through their programme and in attaining a development and a position, which enable them to look forward to the future with equanimity, and to meet all reasonable wishes of the shareholders. To celebrate this anniversary in a fitting manner the Board published a detailed history of the Company in Danish, and had granted liberal donations to the whole of the staff in proportion to their length of service and position. Compared with the 24 preceding years their jubilee year had shown the highest receipts, surpassing even the year 1891, which hitherto had been the best. This satisfactory result was due almost exclusively to the increase of the traffic in the Far East. The increase in the receipts in 1894 came from the war between China and Japan. War was officially declared on August 1st, and the results, so far, were known to the whole world. There was no doubt that the consequences of the war will prove of immense importance to the destinies of the two nations and to their relations with foreign countries. The Great Northern Company had maintained an amicable but strict neutrality towards the two belligerents. Thanks to this attitude, and to the indispensable necessity of the telegraphic connections, neither of the two Powers had interfered with the cables. The service had been performed as regularly as in time of peace, and it was a remarkable phase of this Oriental war that, as in the war between France and China in 1884-85, not only the international cables, but also commerce and navigation have been left undisturbed. Their normal traffic had not suffered, but had even increased a little through the closing of the Chinese Helampo route. At the same time the great political and military events had created an extraordinary traffic of Government and Press telegrams between the Far East and Europe, and it was to this traffic, which would disappear with the cessation of hostilities, that they owed the increase in their receipts. The war had prevented the Board from resuming negotiations with the Chinese Administration with regard to their future relations, and, therefore, the greatest caution was necessary with regard to the management of the Company's revenue. It was therefore proposed, in addition to the payment of the usual extra dividend, and a small increase in the balance carried over, which for the last three years had been reduced considerably, to apply the remainder of the surplus to the creation of an amortisation fund, which will enable the Company to accelerate the repayment of the outstanding debenture debt as soon as the yearly drawings of the 1833 debentures could be increased. The same course was adopted in 1888-90 with the 1881 debentures. Since then the extra dividend had risen by 2s. 2d. per £10 share, and the value of the shares by about £8, which was the best proof of the advantage to the shareholders of the proposed measure.

The report and balance sheet, together with the propositions as to the distribution of the balance, were adopted; the retiring Director, Commodore E. Suenson, was re-elected; Messrs. A. Berner and S. Bille were re-elected auditors, and the proceedings terminated with a vote of thanks to the Chairman.

Telephone Company of Egypt (Limited).

The twelfth ordinary annual general meeting of this Company was held on Tuesday last, at the offices, 14, Austin-friars, E.C., Gen. Alexander Fraser, C.B., R.E., presiding.

The SECRETARY (Mr. Alex. B. Chalmers) read the notice convening the meeting, and the report of the Directors was taken as read.

In moving the adoption of the report and accounts, the CHAIRMAN said: I am able to present to you what you will no doubt deem a satisfactory report of our business in Egypt. You will observe that the revenue account for the year shows a net profit of about £7,000, which after deduction for home expenditure represents a balance of some £6,000, of which we propose to reserve for contingencies during the current year £1,000. This has been necessitated by the fact that the Government contemplates reducing its rates of subscriptions, which may affect the revenue of the current year unfavourably, though, as the Government will probably fix the rate for a period of years, it may tend to increase our business in the end. The Government has always treated us with consideration, and your Directors endeavour to meet its wishes as far as possible. We have also thought it desirable to carry £2,000 from the profit and loss balance to a suspense account, for the purpose of forming a fund for the redemption of our debentures and for extending our connection, of which there is good prospect. After making this deduction from the profit and loss account, there is a balance of £4,966. 6s. 4d., which we propose, with your sanction, to deal with as follows:—To write off £80. 16s. 4d. for depreciation of stores, to pay a dividend of 6 per cent. on the Preferred shares, free of income tax, and to carry forward £1,264. 3s. 10d. I have nothing further to say beyond what is stated in the report, which you have doubtless read, but shall be happy to answer any questions which you may desire to put. I should, perhaps, add that under the Articles of Association the remuneration of the Directors has to be fixed for the current year and confirmed for the past year. This has been hitherto drawn, with the approval of our chief shareholders, at £350 per annum.

Mr. THOMAS LLOYD seconded the motion, which was carried unanimously.

On the motion of Mr. HENRY GREWING, seconded by Mr. LLOYD, the Chairman, General Alexander Fraser, C.B., R.E., was re-elected.

It was proposed by Mr. WILLIAM ADDISON, seconded by Mr. HENTSCH, and carried unanimously, that the remuneration of the Directors for the current year be at the same rate as heretofore, viz., £350.

The auditors, Messrs. Price, Waterhouse and Co., were re-elected, and a vote of thanks to the Chairman for presiding closed the proceedings.

The report of the Directors, above referred to, states that after putting aside a sum of £1,000 to meet contingencies, the revenue account shows a credit balance of £5,018. 1 . 7d. transferred to profit and loss, which, together with £1,948. 4s. 9d. brought forward from 1893, exhibits a balance to credit of £6,966. 6s. 4d. The Directors propose to deal with this balance as follows:—To transfer £2,000 to a suspense account as a fund to provide for redemption of debenture , extensions, &c.; to write off £80. 16s. 6d. for depreciation of stores; to pay a dividend of 6 per cent. on the Preferred Shares, free of income-tax; and to carry forward £1,264. 3s. 10d.

Considerable reconstruction has taken place at Alexandria and Cairo during the past year, including the erection of a new derrick at Cairo, the cost of which has all been charged against the year's revenue. The Company has been led into litigation by its late agent at Cairo, whose irregularities were referred to in the report for 1892, and, although there may be an appeal, judgment in the suit has been given in the Company's favour. The business in the past year has continued to make satisfactory progress, and a fair share of miscellaneous electrical work has been obtained, the profit from this source showing a considerable improvement on previous years.

Norwich Electricity Company (Limited).

The annual meeting of this Company was held on Wednesday at Norwich. Mr. F. W. Harmer presided.

The report of the Directors stated that the great progress and increasing prosperity of the Company is highly satisfactory and has reached a dividend-paying stage within fifteen months of the commencement of its operations. At the end of 1894 the Company had six engines and three boilers at work, compared with three engines and two boilers a year before, and owing to the continued demand for current the present machinery will not be sufficient to carry the station on through the coming winter. The amount of current produced during the first eleven weeks of the present year shows the gratifying increase of 8½ per cent. on the corresponding period of 1894. At present the Company has nearly 4¾ miles of mains. Much credit is due to the engineer and the staff for the efficient manner in which the business of the Company has been carried out during the past year. The result of last year's trading, after paying station and office expenses and interest due to the bank, shows a net profit of £1,356. 11s. 4d., to which must be added £237. 9s. 10d. the balance brought forward from last year, making a total of £1,594. 1s. 2d. standing to the credit of the profit and loss account. Out of this the Directors propose to wipe off the preliminary expenses, £382. 4s. 2d., and to place a sum of £400 to a reserve fund for machinery renewals, leaving £811. 17s. available for a dividend of 3 per cent., free of income tax, for the year 1894, and to carry forward £112. 5s. 8d. The time has now come to invite applications from the shareholders and the public either for further Ordinary shares or for Four per Cent. Mortgage Debentures, a limited number of which the Directors propose to issue.

The CHAIRMAN, in moving the adoption of the report, said the Company had given great satisfaction to its patrons, not a single customer who had once adopted their service having given it up. They were under a great debt of obligation to Messrs. Laurence, Scott and Co., whose plans in the main the Company had adopted. Whilst the Company had made the most rapid progress, there was one point which had caused them some surprise, and that was the failure of the Company to establish their service in many private houses. Personally, he thought a demand would be created if a little time were allowed. He was astonished that people were still so ignorant of the laws of health as to refuse to adopt the most healthy and useful system of lighting now known. Notwithstanding this, the great success of the Company made it necessary for them to issue more capital. The Directors had not cared to ask the public for money until they had proved beyond a doubt that the Company was going to succeed. They proposed to issue debentures as well as Ordinary shares, and as there was £40,000 at the back of them, it would be seen that the investment would be as secure as the bonds of the Norwich Corporation. Mr. Harmer concluded by warmly complimenting the electrical firm and its manager, Mr. Long and his staff, for the way they had carried out the work entrusted to them.

The report was adopted.

The two retiring Directors (Messrs. Harmer and Buxton) were re-elected, and £105 was voted to the Chairman as a slight recognition of the value of his services to the Company.

Eastern Extension, Australasia, and China Telegraph Company.

The report of the Directors of this Company for the half-year ended December 31st last, to be submitted to the forty-third ordinary general meeting, to be held at Winchester House on Wednesday next, May 1st, at 2 o'clock, states that the gross receipts, including Government subsidies, have amounted during the half-year to £261,322. 14s. 6d., against £251,698. 10s. 6d. for the corresponding period of 1893. The working and other expenses, including £29,791. 6s. 8d. for cost of repairs to cables and expenses of ships, absorb £89,740. 14s. 9d., against £76,574. 15s. 6d. for the corresponding period of 1893, leaving a balance of £171,581. 19s. 9d. From this are deducted £4,584. 17s. 2d. for income tax, £31,895 for interest on debentures, debenture stock, and contribution to sinking fund, and £1,372. 9s. for celebrating the Company's twenty-fifth anniversary, leaving as the net profit for the half-pear £133,729. 13s. 7d., which, with £68,457. 2s. 2d. brought forward from the previous half-year, shows an available balance of £202,186. 15s. 9d. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another like amount on May 2nd, making a total dividend of 5 per cent. A bonus of 4s. per share, or 2 per cent., makes up a total distribution of 7 per cent. for the year 1894. The balance of £89,686 15s. 9d. has been carried to the general reserve fund, which, after being credited with interest received during the half-year and profit on sale of investments, and debited with £100,000 part cost of the new Singapore-Hong Kong cable, now stands at £641,598. 13s. 3d. Three hundred and eighty-nine of the Company's Five per Cent. Australian Government Subsidy Debentures, amounting to £38,900, were drawn on the 1st inst. for payment at par on July 1st next.

The Directors regret to record the death, on November 29th last, of their esteemed colleague the Right Hon. Viscount Monck, who was associated with the Company from its inception. It is not proposed to fill the vacancy.

The Company's maintenance ships have, as usual, been employed on various cable repairs during the half year under review, but owing to most of the cables being duplicated, the revenue has in no instance been materially affected.

Since the close of the December half-year an Inter-Colonial and Telegraph Conference has been held at Hobart, at which the contemplated withdrawal by the Government of Victoria from the tariff guarantees entered into with the Company was discussed, with the result that it was decided to continue the same, with certain modifications, for a fixed period of at least five years from May 1st next.

Mr. C. W. Earle and Mr. G. E. Nicol will offer themselves for re-election as Directors, as will the retiring auditors, Messrs. Deloitte, Dever, Griffiths and Co. and Messrs. Welton, Jones and Co.

Oriental Telephone and Electric Company (Limited).

Report of the Directors of this Company for the period ended December 31st last, to be presented at the first annual general meeting, to be held at Cannon-street Hotel, London, E.C., on Monday next, the 29th inst., at one o'clock :—

The shareholders will recollect that the Company was formed on March 12, 1894, to take over the property and assets of the old Oriental Telephone and Electric Company (Limited), the object in view being a re-arrangement of the capital account of that Company. In order to avoid any dislocation of the business and complexity of accounts, the latter have been continued as from December 31, 1893, the result being a net profit for the year of £8,729. 4s. 9d. As was intimated to the shareholders at the meeting held on March 12, 1894, a dividend on the present occasion can only be declared for the period from the date of incorporation of the Company to December 31, 1894. Under the advice of the auditors, therefore, the Directors have apportioned £7,031. 4s. 6d. of the above sum as being the profit available for disposal, which they propose to deal with as follows: To write off the whole of the preliminiary expenses, £453. 17s. 10d.; pay a dividend at the rate of 4½ per cent. per annum, free of income-tax, £5,871. 1s. 5d.; and carry forward £706. 5s. 3d.

The general business of the Company has, on the whole, been satisfactory, and the electric lighting branch inaugurated by the old Company shows prospects of assisting the revenue of the Company in the early future.

The Bengal and Bombay Telephone Companies have paid improved dividends for the past year, whilst the Telephone Company of Egypt, the capital of which is almost entirely held by your Company, has made good progress. The accounts of the China and Japan Telephone Company have not yet been closed; but, owing to the low rates of exchange ruling, the net revenue of that Company, after payment of debenture interest, will show less favourably than in the previous year.

The two retiring Directors are Mr. W. Addison and Mr. T. Lloyd, who seek re-election, as do the auditors, Messrs. Deloitte, Dever, Griffiths and Co.

Submarine Cables Trust.

The following report of the trustees for the financial year to April 15, 1895, will be presented to the twenty-fourth ordinary annual meeting of the certificate holders, to be held at the offices, Winchester House, Old Broad-street, London, E.C., on May 2nd, at 1 o'clock :—

The revenue, including the balance of £240. 7s. 1d. brought from the previous accounts, amounted to £21,704. 17s. 1d., and during the year the coupons due on April 15, 1894, October 15th, and April 15, 1895, were paid as follows: £1. 5s. balance July 13, 1894. £1. 15s. on account October 15th, £1. 5s. balance February 1, 1895, and £1. 15s. payable April 16th. The expenses of the Trust amounted to £1,194. 5s. 8d., and the payments on account of the coupons to £20,286, together £21,480. 5s. 8d., leaving a balance of £224. 11s. 5d. to be carried forward. A table showing the original and present investments of the Trust is appended to the report, and shows that they remain unchanged since last year.

The trustees regret to report the death of their colleague, the Right Hon. Viscount Monck, who was one of the original founders. The auditors, Mr. John G. Griffiths and Mr. John Gane, offer themselves for re election at the meeting.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1895, pages *304-332, &c. &c.*]

BATTERY AND MOTOR COMPANY (LIMITED).—With regard to the notice which appeared in this column in our last issue, we are informed that the Electric Battery Company did not proceed to allotment. The patents and property were taken over by the Battery and Motor Company, who have taken large works at Bower-road, Victoria Park, N.E.

CHESHIRE ELECTRIC AND STEAM YACHT COMPANY (LIMITED).—This Company was registered on April 16th with a capital of £2,000. in £1 shares, to undertake the conveyance of passengers and goods in launches, yachts, &c., to be propelled by electric or other motive power, purchase, hire or build yachts, launches, or other suitable vessels, with all requisite equipments, dynamos, engines, &c. Offices, 7, Baltic-buildings, Redcross-street, Liverpool.

GENERAL TRACTION COMPANY (LIMITED).—This Company was registered on April 20th, with a capital of £50.000, in shares of £5 each, to enter into an agreement between the Electric and General Contract Corporation (Limited) and this Company, or its representative to carry out contracts or concessions in any part of the world for making, purchasing or working railways, tramways, telegraph and telephone lines, electric and other lighting works, electric, hydraulic or other works, and for the equipment of such works with electric or other plant, and to construct, maintain and work railways, tramways, telegraphs, telephones, &c. The subscribers, with one share each, are Edmund A. Hopkins, William S. Graff Baker, Alfred de Turckheim, Richard B. Johnson, Edward T. Church, Arthur W. Lawson, and Edgar Wyatt. The first Directors are to be nominated by the subscribers.

MANCHESTER SUBURBAN ELECTRIC SUPPLY COMPANY (LIMITED).—This Company was registered on April 22nd, with a capital of £25,000, in £1 shares, to take over a transfer from the Collier-Marr Telephone and Electrical Manufacturing Company (Limited) of a Provisional Order granted to that Company, authorising them to produce, store, supply and sell electricity, for public and private purposes, within the urban sanitary district of Moss Side, and to construct and erect the necessary plant and apparatus for carrying out the objects of the Order, laying mains, making connections, &c. The subscribers, with one share each, are Joseph Nasmith, William Wilson, George Hadfield, William G. Thompson, John Lawson, John Thompson, James Nuttall. The first Directors are Joseph Nasmith, Thomas Parker, and Edward J. Piper. Office, 8, South King-street, Manchester.

ELECTROPHONE (LIMITED).—The statutory return of this Company, made up to July 13, 1894, was filed on March 30th last, when only the even signatories' shares were taken up out of a nominal capital of £20,000 in £5 shares, and nothing is called thereon. The first annual return, made up to March 28th, was filed on April 2nd, when 1,584 shares were taken up, of which 500 have been issued as fully paid. On each of the remainder, calls amounting to £2. 5s. have been made, £1,008. 10s. has been paid, leaving £1,430. 10s. in arrears.

EUROPEAN SIMS-EDISON ELECTRICAL TORPEDO COMPANY (LIMITED). The annual return of this Company, to January 14th, has been filed. The nominal capital is £201,040, divided into 10,000 Ordinary shares of £20 each, 1,000 Founders' shares of £1 each, and 40 Preference shares of £1 each; 7,880 Ordinary and all the Founders' shares have been taken up, and 7,350 Ordinary have been issued as fully paid. The full amount has been called on the remaining Ordinary and the Founders' shares, resulting in the receipt of £10,458, and leaving £1,142 in arrears. Since the filing of the return the Company has passed a resolution for voluntary liquidation.

HARGREAVES AND SHAW (LIMITED).—An agreement has been entered into by this Company with Ellis Hargreaves and Ellis J. Hargreaves, electrical engineers, of Ashton-under-Lyne, for the sale to the Company of the business of electricians and mechanical and electrical engineers, carried on by them at the Atlas Works, Ashton-under-Lyne, for £450, to be satisfied by the allotment of 45 fully-paid shares to each of the vendors.

CITY NOTES.

AFRICAN DIRECT TELEGRAPH COMPANY (LIMITED).—The fourth drawing for payment of 115 of this Company's Four per Cent. Mortgage Debentures will take place on Wednesday, May 1st, at 3:30 p.m., at the offices of the Company, Winchester House, London, E.C., and the second drawing for payment of 14 of the Company's Four per Cent. registered Debentures (series "B") will take place on the same date, at the same time and place.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended April 21st, were £856, as against £886 in the corresponding period of 1894, being a decrease of £30. The total receipts for the half-year amount to £15,219, against £14,613, an increase of £606.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The revenue return of the Company for the quarter ended March 26, 1895, is as follows:—Sale of current for public lighting £3,191, against £3,100 in the corresponding period of 1894; private lighting, &c., £26.622, against £12,460; other sources, £340, against £404—total, £30,153, against £15,964, an increase of £14.189. The increase in lamps connected during the quarter ended March 26, 1895, was equivalent to 13,134 8-c.p. lamps, against 19,293 8-c.p. lamps in the corresponding period of 1894.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announce the payment by warrants on May 1st of interest for the half-year ending April 30th on their Four per Cent. Mortgage Debenture Stock. The transfer books will be closed from April 26th to May 1st, inclusive.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY (LIMITED).—This Company announce the payment by warrant on May 1st of interest on their Four per Cent. Mauritius Subsidy Debentures for six months to April 30, 1895. The transfer books will be closed from April 26th to May 1st, inclusive.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ending 21st inst. amounted to £1,386. The amount for the corresponding week last year was £682.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the week ended April 19th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,808.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have decided to recommend to the forthcoming meeting of shareholders a dividend of 6s. per share on both the First and Second Preference shares of the Company, for the six months ended December 31st last.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Apr. 17.		Price Wednesday, Apr. 24.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Apr. 24.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	10 0	Anglo-American ... xd	41	43	44	46	4 7 0	Jan., Apr., July, Oct.	44	..
£2,993,560	Stock	20 0	Do. Preferred ... xd	78½	79½	82	83	4 15 5	,, ,,	82¾	79
£2,993,560	Stock	5/0	Do. Deferred	6¾	7¼	8¼	8¾	..	..	8¼	7
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 17 8	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	12¼	12¾	12¼	12¾	5 2 0	Mar., June, Oct., Dec.	12⅝	12 7/16
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	110	114	110	114	4 9 3	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	148	152	148	152	4 12 1	Jan., Apr., July, Oct.	150	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	,, ,,	..	..
12,931	5	2/0	Direct Spanish (fully paid)	4	4½	3½	4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9½	10	9½	10	5 0 0	,, ,,	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	8¾	9¼	9	9½	4 4 3	Jan., Apr., July, Oct.	9½	..
400,000	10	2/6	Eastern	16½	16¾	16½	16¾	3 19 6	,, ,,	16¾	16½
70,000	10	6%	Do. 6 per Cent. Preference	17¼	17¾	17¼	17¾	3 7 7	,, ,,	..	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	123	126	124	127	3 4 0	May and November	126	125
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	108	105	108	4 13 8	February & August	..	..
250,000	10	2/6	Eastern Extension	17½	17⅞	17½	17⅞	4 0 8	Jan., Apr., July, Oct.	17⅞	17½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	123	126	123	126	3 3 6	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	107	103	107	4 14 9	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	103	107	4 14 9	,, ,,	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106	109	106	109	3 15 6	February & August	..	—
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 10	May and November	115	..
180,227	10	2/3	Globe Telegraph and Trust	9¾	10	9¾	10½	4 8 11	Jan., Apr., July, Oct.	10½	9¾
180,042	10	6%	Do. 6 per Cent. Preference	16⅝	16⅞	16⅝	16⅞	3 11 3	,, ,,	16⅞	16⅝
150,000	10	5/0	Great Northern	22	22½	22	22½	3 15 7	Jan., April, and July	22½	22½
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	106	
17,000	25	12 6	Indo-European	52	54	51	53	4 14 4	May and November	53	52½
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	105	109	105	109	5 11 1	March & September	..	—
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	105	108	3 15 2	..	..	—
11,839	8	4/0	Reuter's	4	5	4	5	..	April and October	..	.
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	120	125	122	127	4 14 6	,, ,,	123	122½
15,609	10	5/0	West African Telegraph	4	5	4	5	..	January and July	..	—
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	101	104	4 16 10	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	.	—
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	98	103	7 15 4	June and December	99½	..
88,321	10	6d.	West India and Panama	1	1½	1	1½	..	..	1½	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	11	11½	11	11½	5 4 4	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	109	112	109	112	4 10 8	June and December	..	..
64,242	15	3/0	Western and Brazilian	9¾	10¼	9¾	10¼	4 9 5	May and November	10	..
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	—	6¾	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	3¾	4¼	3¾	4¼	..	..	4⅛	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 16 3	February & August	..	—
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 16 3	,, ,,	..	—
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115	120	115	120	6 0 2	May and November	..	—
£166,000	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	101	103	101	103	5 17 8	March & September	..	—
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	—	..	..	..
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	—	May and November	..	—
171,504	£1	..	Oriental Telephone and Electric (fully paid)	3/16	¼	3/16	¼	..	Yearly	—	..
484,597	5	2/6	National	5¼	5½	5¼	5⅝	4 13 0	June and December	5 7/16	5¼
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15½	16½	15½	16½	3 12 9	,, ,,	16¼	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	,, ,,	15¼	15 1/16
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¾	6	5¾	6	4 3 4	—	6	5¾
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	104	105	3 6 8	January and July	105½	104½
68,000	5	1/0	United River Plate	1	2	1	2	..	,, ,,	..	—
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	85	90	85	90	5 9 11	,, ,,	—	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	13	14	13	14	1 15 8	—	13 11/16	13½
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15	15½	15	15½	3 17 5	..	15 3/16	15½
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 18 6	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5	5½	5	5½	3 17 9	—	5½	5⅜
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		—	—	..	—
8,322	£5	..	House-to-House Electric	..		..		..	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		—	—	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		—	January and July	—	—
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7½	7¾	7½	7¾	—	—	..	—
111,000	5	..	London Electric Supply	..		..		—	—	..	—
49,900	£10	5/0	Metropolitan Electric Supply (fully paid)	9¾	10¼	10	10½	2 7 7	..	10½	10
£150,000	Stock	4½%	* Do. 4½% Debs.	118	120	118	120	3 15 11	June and December	..	—
6,152	£10	2 0	Notting Hill Electric	7¼	7¾	7¼	7¾	..	..	..	..
19,980	£5	4/0	St. James and Pall Mall	7½	8	7½	8	..	..	7¾	7½
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8½	9	3 17 9	—	8 15/16	8¾
59,900	5	5%	Westminster Electric Supply (fully paid)	7⅝	7⅞	7⅝	7⅞	3 3 6	—	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2½	2¾	2½	2¾	6 6 7	—	2 9/16	2½
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2¾	2¼	2⅝	4 16 0	.	2⅜	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	113	1 6	113	116	3 18 1	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2½	3	2½	3	—	January and July	..	—
12,139	5	—	Edison and Swan United	1⅝	1⅞	1⅝	1⅞	—	..	..	—
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		..	..	—	—
120,000	2	..	Electric Construction	¼	½	¼	½	—	..	—	..
12,845	2	2 9¾	Do. 7 per Cent. Cumulative Pref.	1¼	1¾	1¼	1¾	—	..	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1¼	1½	1¼	1½	—	..	..	—
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	..	1½	..
60,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	February & August	22½	21½
£210,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	101	1 3	101	103	4 7 7	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	—	..	..
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	⅛	—	⅛	..	..	..	..
37,370	12	30/0	Telegraph Construction and Maintenance	39	41	39	41	8 15 7	March and July	40½	39¾
£150,000	100	6%	Do. 5 per Cent. Bonds	105	108	106	109	4 11 9	January and July	107	..
37,511	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	.		..		..	.	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,870	10	12/0	W. T. Henley's Telegraph Works Ordinary	9½	10½	9½	10½	5 11 3	..	..	..
£30,000	10	..	Do. Preference	..		..		..	..	..	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1½%	City and South London Railway	45	47	45	47	2 13 2	May and November	—	..
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	..	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	130	133	130	133	3 0 2	May and November	..	..
37,500	£10	2%	Liverpool Overhead Railway	8 1/16	8 3/16	8⅝	8⅞	2 5 1	..	..	..
6,295	10	6%	Do. 5% Preference	14	14½	14	14½	3 11 5	..	..	..
125,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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